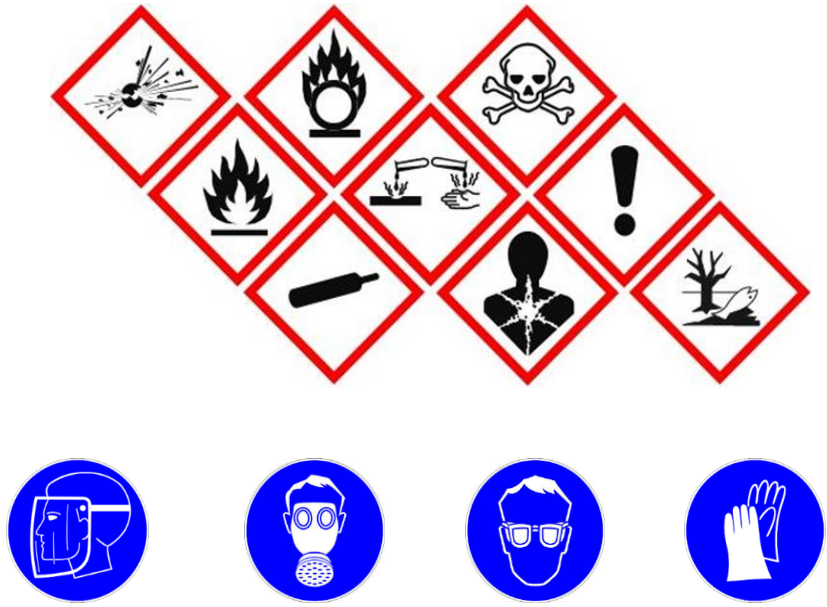
Guidelines for the safe and responsible handling of bituminous products



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Acknowledgements

Sabita gratefully acknowledges the valuable contribution of the members of the Road Pavements Forum's Binder Distributor Task Team in compiling the original version of this guideline document for the industry.

Some of the material incorporated in this document is based on guidelines developed by The Energy Institute (Formerly the Institute of Petroleum), CONCAWE, the Refined Bitumen Association (RBA), Eurobitume, Austroads, the New Zealand Pavement and Bitumen Contractors Association (NZBCA) and the Australian Asphalt Paving Association (AAPA). Their permission to do so is gratefully acknowledged.

The comprehensive revisions of this document draw on the most up-to-date information, knowledge and experience available from various sources including specific techniques and methodology developed by various Industry Organisations and Health and Safety Practitioners.

In particular, the current revision, culminating in this 5th Edition, incorporates specific guidance on the management of the potential risks of hydrogen sulphide (H_2S) in the manufacture of Polymer Modified Bitumen (PMB). In this regard SABITA greatly appreciates and acknowledges the valuable contributions of the following organisations and individuals:

- Caroline Marais, SHEQ Officer - Spraypave Alberton
- Alan Wills, Alan Wills & Associates, Durban
- Nik Vishwanath, Technology Implementation Manager, Road Science, Bay of Plenty, New Zealand

Also included in this edition, is references to other SABITA guides for the management of other *"Significant High-Risk Activities"* associated with manufacture, storage and handling of bituminous products.

Disclaimer

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Preface

The standards of worker health, safety and environmental conservation are constantly under review in the bituminous products industry as the state of knowledge increases. This guideline reflects the state of knowledge and HSE procedures applicable at the time of publishing.

For this 5th Edition, the purpose and scope of the manual has been revised to better serve the objective of providing generic "high-level" guidance for the most common hazards associated with bitumen storage and handling activities. It is therefore reiterated that this document is not intended to be a detailed or exhaustive demonstration of HSE Management of all activities associated with the storage and handling of bituminous products. Where specific guidance on "significant high-risk activities" is indicated or requested by SABITA members, these will be addressed in specific guides such as those already in place and referenced at the end of this publication.

Note*: In accordance with global nomenclature, the term "bituminous" refers exclusively to binders and mixtures of binders and aggregate containing bitumen. The term does not include tar products produced by the pyrolysis of coal.*

As it is now globally accepted that the use of coal tar products as binders for road construction may introduce undue health and environmental hazards; their use is no longer considered as an option. Sabita therefore does not endorse the use of coal tar products as binders and reference to this application is excluded from this document.

