



Procedure for Hydrogen Sulphide

AZSPU-HSSE-DOC-00066-2

This number supersedes **UNIF-HSE-PRO-201-C1**

Authority:	AzSPU Safety & Compliance Systems Manager	Custodian:	Safety Systems/CoW Lead
Scope:	AzSPU	Document Administrator:	Document MS Coordinator
Issue Date:	12 October 2004	Issuing Dept:	Safety & Compliance Systems
Revision Date:	25 January 2011	Control Tier:	2
Next Review Date:	14 February 2011		

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1. PURPOSE / SCOPE

1.1 PURPOSE

This Safe System of Work contains the information and guidelines necessary to assist in reducing the risks encountered when working with Hydrogen Sulphide to as low as reasonably practicable.

1.2 SCOPE

The contents of this procedure are applicable to all BP owned and managed sites / installations in Azerbaijan and Georgia. Contractors working on BP owned or managed sites / installations are also responsible for alignment with this procedure.

This document does not replace the procedures prepared and adopted by specialist contractors. Neither does it supersede any national regulatory requirements.

This procedure contributes to compliance with Group Control of Work (CoW) standard that the Hazards associated with BP activities are identified and that the risks are assessed and managed.

All guidelines contained shall be regarded as the minimum requirements for BP owned or managed sites / installations in Azerbaijan and Georgia.

The scope covers defined activities of BP and Contractors at all BP AzSPU sites and installations.

For detailed procedures to be followed during drilling, well testing and well servicing operations, refer to the BP Drilling Operations Guidelines (EUR-D-001), Hydrogen Sulphide (H₂S) Procedures.1120/GEN.

2. DEFINITIONS

Refer to document [AzSPU-HSSE-DOC-00021-2](#) HSE Definitions for definitions common to this Procedure. Definitions specific to the Procedure are included below.

SM	Site Manager
SC	Site Controller
OIM	Offshore Installation Manager
AA	Area Authority
PA	Performing authority
TRA	Task Risk Assessment
H ₂ S	Hydrogen Sulphide
PSA	Production Sharing Agreement
ALARP	As Low as Reasonably Practicable
CoW	Control of Work
UTG	Upstream Technology Group
SRB	Sulphate Reducing Bacteria
PPM	Parts Per Million
Mg/l	Milligrams Per Litre
LEL	Lower Explosive Limit
AGT	Authorised Gas Tester

ERT	Emergency Response Team
OES	Occupational Exposure Standard
LTTEL	Long Term Exposure Limit
STEL	Short Term Exposure Limit
TWA	Time Weighted Average

3. GENERAL REQUIREMENTS

3.1 BP AZSPU REQUIREMENTS

It is a company requirement that all tasks are subjected to an assessment of risk to demonstrate that risks have been reduced to as low a level as reasonably practicable (ALARP). This can be achieved by complying with the BP existing standards. Where compliance with BP standards cannot reasonably be achieved, a formal level 2 Risk Assessment will be undertaken to identify any additional controls and demonstrate that risks remain as low as reasonably practicable, whether by compliance with BP Standards or through level 2 Risk Assessment.

- Operating Management System OMS Essentials 3.2.1 and 4.5.1

3.2 LEGISLATION & STANDARDS

This procedure complies with applicable national law. Applicable national law is national law as amended by project specific agreements, e.g. the ACG Production Sharing Agreement (PSA), and relevant International Conventions, if any, in force in Azerbaijan or Georgia, as applicable.

In the absence of national legislation, or where national legislation is inconsistent with the requirements of project specific agreements, BP Group Standards or applicable requirements from UK or US legislation will be complied with.

Where requirements conflict, legal advice has been obtained and a defensible compliance position adopted.

The standards and practices contained in this procedure are consistent with those internationally recognized within the petroleum industry.

3.3 STOPPING UNSAFE WORK

To stop the continuation of potentially unsafe work at the earliest possible stage, the Control of Work (CoW) Policy and this procedure for Hydrogen Sulphide make it very clear that all personnel are obliged and have the authority to “**STOP**” the work that they consider to be unsafe.

