# Table of contents

- **Introduction** .......................................................... 3
- **Background** ................................................................... 3
- **What was the purpose of the compliance program?** ............... 4
- **What did the program include?** ......................................... 4
- **What did the program target?** ........................................... 5
- **Results** ........................................................................... 5
- **Discussion** ....................................................................... 7
- **Recommendations** ............................................................ 15
- **Conclusion** ...................................................................... 15
- **Where to from here?** .......................................................... 16
- **Acknowledgements** ............................................................ 16
- **Further information** ............................................................ 17
- **Attachment 1: Program evaluation industry survey results** .......... 18
Introduction

In 2016, Workplace Health and Safety Queensland (WHSQ) conducted a compliance program at 41 bitumen and asphalt plants across Queensland. The aim of the program was to ensure the risk of fire and explosion at these plants is being adequately managed and complies with the requirements of the Work Health and Safety Regulation 2011 (WHS Regulation). This report summarises the activities and findings of the compliance program and includes a number of recommendations for industry to reduce fire and explosion risks at bitumen and asphalt plants.

Health and safety risks associated with constructing bitumen and asphalt pavements (i.e. laying road surfaces in the field) were not covered by this program.

Background

Between 2012 and 2014, there were three dangerous incidents reported involving fires and explosions at bitumen plants in Queensland. In all three incidents, fragments of a storage tank’s shell were thrown throughout the workplace. In one event, fragments were ejected into a neighbouring property exposing on-site and off-site people to imminent risk of harm. Due to its complex composition, bitumen presents unique flammability hazards when held in heated storage tanks. Hazards must be characterised and understood in order to identify and implement the required risk control measures to reduce the risk of fire and explosion so far as reasonably practicable.

Fire and explosion hazards

Bitumen is a highly-viscous petroleum product obtained from crude-oil refining. It is a solid or semi-solid at room temperature which needs to be heated, commonly between 140-190°C, to enable it to be handled as a liquid. These temperatures are usually maintained from initial manufacture to its end use which presents unique circumstances that need to be considered when assessing fire and explosion risks. As a petroleum-industry sourced product, hydrocarbon vapours can be evolved and collect in the confined ullage space of a storage tank or other enclosed containers containing heated bitumen. These vapour-related risks may be influenced by possible variations in the contents of bitumen products depending on:

- the refining process
- whether solvents such as diesel are used to flush pipelines as bitumen moves from tank to tank
- storage and handling temperatures
- the time spent at elevated temperatures including product overheating
- oxygen and moisture content within storage tanks
- the level of degradation.

To establish what guidance is available for industry to characterise the fire and explosion risks and risk control measures, a review of existing industry guidance was conducted on current industry practices to identify gaps that may exist.

Review of existing industry guidance

The duty of a person conducting a business or undertaking (PCBU) under the work health and safety (WHS) legislation is to reduce risks to health and safety of persons so far as is reasonably practicable. PCBUs must take account of the availability and suitability of ways to eliminate or minimise a risk. Knowledge is available in various ways including considering reputable technical standards such as those published by Standards Australia, industry publications and published scientific and technical literature.

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To support the site inspection process and develop a targeted assessment tool, WHSQ undertook a review of existing guidance material (i.e. reputable technical standards) to manage fire and explosion risks in the Queensland bitumen industry. It was found that while there are established Australian Standards on hazardous areas, there was no Australian industry-specific guidance document to address fire and explosion hazards for heated bitumen tanks at bitumen and asphalt plants. The report’s ‘Discussion’ section and ‘Further information’ section provide information on relevant guidance that may be used to address heated bitumen tanks. This gap provides an opportunity for the industry to build on this for local applications (refer to ‘Discussion’ section).

What was the purpose of the compliance program?

The purpose of the program was to:

- evaluate the industry’s ability to identify fire and explosion hazards associated with bitumen products, particularly those stored in heated tanks
- assess the industry’s ability to control fire and explosion hazards
- ensure compliance with applicable WHS legislative requirements
- where applicable, share information with PCBU s about known ways for managing fire and explosion risks.

What did the program include?

The compliance program included 41 specific site inspections of bitumen and asphalt plants across Queensland. A significant component of the program also included engaging with the industry throughout the program development and implementation phases.

Engagement initiatives included:

- initial industry consultation meeting with the industry representative organisation Australian Asphalt Pavement Association (AAPA) to discuss reported incidents, related issues and intervention program proposal
- developing program goals and implementation in consultation with AAPA
- WHSQ project coordinator participating in nationally-recognised bitumen industry training
- engaging with Queensland’s three bitumen importers/suppliers regarding product information and storage and handling practices
- consulting with industry representatives, AAPA and interstate WHSJ jurisdictions to develop an assessment tool and companion guide to support program objectives
- training of WHSQ inspectors via classroom and on-site visits addressing bitumen industry hazards, use of the assessment tool and companion guide
- site inspections conducted by WHSQ inspectors
- program evaluation surveys conducted for both WHSQ inspectors and PCBU s
- feedback presentation session provided to AAPA and its members.

The inspection process

WHSQ inspectors conducted site inspections using a WHSQ-developed assessment tool. The tool covers various WHS regulatory requirements relating to flammability hazards associated with bitumen product tanks and management of the associated risks. It was also converted into a pre-inspection checklist for use by PCBU s prior to WHSQ’s site inspection. Each workplace was given at least two weeks’ notice to prepare for the site inspection.

After the inspection process, WHSQ carried out surveys of all PCBU s and inspectors who participated in the program for program evaluation purposes.

