Safe Handling of Pyrophoric Material

Procedure

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RECORD OF AMENDMENT

Revision	Section	Amendment
1	General	Replacement in kind. Transferred to corporate template.
1	5	Updated to have consistent wording to other HSE Procedures.

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TABLE OF CONTENTS

1 PURPOSE 5

2 SCOPE 5

3 PROCEDURE 6

3.1 Formation of pyrophoric material 6

3.2 Handling pyrophoric material 8

4 ROLES AND RESPONSIBILITIES 11

5 MONITOR REVIEW AND ASSURE 13

5.1 Monitoring 13

5.2 Review 13

5.3 Assure 13

6 REFERENCE AND COMPLIANCE DOCUMENTS 14

7 ABBREVIATIONS AND DEFINITIONS 15

LIST OF TABLES

Table 3-1: Hazard pictograms for labelling of pyrophoric material 9

Table 4-1: Key roles and responsibilities 11

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1 PURPOSE

The purpose of this procedure is to establish, document and communicate the process for preventing the risk of injury or harm to people who are required to handle pyrophoric material. It also:

- Defines the behaviour and formation of pyrophoric material;
- Ensures that the hazard posed by the build-up of pyrophoric material in process equipment is recognised and controlled;
- Makes personnel aware of the precautions to be taken when handling and managing the risk of pyrophoric material; and
- Provides guiding information for developing and implementing controls to ensure the safe handling of pyrophoric material at Company worksites.

2 SCOPE

This procedure applies to persons working for or on behalf of the Company in situations where the Company has a legal obligation and/or the authority to introduce and implement Health Safety and Environment (HSE) requirements consistent with those required on Company property.

This procedure describes measures to ensure the safe and efficient removal and disposal of pyrophoric material. These measures shall be taken into account when developing facility operating and maintenance procedures and work instructions, and applied as part of the Permit to Work (PTW) process in the Company's Integrated Safe System of Work (ISSOW).

This procedure only covers the pyrophoric material formed in the process equipment due to the presence of a sulphur compound. It does not cover any other pyrophoric compound, chemical, substance, or solid used or stored for any other purpose, for example, as a reagent in the laboratory.

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3 PROCEDURE

3.1 Formation of pyrophoric material

Pyrophoric materials are substances that spontaneously ignite upon exposure to oxygen (oxidisation). The pyrophoric material subject to this procedure is iron sulphide (FeS) which forms by a chemical reaction between a sulphur compound, normally hydrogen sulphide (H_2S) and iron oxide (FE_2O_3), over a long period of time in an oxygen -free atmosphere. Pyrophoric iron sulphide can be formed on the internal surfaces of carbon steel vessels or equipment containing H_2S.

3.1.1 Pyrophoric material hazards

Iron oxide present on the internal surfaces of vessels, pipes or equipment will react with H_2S and form pyrophoric iron sulphide. Pyrophoric iron sulphide can form even at very low H_2S concentrations (< 0.1 ppm) as long as the partial pressure of H_2S exceeds the partial pressure of oxygen in the system.

If pyrophoric material dries out in the presence of oxygen it may spontaneously combust. The reaction is exothermic and causes a rapid increase in temperature that provides enough heat to ignite any combustible material in or around the deposit. Even if hydrocarbon is not present for the pyrophoric material to cause a fire or an explosion, the material can generate enough heat to damage the vessel or equipment. In addition to the fire hazard, pyrophoric material can also decompose into the toxic gas sulphur dioxide (SO_2).

If pyrophoric material is suspected to be present in equipment that normally remains under a liquid while in operation, the liquid shall be emptied very slowly. During the purging process to displace inert gas with air after removal of hydrocarbons, any exposed areas shall be kept wetted to prevent possible drying of pyrophoric material.