3.4 DEVIATIONS

This procedure is written in sufficient detail that it should be able to be applied consistently at all sites / installations. There may still be the requirement for some local rules covering site / installation specific logistical/administrative arrangements and local variations in responsibilities to reflect differences in organisational arrangements. These local rules should not deviate from the core processes within this document. Any form of deviation from this procedure, including but not limited to local rules, shall be requested and authorised in accordance with SSOW, Deviations from Regulations and Procedures (Doc. No: [AZSPU-HSSE-DOC-00011-2](#)).

3.5 LANGUAGE FACILITATION

Due to the various languages spoken at sites / installations, there is a necessity to assist all with “an ease of understanding”.

4. RESPONSIBILITIES

4.1 SITE MANAGER (SM) / SITE CONTROLLER (SC) / OFFSHORE INSTALLATION MANAGER (OIM)

The Site Manager / Site Controller / Offshore Installation Manager shall be responsible and accountable for the application of this procedure in his area of responsibility. He shall ensure:

- That adequate number of Competent responsible persons are appointed to manage and maintain the requirements of this procedure
- The assessment and management of health risks on the site / installation
- Review of Risk Assessment findings and recommendations
- Systems are in place to implement and track the actions resulting from the Risk Assessment
- Sufficient monitoring systems and equipment is in place and there is adequate equipment available on site e.g. BA.
- Such mechanisms are in place to communicate the findings, recommendations and requirements of the Hydrogen Sulphide Risk Assessment to all relevant personnel (including contractors, visitors, etc).

4.2 AREA AUTHORITY (AA)

Area Authorities shall ensure that:

- Hydrogen Sulphide Risk Assessments are carried out before any related tasks are undertaken or begun where H₂S may be present
- Personnel working under their supervision are aware of the risks involving Hydrogen Sulphide and are aware of the necessary precautions.
- Personnel working under their supervision are trained in the use of monitoring devices and other protective systems.

4.3 HSE MANAGER

The HSE Manager is responsible for:

- Maintaining this Safe System of Work
- Ensuring Company training programmes comply with the requirements of this Safe System of Work

4.4 HS&E ADVISORS

HS&E Advisors are responsible for providing technical support, guidance and advice, whenever required.

5. HYDROGEN SULPHIDE HEALTH & SAFETY REQUIREMENTS

5.1 HYDROGEN SULPHIDE DESCRIPTION

5.1.1 Where Hydrogen Sulphide Can Occur

Hydrogen Sulphide can occur naturally:

- In crude oil and gas
- During the decomposition of organic materials, including sewage
- In de-oxygenated seawater, which encourages the growth of Sulphate Reducing Bacteria (SRB)

In addition, Hydrogen Sulphide can be produced as a by-product:

- While processing hydrocarbons that contain Sulphur
- From the chemical action of acids on metallic sulphides; for example, during the chemical cleaning of equipment containing Iron Sulphide deposits.

H₂S is generated by bacteria in seawater, which thrives in conditions of oxygen deficiency and, together with organic materials as a nutrient, reduces the sulphate in seawater to hydrogen sulphide

5.1.2 Properties and Characteristics of Hydrogen Sulphide

Principle characteristics of H₂S are:

- Highly toxic, colourless, flammable gas which, in relatively low concentrations, can quickly cause unconsciousness
- Approximately 20% denser than air and therefore can accumulate in depressions around an area where the gas is present
- Has an auto-ignition temperature of 260° C, is flammable in the range of 4.3% to 45% volume in air and burns with a blue flame to produce sulphur dioxide, which is also toxic
- Is highly corrosive to certain metals. In particular, materials containing copper should never be used due to the possibility of an explosive reaction with H₂S
- In air, concentrations are measured in parts per million (ppm) on a volume-to-volume basis. In water, concentrations are measured in milligrams per litre (mg/l)

5.1.3 Toxicity

Warning: Hydrogen Sulphide is highly toxic and can cause unconsciousness and death at quite low concentrations.