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2 Hazardous area is an established term used to describe areas where an explosive atmosphere may exist such that an ignition source may cause a fire or explosion. Hazardous area is defined in the WHS Regulation 2011 (Schedule 19) and relevant Australian Standards. Where the term ‘explosive’ is used in this report it also means ‘flammable’.
What did the program target?

With the program’s focus on fire and explosion prevention under the WHS Regulation, the following areas were targeted:

- register of hazardous chemicals
- placarding and manifest requirements
- emergency response provisions for bitumen risks
- first aid provisions for bitumen burns
- personal protective equipment (PPE) for handling hot bitumen and hazardous chemicals
- identification of fire and explosion hazards associated with bitumen products - including hazardous area classifications where applicable
- control of ignition sources within hazardous areas - including temperature controls for heated bitumen tanks where applicable
- control of hot work - including responses to bitumen blockages where gas torches are used
- controlling steam explosions in heated bitumen tanks - including any incompatibility risks where bitumen emulsions are also stored on site
- spill containment, impact protection and firefighting equipment for bulk tanks
- inspection, maintenance and testing of bitumen storage and handling systems.

Results

The following is a summary of the outcomes from the site assessments:

- all PCBUs conducted a pre-inspection review using the checklist provided by WHSQ
- 73 per cent of the target areas (questions) in the assessment tool were compliant (60 per cent) or n/a (13 per cent)
- 41 per cent of site assessments identified other non-compliant health and safety matters not included in the target areas of the assessment tool
- no improvement or prohibition notices were issued as a result of the site assessments however, 85 per cent of PCBUs had entered into agreed actions with inspectors to implement improvements
- on average, each PCBU spent approx. $18,000 and 40 hours responding to corrective actions raised during the program.

The highest levels of compliance (> 90 per cent) were:

- first aid equipment specific for responding to bitumen burns
- PPE specific for working with heated bitumen
- documented emergency plan
- safety data sheet (SDS) register
- established temperature controls for heated-bitumen tanks
- administrative controls for managing hot-work activities on-site
- emergency response procedures for spills and fires from bulk tanks.

The lowest levels of compliance were:

- 37 per cent (15) of PCBUs were not able to identify the flashpoint, auto-ignition point or maximum heating temperature for all bitumen products stored on site
- 32 per cent (13) had not carried out or finalised a hazardous area classification
- 29 per cent (12) did not have documented administrative controls for re-heating or re-commissioning bitumen storage tanks that may contain moisture/water (e.g. no reheating or boil-out procedures)
- 18 per cent (7) of workplaces with classified hazardous areas had not recognised these areas in their controls for managing hot work (i.e. not recognised in hot-work permitting procedures)
- 18 per cent (7) required additional impact protection barriers for aboveground tanks or pipework
- 15 per cent (6) did not have documented administrative controls for responding to bitumen blockages
- 15 per cent (6) did not have a proactive system for inspecting, testing and maintaining their aboveground tanks and pipework etc.
It was also found that approximately half of the workplaces (49 per cent) did not use gas torches (e.g. Blu-rays) to respond to bitumen blockages thereby eliminating a potential ignition source at these sites. In addition, approximately half (46 per cent) did not use cutbacks to flush or clean transfer pipelines to bulk bitumen tanks thereby reducing a flammability hazard, particularly for heated tanks.

**Industry feedback**

Industry feedback was received via an online survey conducted in May 2017. All PCBUs involved in the program participated in the survey. The survey consisted of questions to assess a number of aspects including:

- pre-inspection activities
- the assessment tools
- site inspections conducted by WHSQ.

Refer to Attachment 1 for all survey responses. The key findings are below.

Feedback about the pre-inspection activities and tools indicated that:

- two (2) weeks was adequate notice to prepare for WHSQ’s on-site assessment
- opportunity to undertake a pre-inspection review was utilised by all PCBUs with most (90 per cent) using the PCBU’s pre-inspection checklist directly
- feedback on the time spent carrying out pre-inspection reviews was reported as:
  - 20 per cent spent less than half a day
  - 30 per cent spent between half and one day
  - 40 per cent spent between one and two days
  - 10 per cent spent more than two days.

Of particular note, one PCBU had conducted an internal review/audit of each site using the pre-inspection checklist. Corrective actions were implemented which included arranging external hazardous area inspections. The PCBU estimated that approximately 80 man-hours was spent preparing for the regulator’s inspection (across multiple sites).

Feedback on the pre-inspection checklist included positive remarks that it was helpful, well-written, and well supported (e.g. PCBUs were able to contact the program coordinator for further advice in relation to the assessment tool). The pre-inspection checklist was found to have served as a valuable tool to assist PCBUs when engaging specialist services to treat concerns in some areas (i.e. issue identification and scope of works).

PCBUs reported that the three most frequent types of corrective actions they carried out in response to this program were:

- reinforcement of existing isolation and/or engineering controls - 73 per cent of PCBUs
- review of existing hazard identification assessments - 55 per cent of PCBUs
- reinforcement of existing administration controls - 45 per cent of PCBUs.

From a cost-of-compliance perspective, an indicative cost for each PCBU was reported to be on average, approximately $18,000 and 40 hours responding to corrective actions (ranges included $1,000 to $50,000 and 8 to 150+ hours).

The most common WHS changes observed by PCBUs across the industry have been:

- an improved understanding of hazardous area management
- a further focus on the use of cutters (more volatile petroleum products such as diesel) to manage the associated risks.

Feedback from PCBUs was found to be positive in regards to the program objectives and how it was conducted.
This was demonstrated in the survey responses with comments such as:

- Overall a very useful inspection.
- Auditors were open, honest and feedback was positive.
- The inspection was well received and allowed us to improve on-site compliance programs.
- Overall, we were very happy with the audit program.
- I felt that the auditors were genuinely trying to partner with the industry for improvements which was well received.
- Our site is safer for having the program conducted.