3.1.2 Risk assessment

The work group shall conduct a risk assessment to identify the specific control measures required for the handling of hazards associated with pyrophoric material. The type of risk assessment conducted will depend on the complexity of the work and the conditions under which the work is to be carried out. The use of oxidising chemicals for neutralisation or conditioning of the pyrophoric material shall be considered to be a specialist activity. Consequently, any side effects of using such chemicals shall be clearly understood to avoid possible damage to equipment. The neutralisation and conditioning processes require a minimum of two (2) people in attendance.

3.1.3 Pyrophoric material testing

If uncertainty exists whether a certain part of the process may contain pyrophoric materials, samples may be taken, kept in a safe state and sent to an authorised external laboratory for testing. The suspected material shall be treated as pyrophoric until results received from testing determine otherwise.

Testing at a particular point in time shall not be used as indicative of conditions beyond this point – process conditions may change and pyrophoric material form where previous tests have indicated it was not present.

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3.1.4 Control of hydrocarbon processing equipment

The presence of pyrophoric material shall be anticipated in steel piping and items of equipment with internal surfaces that are not coated or where coating may be compromised. The formation of pyrophoric material is highly probable if any rusty powder has formed and settled out in the equipment. Such items of equipment shall not be exposed to the atmosphere until hydrocarbons have been removed and any residual measured to be as close as possible to 0% Lower Explosive Limit (LEL), no higher than 5% LEL.

A task specific risk assessment shall be conducted for each case to reduce the possibility of spontaneous combustion of the pyrophoric material.

The following control measures shall be used as a guide when exposing such equipment to the atmosphere:

- Where equipment that may contain pyrophoric material where the introduction of water is permissible it shall be applied to inhibit the reaction and enable the safe removal of the pyrophoric material (see Section 4.1 below);
- Where the introduction of water is not suitable in certain applications, for example in cryogenic systems due to very low temperatures. The preferred method to stabilise the pyrophoric material is to purge the equipment with inert gas to reduce the oxygen content to 0% and then commence removal;
- Items of equipment that are temporarily out of operation shall be continuously purged with an inert gas to prevent air from entering the equipment;
- If pyrophoric material is suspected to have formed in a vessel where confined space entry is required, then the vessel shall be water flushed extensively, possibly with a surfactant additive to remove material before entry for example: glycol contactors containing structured packing may contain pyrophoric material and this hazard shall be addressed for any work within the vessel; and
- Gas turbine and gas systems which contain "sour gas" (natural gas containing significant amounts of hydrogen sulphide) shall have duplex filters installed on the fuel gas inlet to ensure removal of ferrous sulphide (fine black dust). These filters shall have water-flushing connections which operators utilise for flushing to avoid auto combustion of pyrophoric material when they are opened.

3.1.5 Control of vapour space of sour systems and process systems

The ratio of H_2S/O_2 hydrogen sulphide to oxygen is normally too low within the vapour spaces of a sour or stagnant water system for pyrophoric material to form. However, the following measures could be considered for treating and controlling the formation of pyrophoric material:

- Pyrophoric material can be safely neutralised by using an alkaline based compound called "Pyrisol" which dissolves the iron sulphide and minimises the danger of combustion. This process does not liberate any H_2S hydrogen sulphide and dissolves all wet iron scale and sulphur. By-products of the process can also be disposed of safely;
- Pyrophoric material can be deactivated by reducing the oxygen concentration to below 10% and allowing 24 hours for deactivation to take place. The low oxygen content in the vapour spaces of oily water separators, vent lines, flame arrestors and under gas tight floors will normally ensure that safe deactivation conditions exist; and

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- In vapour spaces that contain a high concentration of H_2S and where oxygen has been absent for a long period of time, it shall be assumed that pyrophoric material has formed. Introduction of air shall only occur after ensuring that the concentration of flammable vapour in the space is below 5% of its LEL before commencing removal as detailed in Section 4.1.