Hydrogen Sulphide is an irritant and an extremely toxic gas, between five and six times as toxic as Carbon Monoxide. After exposure to Hydrogen Sulphide, symptoms usually begin immediately:

- **Lower level exposure** causes irritation of the eyes, nose and throat

- **Moderate exposure** levels can cause headaches, dizziness, nausea and vomiting as well as coughing spasms and breathing difficulties within 15 minutes
- **Higher exposure** levels can cause shock, convulsions, coma, and damage to the heart, brain damage and death.

Very low concentrations of Hydrogen Sulphide can be detected by the offensive odour of rotten eggs. However, personnel working in areas where Hydrogen Sulphide is present may become accustomed to the smell because prolonged and repeated exposure will cause the sense of smell to tire (not being able to smell it, may mean that concentration of H_2S has increased, not decreased). Higher concentrations of Hydrogen Sulphide can paralyse the sense of smell immediately and cause rapid loss of consciousness. Death may result within minutes unless the casualty is moved to fresh air and resuscitated.

5.1.4 Corrosiveness

Hydrogen Sulphide is highly corrosive, especially in association with moisture or oxidizing gases such as Oxygen and Carbon Monoxide. Iron and steel are particularly vulnerable.

Corrosion mechanisms associated with Hydrogen Sulphide include:

- General corrosion
- Pitting
- Crevice corrosion, including Sulphide Stress Corrosion Cracking which can lead to sudden and catastrophic failure
- Hydrogen induced cracking, also known as hydrogen embrittlement

Any equipment likely to be exposed to Hydrogen Sulphide must be made of appropriate materials, constructed and operated to take account of these corrosion problems.

5.1.5 Pyrophoric Scale

Carbon steel lines and equipment that carry gas or liquids containing hydrogen sulphide may develop a layer of pyrophoric scale (iron sulphide) on their internal surfaces. When these lines or equipment are opened up to atmosphere, oxygen from the atmosphere will react with the pyrophoric scale to produce spontaneous burning. If hydrocarbons or other combustible substances are present during this reaction, an explosion may result.

Warning: A by-product of this oxidising process is Sulphur Dioxide, which is also toxic.

Whenever such lines and equipment are opened up to atmosphere, their internal surfaces should be doused thoroughly with water or blanketed by steam in order that any pyrophoric scale is rendered harmless.

Warning: Equipment and pipe work that has been on sour-gas duty (i.e. contains more than 0.5% by weight of H_2S) should only be opened in one place at a time unless the pyrophoric scale has been thoroughly wetted. Opening the system in more than one place can cause through drafts capable of igniting the scale.

If the introduction of water is not permissible, either due to corrosion potential or the risk of freezing, a nitrogen purge followed by a further purge with a mixture of 5% oxygen in nitrogen will allow controlled oxidation.

Pyrophoric scale that has been removed from lines and equipment shall be placed in a drum and immediately covered with water. It must then be disposed of by:

- Burying or burning in a suitable area as determined by legislation (onshore situations)
- Slurrying with water and storing in sealed drums, clearly marked 'PYROPHORIC SCALE', and manifested as dangerous goods and sent onshore (offshore situations).

Apart from the hazards to personnel, H₂S also poses a risk of sulphide corrosion and hydrogen embrittlement to metals. Protection methods for metals are detailed in BP Hydrogen Sulphide Technical Safety Aspects Guidance Note GN 91/30 (refer to BP Engineering Standard GS 136-1).

5.2 HYDROGEN SULPHIDE DETECTION KNOWN H₂S AREAS

5.2.1 Known H₂S Areas

In cases where H₂S is known to be present or may be present in well fluids, appropriate measures shall be provided to prevent exposure of personnel to this hazard.

Procedures, especially those relating to breaking of containment, confined space entry and gas testing, shall be the principle means of protecting personnel. Portable instruments may be used together with procedures to monitor potential hazards in which personnel are present.

The personnel using and relying on the detection equipment shall be trained in its use.

5.2.2 Hydrogen Sulphide Fixed Detection System

Note: It is BP policy that the protection of site personnel is primarily achieved by the safe working practices defined in this document, not by the use of fixed detectors. However, fixed detection methods may be installed for other reasons.