In terms of recording outcomes of inspections by WHSQ, a number of PCBs indicated that it would have been beneficial to have received a post-inspection report from each inspector. It was noted that email correspondence was used instead. While this was deemed acceptable, it was noted that more formal documents like inspection reports are more appropriate for a company’s executive group.

There were a number of requests for further information on specific issues such as the relevance of international codes or standards in meeting Queensland WHS requirements, hazardous area classifications (zones), and the associated electrical safety requirements (discussed below).

**Discussion**

The following aims to address a number of specific issues raised during the program and to promote what compliance looks like.

**Should the industry consider the Energy Institute’s Bitumen Safety Code?**

During the issue identification and literature review process, WHSQ identified a lack of local guidance on fire and explosions risks associated with heated bitumen tanks. This lead to a United Kingdom (UK) reference which did address the issue, the Energy Institute, *Model code of safe practice, Part 11, Bitumen safety code (2005)*. However, industry questioned the relevance of an international guide when aiming to meet Queensland WHS regulatory requirements.

Its relevance must be considered in the context of the PCBU’s duty to acquire a state of knowledge about a hazard or risk and ways of eliminating or minimising the hazard or risk. State of knowledge is a relevant matter that must be taken into account when determining whether a risk (e.g. of fire and explosion) has been minimised so far as reasonably practicable under the *Work Health and Safety Act 2011* (WHS Act). While bitumen composition may vary considerably across different markets (i.e. internationally), there are enough similarities in the chemical composition that it is reasonable to accept a UK code or standard to address a similar risk in Queensland, unless it can be demonstrated otherwise. It is not unusual for international standards and codes (e.g. US National Fire Protection Association standards for fire protection systems) to be referred to in helping to manage WHS risks within Queensland. This is more likely in the absence of a more specific standard being available locally to address an issue.

Further information is available in:

- section 18 of the WHS Act³ as it defines ‘reasonably practicable’
- Safe Work Australia (SWA), *Interpretive guideline- Model Work Health and Safety Act, The meaning of ‘reasonably practicable’*⁴ which provides a comprehensive outline of its interpretation and application.

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³ WHS Act 2011 is available at [worksafe.qld.gov.au](http://worksafe.qld.gov.au)

SWA provides a useful discussion on the relevance of standards, including international standards, to the WHS laws in its publication, Information sheet- Australian and other standards⁵.

Other notable international codes, standards and guidelines on bitumen safety include:

- American Petroleum Industry (API) Recommended Practice 2023: Guide for safe storage and handling of heated petroleum-derived asphalt products and crude-oil residua (note: bitumen is known as asphalt in the US).
- Eurobitume (European bitumen industry representative) also provides a range of HSE publications on the safe handling of bitumen, including at storage and handling plants available at eurobitume.eu/publications/documents.

If there is concern within industry about the suitability of an international standard or code as it applies to local conditions, there is an opportunity for industry to develop its own code to address the safe management of bitumen products. For example, specifically targeting heated bitumen tanks at bitumen and asphalt plants that is tailored to Australian conditions and products. It should be noted that the Australian Institute of Petroleum (AIP) published CP20: Code of Practice for Safe Handling of Bitumen Products in 1993 which included advice about avoiding fires and explosions at depots. Unfortunately, when AIP relinquished publication of its various industry codes to Standards Australia in 2006, this Australian industry code was withdrawn and to date has not been re-published. It is recommended that AAPA consider developing a similar code or guidance on managing safety at bitumen and asphalts plants.

Fire and explosion hazards associated with bitumen

Flash point is a physico-chemical property that is used to indicate a chemical’s flammability hazard. Whilst it is an important indicator of a liquid’s fire and explosion risk, particularly at ambient temperatures and pressures, for bitumens stored in heated tanks it should not be the only factor considered. The Energy Institute’s (UK) Bitumen Safety Code provides the following advice about the flash point of paving, hard and oxidised grades of bitumens:

Due to the slow and variable after reactions which can occur during storage in heated tankage (giving rise to the evolution of very light flammable vapours), the flashpoint is not a reliable indicator of the temperature at which the product in a confined space is likely to produce a flammable atmosphere.

Bitumens (paving grades) commonly have a flash point above 250°C. However, this may differ slightly between suppliers. Despite this flash point, the majority of Queensland suppliers state in their safety data sheets (SDS) that flammable or explosive vapours can build up in the vapour space of storage tanks. Any such advice from a bitumen supplier must also be considered when identifying fire and explosion risks.

Application of hazardous areas (including zones) to heated bitumen tanks

PCBUs that store heated bitumen at temperatures >100°C or other bitumen products that contain a flammable liquid (e.g. cutters and primes) need to carry out a classification to determine if a hazardous area exists at their workplace. Hazardous areas are areas where an explosive atmosphere is expected to exist from time-to-time and therefore require special precautions to be taken to ensure ignition sources are not present anytime the explosive atmosphere is.

Hazardous areas from gases and vapours (including liquids) are typically classified in accordance with AS/NZS 60079, Part 10.1: Classification of areas - Explosive gas atmospheres (AS/NZS 60070.10.1). This standard provides objectives, methodologies and procedures for carrying out a classification that

⁵ Safe Work Australia publication, Information sheet-Australian and other standards available at safeworkaustralia.gov.au
require a range of factors to be considered. Such factors include a product’s volatility, its flammability characteristics, how it is stored or handled and likely grades of release.