In the case of the Ichthys Project, the potential for the formation of pyrophoric materials will exist in the following processes:

- Offshore: In the Monoethylene Glycol (MEG) regeneration systems, the glycol contactors and the rich MEG storage tanks. All flare, vent and drain systems will have the potential. Possibly flash and fuel gas; and
- Onshore: Equipment in the processes upstream of and in the acid gas removal unit. Specifically these areas include the slug catcher, the amine absorption column, the amine regeneration column, the regenerator reboiler and, to a lesser extent, the mercury removal bed, the amine storage tanks, the amine drain drum and the contaminated acid gas removal unit hydrocarbon drain tank. Drain systems and sumps.

Routine checks shall be performed to monitor the percentage of oxygen in various spaces within these sour systems and measures shall be taken to keep the oxygen levels as low as possible.

3.2 Handling pyrophoric material

3.2.1 Measures for pyrophoric material removal

Pyrophoric material can exist in various forms, for example: as loose scales or as a fine coating. A thorough visual inspection and risk assessment shall be conducted before starting the removal process.

The following control measures shall be considered as a minimum during the removal of pyrophoric material:

- The pyrophoric material shall be kept thoroughly wet with water to prevent it from oxidising;
- Continuous gas monitoring shall be carried out throughout the removal process; and
- Appropriate firefighting equipment shall be readily available throughout the process. Fire extinguishers containing dry powder substances shall be on hand wherever pyrophoric material is present, and a charged fire hose. The PTW system will assist in the selection of appropriate equipment through the risk assessment process.

Note: Do not scrape pyrophoric material in its dry state. The material may give off sparks when struck or scraped.

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3.2.2 Pyrophoric material transport and disposal

Pyrophoric material has been classified as a dangerous good in the Australian Dangerous Goods (ADG) Code (Division 4.2 PG 1) and in the Globally Harmonised System (GHS). This material shall therefore be disposed of as an identifiable consignment. Refer to the Company Waste Management Standard. The minimum measures that shall be taken for the disposal of pyrophoric material are as follows:

- Pyrophoric material shall remain wet, preferably submerged in water or other suitable medium for storage and transportation to the designated safe area for its disposal;
- All pyrophoric material, including debris suspected of containing pyrophoric iron material (even if not confirmed), shall be disposed of in approved watertight containers;
- Any containers used for transporting pyrophoric material shall be clearly identified and shall never be transported together with flammable materials. The container shall also be suitable to transport equipment that may contain pyrophoric material and shall be wrapped in plastic bags to exclude oxygen; and
- The pyrophoric material shall be shipped to an approved waste facility. The Materials and Logistics personnel shall be consulted in this regard.

Table 3-1: Hazard pictograms for labelling of pyrophoric material

Globally Harmonised System (GHS)	Australian Dangerous Goods (ADG) Code
	
Category 1 (Both solid and liquid)	Division 4.2
Remarks: Australia has implemented the GHS for the classification, labelling and safety data sheet (SDS) of dangerous or hazardous goods from 2012 and it will be enforced as mandatory from 1 January 2017. However, both the ADG Code and the GHS are acceptable during this transition period.	

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3.2.3 Personal protective equipment (PPE)

Besides the mandatory personal protective equipment (PPE) required by the Company Personal Protective Equipment Standard, the following special PPE shall be worn by the working party for the handling of pyrophoric material:

Eye Protection: Additional eye protection (safety goggles) shall be considered when handling pyrophoric material. Personal eye and face protectors shall comply with the requirements of AS/NZS 1336 Eye and Face Protection Guidelines and AS 1337 Eye Protectors for Industrial Applications.

Eye Wash: Suitable facilities for quick drenching or flushing of eyes shall be located as near as possible to the workplace for immediate emergency use, flush eyes for a minimum of 15 minutes if exposure occurs.

Skin Protection: Heavy chemical-resistant gloves shall be worn when handling pyrophoric material. Gloves shall comply with AS/NZS 2161.10.3 Occupational Protective Gloves against Chemicals and micro-organisms. Clothing shall be flame and chemical resistant.