Areas where an accumulation of H₂S is possible may be monitored by use of **fixed detectors** that react to H₂S and give early warning of its presence. However, these should not be relied on to prove the area is clear of an H₂S hazard. Personnel should not approach an area where such a suspected release has taken place unless they are wearing self-contained breathing apparatus.

Warning: There may also be a risk of ignition and explosion in such a scenario; if the lower explosive limit (LEL) for H₂S or the LEL of other process gases has been reached or exceeded, then personnel should not approach the area. Isolations should be applied remotely.

5.2.3 Hydrogen Sulphide Portable Detection Equipment

Where a specific risk of H₂S has been identified, personnel are recommended to use **portable detectors** or wear **personal electronic detectors** that alarm when H₂S level reaches 5 PPM.

Portable Hydrogen Sulphide monitors must be provided so that in the event of a Hydrogen Sulphide escape, the extent of the danger can be established.

Chemical sampling methods of Hydrogen Sulphide detection are preferred, because they are much more reliable than instruments. It is important to ensure that the detector tubes

used to monitor Hydrogen Sulphide are always within the test expiry date.

Note: Chemical sampling methods are not suitable in certain circumstances; for example, for confirming that clean air has been reached when escaping from a Hydrogen Sulphide hazard.

5.2.4 Areas Not Currently Producing H₂S

In cases of producing sites, which at present do not have H₂S in their well fluids, sampling shall be undertaken at defined intervals in order that any onset of H₂S is established early.

5.2.5 Other Areas

Appropriate measures shall be provided for non-process systems/areas, which have the potential to produce H₂S. These measures shall be determined by suitable risk assessment.

5.3 HYDROGEN SULPHIDE PRECAUTIONS

5.3.1 Classification of H₂S Risk Areas

Warning: Notices warning of the presence of H₂S and stipulating access requirements must be posted at the perimeter of medium and high-risk areas, and at every access point.

5.3.1.1 High Risk Areas

High risk areas are those areas where Hydrogen Sulphide is likely to be continually present above the 8 hour Time Weighted Average Long Term Exposure Limit of 5 PPM (see *Appendix A*) for long periods during normal operations and where routine monitoring is mandatory.

Note: It is usual BP practice to paint pipe work and vessels containing hazardous concentrations of Hydrogen Sulphide yellow, or with yellow bands.

In areas where H₂S is likely to be encountered, sufficient self-contained (positive pressure) breathing apparatus sets (working sets) shall be kept for all persons normally working in that area. Two full spare air cylinders for each set shall be held in reserve in an open-air safe area. Adequate numbers of 10-minute duration escape sets shall also be provided.)

If the presence of H₂S in the air is suspected or an alarm is activated, personnel must leave the area immediately, if possible heading first 90 degrees to the current wind direction then head upwind to a safe area.

Entry into such areas shall be permitted only under a planned entry procedure and a work permit. Personnel, working in pairs, must wear self-contained positive pressure breathing apparatus or an airline. A standby rescue team must be in attendance.

Consideration should be given to the installation of wind direction indicators (windsocks or flags) in high-risk areas, to aid direction of escape upwind/across wind.

5.3.1.2 Medium Risk Areas

Medium risk areas are those areas where Hydrogen Sulphide may occur during certain

planned operations and maintenance activities and where monitoring is carried out during these operations.

Only authorized persons should enter these areas. Work shall be carried out under permit to work procedures that must list precautions to be taken. The area should be monitored with portable Hydrogen Sulphide detection equipment during these activities.

In both the above cases, it is vital that the source of any H₂S is clearly identified and an assessment made of any potential for deterioration.

5.3.1.3 Low Risk Areas

Low risk areas are those areas where Hydrogen Sulphide is not likely to occur in normal operations, and if it does occur it will exist only for a short time, e.g. system malfunction.

Personnel entering low risk areas must be made aware of the possibility of the presence of Hydrogen Sulphide and the emergency arrangements in force at the site.