Classification does not only apply to the storage and handling of chemicals that are classified as flammable (e.g. Dangerous Goods of classes 2.1, 3 or 4.3). It also applies to other chemicals that may produce an explosive atmosphere based on how they are stored, handled or used at a workplace. For example, combustible liquids stored at temperatures or pressures that generate flammable/explosive vapours or gases. AS/NZS 60079.10.1 includes a range of illustrative examples of hazardous areas for common storage and handling systems and chemicals. One example applies to storages of non-flammable liquids that may release flammable vapours into the ullage (vapour space) of a tank or tanker compartment (refer to section ZA.5.2.12).

In addition to the example area in section ZA.5.2.12, AS/NZS 60079.10.1 states in section 5.4.6 items (i) – (iv) that classifications in accordance with a range of other international codes are also acceptable where their application to the particular situation can be clearly demonstrated. These international codes include:

- **IP 15 (Energy Institute), Model code of safe practice, Part 15: Area classification for Installations handling flammable fluids**
- **API RP 505 (American Petroleum Institute), Recommended Practice for classifications of locations for electrical installations at petroleum facilities classified as Class 1, Zone 0, Zone 1 and Zone 2**
- **API RP 500, Recommended Practice for classifications of locations for electrical installations at petroleum facilities classified as Class 1, Division 1 and Division 2,**
- **BS 5908, Code of practice for fire precautions in the chemical and allied industries.**

This reference to the use of international standards is particularly relevant for heated bitumen as the Energy Institute publication (IP 15) described above states in section D3.2.1, note 4 that:

“For unclassified products (petroleum products with a flashpoint above 100°C) such as bitumens and heavy residual and bunker fuels stored under confined heated conditions in fixed roof tanks (i.e. unventilated ullage space), the flash point of the product is not a reliable guide to the presence or absence of a flammable (explosive) atmosphere that may have built up in the tank vapour space. For this reason it is prudent to classify the ullage space of all such tanks as Zone 0, with a 1.5 m Zone 1 hazardous area around roof vents and other openings. For further information see EI “Model code of safe practice - Part 11, Bitumen safety code”.

The results from a hazardous area classification should be documented and where applicable, any area classified as hazardous should be displayed on a scaled-plan. Where a classification determines that a hazardous area does not exist, the grounds for this should also be recorded as they may form the basis of any controls that are required to avoid the generation of a hazardous area.

Hazardous area classifications should be carried out by a competent person. PCBUs (including any of their employees) that do not have the relevant skills and experience should seek the assistance of a contractor who does. Section 2.16.2 of AS/NZS 4761.1 states in its competency unit for classifying hazardous areas that it typically applies to engineering job function, at least, an engineering associate level.

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6 The illustrative examples in AS/NZS 60079.10.1 are informative in nature, non-exhaustive and based on historical industry experience. They represent guidance only and may need to be adapted to take account of the individual circumstances of each workplace. Their limitations are noted in section 5.4.6.

7 AS/NZS 4761.1 - Competencies for working with electrical equipment for hazardous areas (EEHA) Competency Standards
WHSQ provides a contact list of specialist hazardous area consultants\(^8\), some of whom perform hazardous area classifications. In addition, the Electrical Safety Office provides a list of hazardous area auditors\(^9\) who can also perform hazardous area classifications.

**Note:** Where an accredited auditor has been involved in the selection or installation of any electrical equipment within a hazardous area, the accredited auditor cannot authorise its energisation under section 221 of the Electrical Safety Regulation 2013 (ES Regulation).

The program revealed that 68 per cent of workplaces had carried out or were in the process of carrying out a hazardous area classification for their bitumen storage tanks. This means that the remaining 32 per cent of workplaces had not yet carried out a classification. It is therefore recommended that all workplaces carry out a classification for their heated bitumen storage tanks and keep a copy of its outcomes for future reference. Where a classification identifies the existence of a hazardous area, please note the advice below about electrical equipment (or other plant that could act as an ignition source) and its effects.

**Electrical safety for hazardous areas**

Section 30 of the *Electrical Safety Act 2002* (ES Act) states that a PCBU’s primary duty of care is to ensure their business or undertaking (workplace) is conducted in a way that is electrically safe. This duty includes ensuring that all electrical equipment used in the conduct of the person’s business or undertaking is electrically safe (refer also to section 38 of the ES Act). Section 38A of the ES Act also states that if a PCBU has a duty under this Act, an officer of the PCBU must exercise due diligence to ensure the PCBU complies with its duty. The electrical safety legislation recognises the application of AS/NZS 3000 - *Wiring Rules* wiring rules as a way of achieving electrical safety.

Clause 7.7 of AS/NZS 3000 states in its scope that the particular requirements of this Clause 7.7 apply to the selection of electrical equipment and its installation to ensure safe use in areas where flammable or combustible materials are produced, prepared, processed, handled, stored or otherwise exist, and therefore may give rise to an explosive atmosphere.

Clause 7.7.2 of AS/NZS 3000 states the responsibility for classification of a hazardous area rests with the persons or parties in control of the installation. The requirements are contained in AS/NZS 60079.10.1 for gas and vapour and AS/NZS 60079.10.2 for combustible dust.

Clause 7.7.2.4 of AS/NZS 3000 states that electrical equipment selected for use in a hazardous areas shall comply with the appropriate requirements of AS/NZS 60079.14 and shall be installed in accordance with the installation requirements of AS/NZS 60079.14.