SABITA Health, Safety and Environment Policy

Sabita encourages its members to carry out their business in such a way that the health and safety of their employees, and of other persons both on and near their sites, is not endangered, and that the quality of air, water and soil is protected for the continuing benefit of all ecosystems.

Accordingly, in adopting a responsible integration of environmental and economic considerations, members are urged to design, operate and maintain their facilities in such a manner as to:

- avoid harm or injury to the health of employees or other persons on their premises, or those living in the vicinity;
- avoid damage or loss to the environment;
- ensure the manufacture of quality products, and promote the safe and efficient delivery of those products; and
- implement the best available technology to limit emissions, noise and the production of waste.

Through visible management, commitment and the contributions of employees, these members strive for continuous improvement in their performance under the health, safety, and environmental requirements of the State and the industry, and compliance with the relevant legislation. It is anticipated that every employee of Sabita's membership, and those on their premises and work sites, will comply willingly with this policy.

Sabita members not directly involved in the manufacture, storage and transportation of bituminous binders should also note the wide-ranging benefits resulting from the implementation of safe and healthy working practices.

CONSERVATION OF LIFE AND THE ENVIRONMENT IS AN OBLIGATION

Glossary of terms and abbreviations

Additive	Any substance which is added in small portions to bitumen to impart some particular property, e.g.: improve adhesion, lower viscosity.
Adhesion agent	An additive, which forms a water resistance chemical bridge between binder and stone chip.
Anti-foaming liquid	A substance which when applied to the surface of bitumen reduces the surface tension. This action breaks foam as it forms on the treated surface.
Auto ignition	When a material ignites on its own accord unaided by an external source of ignition such as a flame.
Auto ignition temperature	The temperature at which a material will ignite on its own accord. (Not to be confused with flash point which requires an external source of ignition such as a flame).
AOE	Assessment of Exposure as contemplated in the RHCA. Synonymous with Health Risk Assessment.
Assessment	Means a programme to determine any risk from exposure to an HCA associated with the workplace in order to identify the steps needed to be taken to remove, reduce or control such HCA.
Barrier cream	A cream or ointment applied to the skin prior to contact with irritant substances. Some work by blocking the pores of the skin with soapy solids – "dry work" – others by spreading a water-resistant film – "wet work". They may later be wiped or washed off taking the irritant with them.
Bituminous binder	A mixture of bitumen, modifiers, emulsifiers and cutters used for road sealing or the manufacture of asphalt mixes.
Bitumen	A viscous or semi-solid black or brown substance derived from the distillation of crude petroleum oil. Bitumen softens when heated and is pumpable at 120ºC or more.
Bitumen emulsion	Very fine particles of bitumen dispersed in water with the aid of chemical emulsifiers. Acid emulsifiers make Cationic emulsions and Alkaline emulsifiers male anionic emulsions. Usually emulsions contain 60-73% bitumen.