Safety Shower: A safety or drench shower shall be available near the worksite. The flushing time in the shower shall be a minimum of 15 minutes.

Respiratory Protection: Respiratory protection shall be worn where there is a risk of exposure to airborne scale or hydrocarbons which may exceed exposure standards during the removal and/or decontamination processes.

Where there is a risk of exposure to airborne pyrophoric material or particles, personnel shall wear a P2 particulate respirator which meets the requirements of AS/NZS 1716 Respiratory protective devices. Where there is a risk of exposure to hydrocarbons, personnel shall wear a full-face respirator fitted with an organic vapour cartridge (A1/P2) with a particle pre-filter.

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4 ROLES AND RESPONSIBILITIES

The key roles and associated responsibilities for activities covered by this procedure are summarised in Table 4-1. All personnel involved in dealing with pyrophoric material which may be present during the maintenance of equipment handling hydrocarbons, shall make themselves fully aware of the associated hazards and required controls defined in this procedure.

Table 4-1: Key roles and responsibilities

ROLES	RESPONSIBILITIES
Permit Holder and Work Group	• Ensure that their work party members are competent to execute the assigned task. • Facilitate a Toolbox Talk involving every member of the work group to ensure that the potential hazards, consequences, controls and conditions applicable to the work are fully understood. • Ensure that all work group members are locked on to the corresponding isolation. • Ensure that the permit is endorsed for that shift prior to work commencing and that it is displayed at the worksite. • Ensure that if the work scope changes, all work is to stop and be reassessed in conjunction with permit authorities. • Ensure that the work described in the risk assessment, the permit and the associated certificates is properly completed and that it accurately represents the activity. • Ensure that the worksite is left in a safe and tidy condition on the suspension or completion of work activities. • Ensure that there is an effective handover of the work at the end of the shift including a status update to the Issuing Authority and the Area Authority. • Formally close (sign off) the permit as work finishes or is suspended at the end of a shift or on completion of the work, and ensure that work group members are informed accordingly.
Team Leader and Work Scope Approver	• Review the proposed location and nature of the work to determine if the work is required or if lower-risk alternatives exist • Appoint a "competent person" (see the definition in Table 7-1 in Section 8) to coordinate the initial planning of the proposed work • Conduct an initial site inspection as part of the detailed work planning • Develop the scope of work, or review the existing scope of work to clearly identify specific work requirements, including the permits for the work, the preparation work, the equipment required and the resources needed • Review and approve, or recommend for approval the safe work method for the proposed work • Assign capable and competent personnel to conduct the proposed work.

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ROLES	RESPONSIBILITIES
Area Authority	• Participate in the work planning and risk assessment as required. • Ensure both potential and identified hazards, precautions and conditions are defined, and agreed controls are implemented prior to the issue of the permits. • Verifying that all precautions specified for the work are implemented by means of a site-check, including the checking of isolations prior to first issue. • Ensure that the work party is working on the specified equipment via placement of an Equipment Identification Tag (EIT). • Endorse all permits within their area of control prior to work starting and at the start of each subsequent shift. • Monitor and control work activities. • Ensure that all work carried out by personnel within their area is covered by a valid risk assessment/permit when required. • Verify, by means of a site-check, that the work is properly completed and the area and equipment is left in a safe condition.
Material and Logistics personnel	• Provide advice on the correct means to safely store, pack and transport pyrophoric material.

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5 MONITOR REVIEW AND ASSURE

5.1 Monitoring

The Vice President HSEQ, Risk & Assurance is accountable for the content and ongoing review of this Procedure as required by the Business Management System Standard.

5.2 Review

The Process Owner or their delegate is responsible for initiating the review process for this document.

5.3 Assure

Compliance with this Procedure shall be monitored in accordance with the Company Assurance Standard.