The purpose of these requirements is to ensure that any electrical equipment installed in a hazardous area is safe and not capable of producing a source of energy (e.g. a spark or a hot surface) sufficient to ignite the explosive atmosphere applicable to the hazardous area. The following process summarises these requirements:

- classification of hazardous areas including their zones (e.g. 0, 1 or 2) and flammability characteristics (e.g. temperature class and gas group)
- selection of electrical equipment that has been designed and certified as compatible for the hazardous area (e.g. provided with a certificate of conformity that the corresponds with the area’s requirements)
- installation and testing of the selected electrical equipment as per the area design.
- maintenance of the electrical installation to ensure its integrity over time.

**Note:** Electrical equipment for hazardous areas is commonly referred to as EEHA.

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\(^8\) [List of industry consultants](#) for hazardous chemicals to assist industry when requiring specialist services in the area of safe management of hazardous chemicals.

\(^9\) [List of accredited auditors who provide classification services](#)
One way that demonstrates that the EEHA process has been followed is the availability of a ‘verification dossier’ for all electrical equipment installed in a hazardous area. After commissioning, verification dossiers are also important references used during ongoing inspection and maintenance activities.

A verification dossier includes:

- the hazardous area classification documents (e.g. diagrams of the zone types and dimensions)
- gas or vapour classification in relation to the group or subgroup of the electrical equipment
- temperature class or ignition temperature of the gas or vapour involved
- external influences and ambient temperature
- the ‘certificates of conformity’ with conditions of use
- records of selection equipment criteria for cable entry systems for compliance with the requirements for the particular type of protection
- instructions for the erections and connection and any other information necessary to ensure correct installation
- drawings and schedules relating to circuit identification
- information necessary for inspection (e.g. list and location of equipment)
- information necessary for any repair of equipment, where required
- details of any relevant calculations (e.g. purging rates)
- descriptive system documentation for any intrinsically safe systems
- optional assessment of consequence of ignition.

New electrical installations proposed within a hazardous area are to be designed, selected, installed and tested in accordance with AS/NZS 60079.14 - Explosive atmospheres Electrical installations design, selection, erection and initial inspection. AS/NZS 4761.1 provides a range of competencies for EEHA work. Section 221 of the ES Regulation requires that prior to the connection to a source of electricity, a competent auditor authorised under the ES Act (known as an accredited auditor) must inspect the electrical installation and confirm that it is electrically safe and complies with the requirements of AS/NZS 3000 - Wiring Rules and any other applicable standards (e.g. the 60079 series).

For existing electrical equipment within a newly classified or amended hazardous area, an EEHA assessment by a competent person as per AS/NZS 4761.1 is required to determine whether the existing equipment is suitably designed, certified and installed (i.e. a fitness-for-purpose assessment). Any subsequent work should be carried out by competent persons and is likely to require further inspections, testing and inclusion of conformity assessments in the verification dossier. If non-compatible equipment is identified during this process it should be brought into compliance in accordance with the risk it poses.

Where possible, any non-compatible equipment that is not required in the hazardous area should be relocated to outside the area or changed to a suitably rated design. If vapour barriers are to be used to achieve this purpose, then the hazardous area classification needs to be re-classified and where appropriate, updated to reflect any reduction in the hazardous area provided by a vapour barrier.

For all electrical equipment that remains within a hazardous area, a verification dossier should be developed in the same way as required for a new installation. It is also recommended that PCBUs and plant owners seek the assistance of a person who is competent with managing compliance of hazardous areas when developing a verification dossier. Where existing electrical equipment requires disconnection and replacement or other electrical installation work in order to bring it into compliance, it must not be re-energised without first being inspected by an accredited auditor as per section 221 of the ES Regulation.
The Electrical Safety Office at worksafe.qld.gov.au/electricalsafety provides the following information about EEHA requirements:

- electrical installations for hazardous areas
- classification process and list of service providers who can conduct classifications
- role of accredited auditors for hazardous areas
- list of accredited auditors to certify the electrical installation in the hazardous area
- information on developing an electrical installation improvement plan for a newly identified hazardous area.

**Taking a portable ignition source into a hazardous area – managing hot work**

Taking an ignition source (e.g. portable power tools, mobile powered equipment, electronic devices, and gas devices/torches) into a hazardous area is a particularly hazardous activity and requires careful management in order to prevent a fire or explosion. Wherever possible, such portable or mobile ignition sources should be prevented from entering a hazardous area. However, there are times where this is not practicable (e.g. when responding to process stoppages, system faults, repairs or maintenance for plant that cannot be taken offline).

Such circumstances require management of the operations to ensure ignition sources are never taken into or allowed to remain within a designated hazardous area anytime an explosive atmosphere is present. Operational controls are typically managed by adopting a work-permitting system. Hot-work\(^{10}\) permit systems are examples of administrative controls (procedural-based) that can be used to manage the risk of fire or explosion. Such permitting systems require authorisation of specific work activities (e.g. welding) by a responsible officer before the work can be undertaken.

**Note:** These requirements are in addition to any requirements for fixed plant or electrical equipment installed in a hazardous area.

The HSE *Guidance on permit-to-work systems- A guide for the petroleum, chemical and allied industries\(^{11}\)* states:

“Hot work is usually taken to apply to an operation that could include the application of heat (e.g. gas torch) or ignition sources (e.g. cordless drill) to tanks, vessels, pipelines etc. which may contain or have contained flammable vapour.”

Using this definition, operations that involve the use of a portable ignition source (Blu-ray or cordless drill etc.) within a hazardous area around a tank farm is an example of hot work.

The results of the program revealed that 17 per cent of workplaces with classified hazardous areas did not specifically make reference to these areas in their hot-work permitting systems. Another 58 per cent were still in the process of determining whether or not hazardous areas were applicable to their workplace.