Boil over	The rapid increase in volume caused by the presence of water in hot bitumen and the subsequent overflow of bitumen from a tank.
Bund wall	An enclosed area around a tank, capable of retaining a spillage from the tank or pipe-work.
Carcinogenic	Capable of causing cancer.
Chemical agent	A GHS-aligned chemical agent or mixture.
Combustible	A substance capable of burning with sufficient rapidity to produce heat and flame.
Cutback bitumen	Bitumen to which solvents such as paraffin have been added to make it more fluid.
Cutter	An additive which is blended with bitumen to temporarily reduce the viscosity of the bitumen to assist spraying e.g., paraffin.
Extender oil	Aromatic oil extracted during the manufacture of petroleum lubricants. Used during the blending of bitumen rubber.
Flammable	(Synonymous with inflammable). Any substance, solid, liquid, gas or vapour, which is easily ignited. The term non-flammable refers to substances, which are not readily ignited, but does not necessarily indicate that they are not combustible.
Flammable liquid	The GHS generally defines a flammable liquid as a liquid having a flashpoint of not more than 93 °C. Flammable liquids are classified in one or more categories as follows: Category 1 - Flash point < 23 °C and IBP ≤ 35 °C 2 - Flash point < 23 °C and IBP > 35 °C 3 - Flash point ≥ 23 °C and ≤ 60 °C 4 - Flash point > 60 °C and ≤ 93 °C
Flammable limits/range	A flammable vapour mixed with air will only ignite if the mixture is in the flammable range. The minimum and maximum percentage gas concentrations, which can be ignited, constitute the lower and upper limits respectively. The flammable limits and the flammable range are also known as the Explosive Limits and the Explosive Range respectively. Flammable limits are expressed as a % of flammable vapour by volume in air.
Flash Off	The rapid evolution of vapour from volatile liquids.
Flash Point	The lowest temperature (corrected to a standard pressure of 101.3 kPa) at which the application of an ignition source causes the vapours of a liquid to ignite under specified test conditions.
Foam	A collection of small bubbles of air or gas forming in liquid, which rise and form a blanket on the surface. For fire-fighting a foam produced from water and chemicals is sprayed on the surface of the burning material to exclude oxygen.
Gas Free	An enclosed space or area is considered to be gas free when the concentration of flammable gas/or toxic gas in it is within prescribed safe limits, and the oxygen content is sufficient to sustain the respiration of workmen entering the enclosed space or area.
GHS	The Globally Harmonized System of classification and labelling of chemicals, a guidance document developed by the United Nations for standardising and harmonising the classification and labelling of chemicals globally, as may be updated from time to time, commonly known as the UN Purple Book.
Hazard	The inherently dangerous properties of a substance or chemical agent.
HCA	A GHS-aligned (hazardous) chemical agent as provided for in Annexure 1 of the RHCA.
Hazard pictogram	A graphical composition, including a symbol plus other graphical elements such as a border, background pattern or colour that is intended to convey specific information, that is assigned in the GHS to a hazard class or hazard category.

Heating flues	An oil or gas fired burner with a wide bore pipe which is fitted to a binder tank for heating purposes.
Hot Work	Work involving flames, or spark producing equipment, which can cause ignition of flammable vapours.
Initial Boiling Point (IBP)	The temperature of a liquid at which its vapour pressure is equal to the standard pressure (101.3 kPa), i.e., the first gas bubble appears. .
Ignition temperature	The temperature to which a solid, liquid or gas must be heated to start burning.
Naked flame	All uncontained flames, fires, exposed incandescent materials and welding arcs.
OEL	Occupational Exposure Limit. A limit value set by the Minister, which represents the airborne concentration of an HCA, where the exposure standard may be— (a) an eight-hour time-weighted average; (b) a ceiling limit; or (c) a short-term exposure limit;
Risk	The probability (likelihood) of a substance, chemical agent, operations or circumstances causing harm to people or the environment.
RHCA	Regulations for Hazardous Chemical Agents, 2021.
SDS (safety data sheet)	A document that is aligned to the GHS, providing information on hazard classification, properties of hazardous chemicals, procedures for handling or working with hazardous chemicals in a safe manner, and the effects of hazardous chemicals on health and safety at the workplace, and that is prepared in accordance with regulation 14A of the RHCA.
Scavenger	A specially formulated chemical that is added to a fluid to react with a contaminant to change the contaminant to a less harmful compound. A number of specialised chemicals (proprietary brands) that react selectively with and remove H_2S are available in the marketplace.
Source of ignition	Naked light, fires, exposed incandescent materials, electric welding arcs, lamps not of the approved pattern, sparks and flames produced by other means. They all provide temperatures in excess of the ignition temperature.
Tremcard	Transport emergency card. To be used for vehicles carrying dangerous goods.
Ullage	The amount by which the tank falls short of being full. The difference between the actual volume of a tank and the safe working capacity of the tank.
UN TDG	The UN Recommendations on the Transport of Dangerous Goods: Model Regulations, Volumes 1 and 2, which are guidance documents developed by the United Nations to harmonise dangerous goods transport regulations, as may be updated from time to time, commonly known as the UN Orange Book.
Vapour	The gaseous form of a substance or mixture released form its liquid or solid state.
Viscosity	A measure of the ease at which a liquid can flow. A high viscosity liquid is one which does not flow easily. Binder viscosities are usually measured in Centistokes.
Volatile solvents	Volatility refers to the ability of a liquid to produce vapour at normal atmospheric pressure and temperature. In relation to bituminous binders' volatility refers to a low boiling point hydrocarbon used in the manufacture of cutback bitumen to produce a binder with a temporarily low viscosity which will increase again as the solvent evaporates, e.g., paraffin.