5.3.2 Breathing Apparatus Training

All personnel who are likely to work in an environment where there could be potential exposure to Hydrogen Sulphide shall be given **positive pressure breathing apparatus training** (self-contained and air-line sets). Only fully trained personnel shall be permitted to wear breathing apparatus and they must receive local refresher training every six months.

Personnel should be trained where and when to remove breathing apparatus after completing a job since there may still be Hydrogen Sulphide present. They should either remove the set at a remote location or test the atmosphere adjacent to the job first. Personnel's medical evaluation and fit test requirements must be taken into account and met.

Training shall also be given in mouth-to-mouth resuscitation and the use of resuscitation equipment.

On plant where high concentrations of Hydrogen Sulphide are likely, consideration should be given to the use of escape breathing apparatus sets or H₂S respirators. These can either be carried by personnel or located at various parts of the plant.

5.3.3 Contingency Planning

It is not feasible to provide a single plan for every contingency at every site. Plans must be prepared on a site by site basis, and should cover:

- Planning for a Hydrogen Sulphide release
- Personnel training
- Hydrogen Sulphide monitoring.

In addition, sites that have a Hydrogen Sulphide risk must have an alarm system that is understood by all personnel.

If the presence of H₂S in the air is suspected, personnel must leave the area immediately. The Area Authority, following Risk Assessment ([AZSPU-HSSE-DOC-00063-2](#)), accompanied by one other person trained to AGT Level 1 shall don breathing apparatus and investigate, by using suitable test equipment, the concentrations of H₂S in the air.

Upon recognition of an H₂S gas hazard, (e.g. by smell) or on activation of personnel H₂S detectors, as a minimum, the following steps should be incorporated into any response to a H₂S release:

1. Evacuate the area, moving upwind/across wind if possible.
2. If necessary, don an emergency BA escape set to effect safe escape.
3. Do not attempt to rescue other personnel from the H₂S area unless equipped with a full duration BA set (leave it to the rescue team).
4. A person outside the H₂S risk area should oversee personnel working in an H₂S atmosphere or on equipment where H₂S is present.

Reference should be made to Appendix B, for what to do on discovery of an H₂S leak or finding a victim of H₂S exposure. (Any accidents/incidents shall be reported in accordance with [AZSPU-HSSE-DOC-00054-2](#), Accident and Incident Investigation and Reporting Procedure).

5.3.4 Planning for a Hydrogen Sulphide Release

A **site action plan** should be prepared showing the location of safe areas according to prevailing wind conditions. For onshore sites usually three safe Areas will be defined:

- Two areas will be in the open air on opposite sides of the site (so that at least one will be up wind of any incident). These areas shall be used for mustering essential personnel.
- The third area (at a remote off-site location) will be used to muster all non-essential personnel.

On offshore Installations, there should be one suitable Temporary Safe Refuge (TSR) where personnel can withdraw to in the event of a release of H₂S. This area of the facility should have shutoff dampers on the Heating, Ventilation and Air Conditioning (HVAC) system to prevent the ingress of H₂S.

Protective / emergency equipment should be stored or located near to the two Safe Areas used for essential personnel. In addition, in areas where H₂S is likely to be encountered, sufficient self contained positive pressure breathing apparatus sets shall be kept for all persons normally working in that area. Two full spare air cylinders for each set shall be held in reserve in an open-air safe area. Adequate numbers of escape sets shall also be provided.

Where operations are being carried out in a known Hydrogen Sulphide area, and where personnel may be required to wear breathing apparatus, it should be ascertained that personnel have no obvious medical conditions that might endanger their health or performance prior to breathing apparatus training.

5.3.5 Training of Personnel

All personnel shall be informed of the hazards relating to Hydrogen Sulphide and they shall receive instruction in the correct use of any personal safety equipment, Hydrogen Sulphide detectors, warning systems and evacuation procedures.

Information relating to Hydrogen Sulphide safety measures shall be prominently displayed at strategic points around the site / installation.

All personnel working in the crew and rescue team should be instructed in basic first aid procedures applicable to victims of Hydrogen Sulphide exposure.