It is recommended that PCBUs review the effectiveness of their hot-work procedures to ensure they remain current and effective. This is particularly important for an established workplace that has recently classified a hazardous area for the first time. Further guidance on hot-work permit systems is available from:

- AS 1674.1 *Safety in welding and allied processes, Part 1: Fire precautions*
- HSE *Guidance on work permit systems- A guide for the petroleum, chemical and allied industries*
- API RP 2009 *Safe welding, cutting and hot work practices in the Petroleum and Petrochemical industries*.

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\(^{10}\) AS1674.1 - *Safety in Welding and allied processes- Part 1: Fire precautions* provides advice for performing hot work.

\(^{11}\) Health and Safety Executive (UK) publication, *Guidance on permit-to-work systems* available at [Guidance on permit-to-work systems: A guide for the petroleum, chemical and allied industries - HSG250](#).
Access to safety information provided by bitumen suppliers

Complete access to fire and explosion hazard data such as flash point, auto-ignition temperature (AIT), maximum heating temperature etc. for the bitumen products stored at each workplace was one of the more common issues identified during this program. 37 per cent of workplaces did not achieve compliance in this area. Many workplaces did have access to flash point data however, other information such as AITs or maximum heating temperatures was not available.

Note: Some bitumen products may not be classified as a hazardous chemical and therefore, an SDS may not be mandatory for these chemicals. Where an SDS is not available for a bitumen product, workplaces should obtain a technical data sheet (TDS) or similar from the product supplier that does provide this information.

Another common finding was that some workplaces who obtained bitumen products from multiple suppliers did not have access to the SDS, TDS or similar from each supplier. Instead, workplaces were assuming that the information provided for one supplier’s bitumen product was applicable to another’s. PCBUs should only refer to the information provided by the supplier as they are best placed to provide this for their products.

PCBUs should obtain all the information they need to identify and assess the fire and explosion hazards and risks associated with their bitumen products and ensure it remains current. Where new information is provided in an updated SDS or TDSs, PCBUs should undertake a review of their existing hazards and risks and update any risk control measures as required.

Responding to pipeline blockages

Program results indicated that approximately half of workplaces used gas torches to respond to bitumen blockages thereby presenting a potential ignition source at these sites that may be eliminated. Another 15 per cent did not have documented administrative controls for responding to bitumen blockages. Freeing a bitumen blockage or ‘slug’, particularly in pipelines and valves, is a task that requires careful management in order to control risks to health and safety. The use of gas torches has been a common way of freeing a blockage within the bitumen industry, particularly at road-works. The technique works by applying a naked flame to the blocked section of pipelines to soften and mobilise the blocked bitumen. Due to the hazards associated with taking a naked flame into an area containing combustible and potentially flammable liquids and vapours, risks to health and safety need to be carefully managed during such work activities.

Where reasonably practicable, safer alternatives to gas torches should be implemented to eliminate the associated risks. Where gas torches/naked flames are used to free blockages, PCBUs should provide adequate controls such as hot-work permits. It is recommended that PCBUs establish clear procedures for responding to bitumen blockages for their on-site and off-site (mobile) operations, including those who have prohibited the use of gas torches.

Managing hazards from hot bitumen in contact with water

Generally speaking, most workplaces had established administrative controls (i.e. safe-work procedures) for managing risks associated with heated bitumen coming in contact with water in tank vehicles (e.g. switch loading procedures). However, similar procedures were less common for managing risks in storage tanks (e.g. when re-commissioning or re-heating a cold tank). The program found that 29 per cent of the workplaces did not have documented administrative controls for re-commissioning or re-heating bitumen storage tanks that may contain moisture/water. That is, there were no documented reheating or boil-out procedures.

Workplaces that store both heated-bitumen and bitumen-emulsion products have additional risks to manage in order to ensure the water content of a bitumen emulsion does not come in contact with a heated-non-emulsion-bitumen (e.g. during incorrect tank vehicle loading and unloading). Correct
identification of fill points and tank segregation are critical controls to achieve this outcome. PCBUs must have in place suitable controls for managing risks associated with hot bitumen contacting water for their fixed storage tanks as well as their tank vehicles. Where administrative controls are used to achieve these outcomes, it recommended that they are documented and staff adequately trained in their use.

**Impact protection for bulk tanks and pipelines**

A number of historical incidents within the chemical industry both locally and internationally have been brought about by mobile plant (vehicles, forklifts or tank vehicles etc.) impacting bulk storage tanks and pipework. Aboveground tanks and pipework within hardstands or other vehicle access areas in particular are at risk of impact. The program revealed that 17 per cent of workplaces required additional impact protection controls around aboveground tanks or pipework.

Section 358 of the WHS Regulation requires that containers of hazardous chemicals, including any pipework or attachments, are protected from damage or excessive loads so far as is reasonably practicable. Whilst not all bitumen products may be classified as a hazardous chemical, given the elevated temperatures they are stored at it is recommended that similar controls be provided for heated bitumen tanks and aboveground pipework. Impact protection is commonly provided by way of bollards, guard rails or other physical barriers such as secondary spill containment structures (e.g. core-filled masonry block wall bunds) around bulk tanks.

**Maintenance of bitumen storage and handling systems**

Fifteen per cent of workplaces did not have a proactive system for inspecting, testing and maintaining their aboveground tanks and pipework. Section 213 of the WHS Regulation provides requirements for inspecting, maintaining and testing plant at workplaces. Plant under the WHS Regulation includes bitumen tanks, attachments, pipework and hoses. A person with management or control of plant at a workplace must ensure that maintenance, inspection, and if necessary testing, of plant is carried out by a competent person in accordance with the manufacturer’s recommendations, or if those aren’t available, in accordance with a competent person’s recommendations. Alternatively, if it is not reasonably practicable to comply with these requirements, inspection and testing should occur annually.