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6 REFERENCE AND COMPLIANCE DOCUMENTS

The documents listed below are relevant to the execution of this procedure:

- Reference documents (R) are documents referred to in the course of developing this procedure; and
- Compliance documents (C) include all standards, regulatory governance, contracts, business rules or policies applicable to this procedure.

DOCUMENT NAME	R	C	DOCUMENT NUMBER
Policies			
Health, Safety, Security, Environment & Quality Policy		C	0000-AH-POL-70000
Standards			
Assurance Standard	R	C	0000-A0-STD-60031
Permit To Work Standard		C	0000-AH-STD-60023
Personal Protective Equipment (PPE) Standard		C	0000-AH-STD-60034
Waste Management	R	C	0000-AH-STD-60047
Procedures			
HSE (CIC) Inspection Procedure		C	X060-AH-PRC-60002
Guidelines, work instructions, forms and templates			
ALARP Demonstration Guideline		C	C075-AH-GLN-0011
CIC individual Inspection Checklists		C	X060-AH-PRC-60039
Risk Matrix		C	0000-A0-TPL-60003
Reference Legislation and AS/NZ Standards			
Australian Standard AS/NZS 1336, Eye and Face Protection Guidelines		C	AS/NZS 1336
Australian Standard AS/NZS 1337.1 Eye and face Protectors for Occupational Applications		C	AS/NZS 1337
Australian Standard AS/NZS 1716 Respiratory protective devices		C	AS/NZS 1716
Australian Standard AS/NZS 2161.10.3 Occupational Protective Gloves against Chemicals and Micro Organisms		C	AS/NZS 2161.10.3
Australian Dangerous Goods Code		C	Not Applicable
Globally Harmonised System		C	Not Applicable

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7 ABBREVIATIONS AND DEFINITIONS

ABBREVIATION/TERM	DEFINITION
ADG Code	(ADGC or ADG7) is the Australian Code for the Transport of Dangerous Goods by Road & Rail and it is published by the National Transport Commission.
AS	Australian Standard.
AS/NZS	Australian and New Zealand Standard.
Company	Any operation or business activity under the control of INPEX Executive Management in Australia, whether located in Australia or another location (as a branch office).
Competent Person	A person who has acquired, through training, qualification or experience, or a combination of those, the knowledge and skills required to carry out a specified task competently.
EIT	Equipment Identification Tag.
exothermic	In thermodynamics, an exothermic reaction is a chemical reaction or process that releases energy, usually in the form of heat.
FeS	Iron sulphide.
FE_2O_3	Iron oxide.
GHS	Globally Harmonized System of Classification and Labelling of Chemicals. The GHS was developed under the auspices of the United Nations, and is an internationally agreed system of chemical classification and hazard communication through labelling and safety data sheets (SDSs). It was designed to replace the various classification and labelling standards used in different countries by using consistent criteria for classification and labelling on a global level.
H_2S	Hydrogen sulphide.
HSE	Health, Safety And Environment.
ISSOW	Integrated Safe Systems Of Work
JHA	Job Hazard Analysis: A team-based technique that focuses on job tasks as a way to identify hazards before they occur. The JHA process focuses on the relationship between the worker, the task, the tools, and the environment, in order to eliminate or reduce hazards to an acceptable level of risk.
LEL	Lower Explosive Limit. The concentration of a flammable gas mixture in the air below which the propagation of a flame does not occur on contact with an ignition source.

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ABBREVIATION/TERM	DEFINITION
MEG	Monoethylene Glycol.
PG	Pictogram.
PPE	Personal Protective Equipment.
PTW	Permit To Work.
SDS(s)	Safety Data Sheet(s).
Sour Gas	In the oil & gas industry, "Sour" gas is natural gas or any other gas that contains significant amounts of Hydrogen Sulphide (H_2S).

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Electronic Endorsement and Approval

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Name	Title	Date and Time	Action
Jamen Williams	Senior Occupational Hyg	12/06/24 08:25	Endorser
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