1. Introduction

Bitumen's are used mostly for road paving or roofing but find uses in a variety of other applications where waterproofing and adhesion are important required properties. Approximately 90% of all Bitumen consumed in South Africa is used to construct and maintain the vast road network. Waterproofing, roofing, flooring, antirust paints and sealants for dams and reservoirs account for the other 10% consumption.

Successful management of the hazards associated with the storage, handling and transport of bituminous products requires a sound understanding of the types, properties and characteristics of

bitumen's and bitumen derivatives. This document summarises the health, safety and environmental data currently available on bitumen's and their derivatives and the information covers the following:

- ✍ Product description, uses and typical properties
- ✍ Hazards and Effects of bituminous products
- ✍ General advice on handling, emergency treatment and disposal

2. Product description

Composition

Bitumen's are complex combinations of petroleum products. Conventional chemical analysis shows that bitumen's contain mainly carbon and hydrogen with small amounts of oxygen, nitrogen and sulphur and trace amounts of metals. A typical analysis is 83% carbon, 10% hydrogen, 7% oxygen, nitrogen and sulphur and trace amounts of vanadium, nickel, aluminium and silicon.

To avoid confusion and misunderstanding that may arise from the use of different terms such as bitumen, asphalt etc., it is essential to be clear about terminology. In this document the following nomenclature is used:

Bitumen

A black or dark brown solid or semi-solid thermo-plastic material possessing waterproofing and adhesive properties. It is obtained from processing crude petroleum oil and is a complex combination of higher molecular weight organic compounds containing a relatively high proportion of hydrocarbons having carbon numbers greater than C25 with a high carbon to hydrogen ratio. It also contains trace amounts of metals such as nickel, iron or vanadium. It is essentially non-volatile at ambient temperatures and is soluble in carbon disulphide. Bitumen is defined in this way in most parts of the world outside North America.

Natural Bitumen's

The term bitumen is also used for "*natural bitumen's*" which can occur as natural deposits or as a component of naturally occurring asphalt, in which it is associated with mineral matter. Although natural bitumen may be similar in physical properties to bitumen, it is different in composition and is not covered by this document.

Asphalt

Refers to a mixture of bitumen (as defined above) with mineral matter such as stone, sand or filler.

Bituminous binders

A mixture of bitumen, modifiers, emulsifiers and cutters used for road sealing or the manufacture of asphalt mixes.

✍ *Refer to the Glossary of Terms for a detailed list of the terms generally used in this document.*

3. Types of bitumen's and bitumen derivatives

3.1. Three main types of bitumen:

Paving Grades (previously known as Penetration Grade)

Usually produced from crude petroleum oil atmospheric distillation residues by using further processing such as vacuum distillation, thermal conversion, partial oxidation (air rectification/semi-blowing) or solvent precipitation. A combination of these processes can be used to make different grades which are normally classified by penetration value specifications. They are principally used for road surfacing and in roofing.

Hard Bitumen's

Manufactured using similar processes to paving grades but have lower penetration values and higher softening points, i.e., they are harder and more brittle. The main use is in the manufacture of bitumen paints and enamels.

Oxidized Bitumen's (Air Blown)

Produced by passing air through a bitumen feedstock under controlled conditions. This produces a higher softening point bitumen with reduced susceptibility to change with temperature and greater resistance to imposed stresses. Applications include use in roofing materials, waterproof papers, electrical components and many other building and industrial products.

3.2. Bitumen Derivatives

The following basic types are available in Southern Africa:

Cutback Bitumen's

Mixtures of bitumen's with volatile petroleum diluents such as white spirit, kerosene, or gas oil to render them more fluid for ease of handling and application. Depending on the level and volatility of

the diluents used, the original properties of the bitumen may be partly or completely recovered by evaporation after application of the cutback. Cutbacks are sometimes heated for handling and application to temperatures up to 175°C. Grades are designated either by the temperature required to achieve a specified viscosity or by the viscosity at a specified temperature. Cutback grades are mainly used in road surface dressing.