Further to these requirements, Queensland’s *Managing Risks of Plant in the Workplace Code of Practice 2013* ([available at worksafe.qld.gov.au](http://worksafe.qld.gov.au)) includes guidance on inspecting, maintaining and testing plant. This code of practice is based on SWA’s model code of practice of the same name and will be applicable in other states and territories that have enacted the nationally-harmonised WHS laws. In addition, section 9.17 of AS1940, which has recently been updated, provides recommendations for inspecting and maintaining flammable and combustible liquid tanks. One of the recent changes to this standard is that aboveground horizontal (Category 4) storage tanks be inspected internally at least once every 15 years (section 9.17, Note 1).

PCBUs should develop an inspection, maintenance and testing schedule for its bitumen storage and handling systems. Such schedules should take account of manufacturer’s recommendations when performing maintenance work. Where manufacturer’s recommendations are not available or applicable, PCBUs should seek advice from a competent person. Successful maintenance schedules enable PCBUs to track previous maintenance work, forecast future work and maximise the reliability and longevity of their plant.
Recommendations

To summarise the findings of this program, the report makes the following recommendations for bitumen and asphalt plants.

1. Obtain an SDS, TDS or similar document from suppliers for all bitumen products stored or used at each workplace and ensure they remain current (last release/version not more than five years old).
   **Note:** SDSs are mandatory for any chemical classified as a hazardous chemical under the globally harmonised system for the classification and labelling of chemicals (GHS) (refer to section 2 of an SDS).

2. Finalise any outstanding hazardous area classifications. Where hazardous areas are identified as a result, review any existing electrical equipment installed in these areas and remove or replace any equipment that is not suitable for use in the hazardous area.

3. Ensure controls are adequate for managing hot work in or nearby any area that has been classified as a hazardous area.

4. Ensure controls for managing the risks associated with heated bitumen and water (including bitumen emulsions) coming in contact with each other are established for storage tanks in addition to any controls that may be in place for tank vehicles.

5. Provide impact protection barriers for storage tanks and pipework that are located in areas where mobile plant (e.g. tank vehicles) may come in contact with them.

6. Develop clear procedures for responding to bitumen blockages and ensure workers are trained.

7. Review inspection and maintenance schedules for bitumen storage tanks and attachments and ensure they meet the requirements of the **Managing Risks of Plant in the Workplace Code of Practice 2013**.

8. Industry to consider developing specific guidance on management of safety (including hazardous areas) at bitumen and asphalts plants (refer to next section).

**Opportunity for industry - bitumen safety code for Australian conditions**

Whilst AS1940 is applicable to storing and handling flammable and combustible liquids such as bitumen and cutters, it is not tailored specifically to the bitumen industry. This is acknowledged in AS1940’s scope which states that some flammable and combustible liquids have other physical and chemical properties, such as those that are heated, that may require precautions and design considerations additional to those in this standard.

Other than the **Austroads Bituminous Materials Safety Guide**, which is intended for use in spray sealing, asphalt and bituminous stabilisation operations, WHSQ is not aware of any safety codes or guidelines published specifically for Australian bitumen manufacturing and storage plants. This creates an opportunity to develop a bitumen safety code that is tailored to Australian conditions.

An option is to review and update the former AIP CP20: **Code of Practice for Safe Handling of Bitumen Products**. This was last published by the Australian Institute of Petroleum in 2001 and discontinued in 2006 when many AIP publications were re-published by Standards Australia except CP20. Such a review should consider international bitumen safety codes and current guidelines such as those mentioned in this report. Such references are relevant through the reasonably-practicable requirements under the WHS Act.

**Conclusion**

While risk control measures for preventing fire and explosions are well recognised and established for specific products (e.g. petrol, LPG, LNG), the program revealed industry-specific challenges when it comes to the unique properties of bitumen and the way it is stored and handled. The program has shown that it is important to engage with the industry in a comprehensive manner early and in an ongoing way when proposing and implementing an intervention program. Advantages for WHSQ were found to include gaining an improved understanding of the industry, its operations and the issues at hand (i.e. fire and explosion causes and control measures). It was found that a substantial investment of time can be
required to gather the required intelligence on current practices, defining the issues, reviewing guidance material and establishing examples of what compliance may look like.

Development of resources in consultation with industry was valuable in both equipping industry to self-assess their operations and for inspections to target the required areas. It was recognised that suppliers play a significant role in influencing an industry and must be included in the engagement process.

Industry’s commitment was clearly evident throughout the program. This was demonstrated by positive and constructive interactions throughout the engagement and inspection activities. More specifically, via feedback on the assessment tool and companion guide, participation in the evaluation survey and outlining costs and resource allocation by PCBUs for improvements (as a result of both self-assessment and WHSQ inspections). Survey responses demonstrated the valuable role such resources play to drive improvements and raising awareness of WHS legislation requirements and what compliance looks like.

Overall, the program has resulted in a greater understanding of the unique hazards presented by bitumen-related products stored in heated tanks and ways to manage the associated fire and explosion risks. While opportunities still remain for PCBUs to improve their safety systems, the program has better placed the industry to reduce the potential for fire and explosions.

Where to from here?