An **Emergency Response Team** shall be established. All ERT and rescue team members should be instructed in basic first aid procedures applicable to victims of H₂S exposure. Training exercises and drills must be carried out on a regular basis.

5.3.6 Monitoring the Presence of H₂S

Portable H₂S monitors must be provided so that, in the event on an H₂S escape, the extent of the danger area can be established.

H₂S monitors should be set to current occupational exposure limits, i.e. 5PPM.

5.4 HYDROGEN SULPHIDE FIRST AID

Symptoms of acute Hydrogen Sulphide poisoning reduce rapidly when inhalation of the gas ceases. It is therefore vital to get casualties into fresh air and to summon medical aid immediately.

Casualties should be kept at rest. If their breathing is slow, laboured or impaired, artificial resuscitation (mouth to mouth or by the use of a mechanical resuscitator) may be necessary.

Note: Before commencing mouth-to-mouth resuscitation, any gas in the casualty's lungs should be first expelled by pressing down on the chest.

6. DOCUMENTS REFERENCES

This procedure shall, where appropriate, be used in conjunction with this suite of AzSPU Procedures referenced below.

Document Number	Title of Procedure
AZSPU-HSSE-DOC-00011-2	Procedure for Deviations
AZSPU-HSSE-DOC-00060-2	Procedure for Permit To Work
AZSPU-HSSE-DOC-00063-2	Procedure for Task Risk Assessment
AZSPU-HSSE-DOC-00013-2	Procedure for Confined Space Entry
AZSPU-HSSE-DOC-00054-2	Procedure for Incident Investigation
AzSPU-HSSE-DOC-00021-2	HSSE Definitions
AZSPU-HSSE-DOC- 00002-2	Procedure for Control of Work

APPENDIX A: CLASSIFICATION OF PHYSIOLOGICAL RESPONSES TO HYDROGEN SULPHIDE

<http://docs.bpweb.bp.com/dkAzSPU:/content/hse/spu/documents/AZSPU-HSSE-DOC-00127-2>

Revision/Review Log

Revision Date	Authority	Custodian	Revision Details
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Control Tier: <<2>>

Document Number: << AZSPU-HSSE-DOC-00066-2>>

Revision Date: 25 January 2011

Print Date: 2/1/2011

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12 October 2004	CHSSE Manager	Central Safety TL	Initial Issue
30 May 2008	Alan McNulty, AzSPU Central H&S Manager	Abbas Islamov, Central Safety TL	<p>General: Through the Procedure the document numbering for referred procedures has been changed from UNIF to AzSPU.</p> <p>Section 1. Introduction The following are new inclusions to Section 1. Legislation and Standards Company Requirements Stopping Unsafe Work Deviations Document Review SSOW Cross Reference Language Facilitation Considerable changes were made to paragraph 1.2 Scope.</p> <p>Section 3. Roles & Responsibilities 3.1 One point added to SM/SC/OIM responsibilities. The recommended personnel's behavior if H2S is found to be in presence in air is strengthened and made more precise – paragraph 6.1 In addition to Appendix A, new appendix is add as follows: Appendix B – Feedback & Improvements Suggestions.</p>
05 December 2008	Yuliy Zaytsev AzSPU Safety & Compliance Systems Manager	Adalat Mamedov, Central Safety TL	Authority position/name and custodian name have changed to reflect org changes in HSE&TD.
14 August 2009	Yuliy Zaytsev AzSPU Safety & Compliance Systems Manager	Niyaz Mamedov HSE Systems / CoW Adviser	<p>Appendix A – Change of terminology from OES (Occupational Exposure Standards) to WEL (Workplace Exposure Limits)</p> <p>The procedure's numbering is structurally changed in accordance with Standardized Document Control Procedure Template requirements.</p>
25 January 2011	Yuliy Zaytsev AzSPU Safety & Compliance Systems Manager	Elman Shikhkerimov Safety Systems/CoW Lead	<p>Section 1 General Requirements Removed reference to Getting HSE right, Golden Rules and replaced with OMS, Group requirements</p>