WHSQ seeks to continue with ongoing constructive engagement with the industry association (AAPA) to support continued improvements in management of WHS risks. More specifically, WHSQ aims to continue to follow up active improvement plans with PCBUs on a site-by-site basis. In addition, it is proposed to revisit a sample 10 per cent of the targeted workplaces (4-5) within the next two years to gauge the sustainability of improvements made to the industry’s fire and explosion prevention measures. This will help evaluate the ongoing success of the program, by assessing how well improvements have been embedded in workplace safety management systems, and help reduce the potential for fire and explosion events in Queensland’s bitumen and asphalt plants.

Acknowledgements

WHSQ wishes to acknowledge the considerable support and assistance of the Australian Asphalt Pavement Association (Queensland) in developing and implementing the program, and the overall positive interactions with the operators within the Queensland bitumen and asphalt industry.
Further information

Further information is available at worksafe.qld.gov.au on the following topics:

- Safe management of hazardous chemicals covering safety duties, emergency planning, notifications, safety alerts and related supporting guides and inspection reports.
- Flammable and combustible liquids and fire and explosion risks
- Hazardous chemical notifications for manifest quantity workplaces managing storage and handling systems (i.e. fuel tanks)

WHSQ assessment tool and companion guide for bitumen is available on request from WHSQ’s Hazardous Industries and Chemicals Branch (HICB) at hicb@oir.qld.gov.au.

Relevant Australian Standards available from standards.org.au include:

- AS1940 The storage and handling of flammable and combustible liquids
- AS/NZS60079 series of standards for explosive atmospheres including:
  - AS/NZS60079.10.1 Explosive atmospheres - part 10.1: Classification of areas - explosive gas atmospheres
  - AS/NZS60079.14 Explosive atmospheres - part 14: electrical installations design, selection and erection
- AS1674.1 Safety in Welding and allied processes- Part 1: Fire precautions

Bitumen industry publication:


Relevant international resources:

- Guidance on work permit systems: A guide for the petroleum, chemical and allied industries, HSG250, Health and Safety Executive, 2005.
- Recommended Practice for classifications of locations for electrical installations at petroleum facilities classified as Class 1, Zone 0, Zone 1 and Zone 2 API Recommended Practice 505 American Petroleum Institute, Washington USA, August 2013.
- API RP 500, Recommended Practice for classifications of locations for electrical installations at petroleum facilities classified as Class 1, Division 1 and Division 2, 2012.
- BS 5908: Code of practice for precautions against fire and explosion in chemical plants, chemical storage and similar premises, British Standards Institution, 2012.
- Eurobitume (European bitumen industry organisation) provides a range of HSE publications on the safe handling of bitumen, including at storage and handling plants available at eurobitume.eu/publications/documents.
Attachment 1: Program evaluation industry survey results

Feedback about the pre-inspection activities and tools:

- 100 per cent reported that two weeks was adequate notice to prepare for WHSQ’s on-site assessment
- 100 per cent reported that they undertook a pre-inspection review (for those PCBUs with multiple sites, 27 per cent reported to have undertaken a pre-inspection review for all sites, 27 per cent reviewed most sites and 18 per cent reviewed some sites)
- 90 per cent reported that they used the pre-inspection checklist and that it was useful when preparing for WHSQ’s site assessment
- Feedback about time spent carrying out pre-inspection reviews included:
  - 20 per cent spent less than half a day
  - 30 per cent spent between half and one day
  - 40 per cent spent between one and two days
  - 10 per cent spent more than two days
- Free-text feedback about the pre-inspection checklist:
  - Helps guide all users to specific questions relating to the industry standards.
  - The pre-inspection checklist was well written. I was able to contact the program coordinator for advice during the preparation stage.
  - The checklist is a very helpful guide. Our company has since utilised the services of a consultant to provide specialist advice on the treatment of concerns in some areas.
- Free-text feedback about the time spent on preparations:
  - Estimate 3 days/site, including reviews.
  - Following the internal review/audit of each site using the pre-inspection checklist, corrective actions were implemented which included arranging external hazardous area inspections. All up I would estimate approx. 80 man-hours were spent preparing for the regulator’s visit.
  - (activities included) Ensuring our paperwork was consistent with audit requirements.

Feedback about the site assessments:

- PCBUs reported that on average, inspectors spent 52 per cent of their time on site assessing the target areas of the inspection checklist as opposed to additional WHS matters
- The three most frequent types of corrective action brought about by this program were:
  - reinforcement of existing isolation and/or engineering controls - 73 per cent of PCBUs
  - review of existing hazard identification assessments - 55 per cent of PCBUs
  - reinforcement of existing administration controls - 45 per cent of PCBUs.
- The least frequent type of corrective action implemented was reinforcement of existing PPE controls - 10 per cent of PCBUs
- On average, each PCBU spent approx. $18,000 and 40 hours responding to corrective actions - ranges included $1000 - $50,000 and 8 – 150 + hours
- Since the introduction of the program the most common WHS changes observe by PCBUs at their workplace or more generally across the industry were:
  - an improved understanding of hazardous area management
  - a further focus on the use of cutters (more volatile petroleum products such as diesel).
- The most common requests for further information as a result of this program were:
  - hazardous area (zones)
  - electrical safety requirements.
- Free-text feedback:
  - Should the industry align with the Energy Institute’s (UK) Bitumen Safety Code?
  - I think it would have been beneficial to have received a post inspection report from each inspector. Email correspondence was utilised instead. This was ok, but the Executive group likes reports.
– **Overall a very useful inspection. Auditors were open, honest and feedback was positive. The inspection was well received and allowed us to improve on-site compliance programs.**

– **Overall, we were very happy with the audit program. It felt the auditors were genuinely trying to partner with the industry for improvements which was well received. Our site is safer for having the program conducted.**