Bitumen Emulsions

Very fine particles of bitumen dispersed in water with the aid of chemical emulsifiers. Acid emulsifiers produce Cationic emulsions and alkaline emulsifiers produce Anionic emulsions. Usually emulsions contain 60-73% bitumen.

Modified Bitumen's

Paving Grade Bitumen's that have been modified by adding polymers or rubber crumbs, with the rubber crumbs requiring the addition of oils and fluxes in some cases. They are mainly used in road construction, roofing and waterproofing, sometimes at elevated temperatures (up to 230°C).

4. Hazards and potential adverse effects of bitumen handling and use

4.1 General overview

The hazards associated with bituminous products are invariably inherent in the very nature of the product, and the handling and application processes. When handling and using bitumen's the potential adverse effects (unwanted consequences) arise from:

- The high temperatures generally necessary for ease of handling and application;
- Vapour and fume emissions associated with the product when heated;
- The combustible and sometimes flammable nature of the product;
- Persistent skin contact, particularly when in solution;
- Contact in piping, storage tanks or other vessels by hot bitumen with water, resulting in violent expansion to steam of more than 1600 its volume. This can give rise to dangerous "froth-over" and may cause boil-over and rupture of the tank roof;
- Use of compressed air to clear pipeline blockage or suspected blockage in hot bitumen lines, or use of air in mixing in bitumen tanks;
  As a general rule the potential adverse effects associated with the manufacture, storage, distribution, product handling and use of bitumen's arise from one, or a combination, of three initiating (Top) events:
  - ❖ Loss of containment; (The default for liquids and gases)
  - ❖ Loss of control; (The most generic Top Event described in more detail when used)
  - ❖ Exposure to; (Occupational Health Hazards/Agents)

In the sections that follow, generic guidance is provided in relation to controlling the hazards associated with handling and use of bitumen's and in Annex A, a generic table of Hazards, Consequences and Recommended Controls has been included as an example of the output of a typical risk assessment process.

4.2 Managing the Health aspects of bitumen storage and handling

Physical hazards and effects - Exposure to elevated temperatures

The most significant personal effect associated with bitumen is heat burns. Bitumen is normally handled at temperatures above 150°C. Modified bitumen's could be handled at temperatures of up to 210°C.

Skin contact with liquid bitumen at these high temperatures will cause severe burns and shock, which can be fatal. Contact with storage tanks and pipelines containing hot bitumen will also cause severe skin burns.

Physical hazards and effects - Exposure to solvents contained in cold bitumen

- Repairs to cold bitumen equipment may involve skin contact with cold bitumen, emulsions or cutbacks containing solvents;
- Prolonged or repeated skin contact with these solvents may lead to dermatitis.

4.3 Chemical hazards and effects - Exposure to toxic vapours and fumes

In confined spaces, vapours or fumes from bituminous products can be a health hazard and may displace oxygen and cause suffocation. Potentially hazardous concentrations of hydrogen sulphide (H_2S) and polycyclic aromatic hydrocarbons (PAH) may also be present in the vapour space of bitumen storage tanks, or in compartments of road tankers. In particular the presence of H_2S in modified bitumen's is of some concern and warrants specific mention and brief discussion in this document.

4.3.1 Characteristics, hazards and effects of H_2S

H_2S occurs naturally in crude oil (sour crudes). Generally, it is considered very unusual (and unlikely) that Paving Grade bitumen sourced from reputable refineries will contain H_2S in significant quantities because the H_2S is removed during the refining process.

- Hydrogen sulphide is a flammable, colourless gas with a characteristic odour of rotten eggs however, because H_2S inhibits (deadens) the sense of smell (at concentrations between 100 - 150 ppm), the familiar 'bad eggs' odour cannot be relied on to warn of the presence of hazardous concentrations;
- Hydrogen sulphide is a chemical asphyxiant and inhalation can cause respiratory paralysis. At concentrations above 1000 ppm the effects on humans could be "nearly instant death"; ***(The OEL- STEL/C for H_2S is 10 PPM and this limit must never be exceeded.)***

4.3.2 H_2S in the manufacturing of polymer modified bitumen (PmB)

In the manufacturing process of polymer modified bitumen Elemental Sulphur is added during the blending process resulting in 'regeneration' of H_2S. Due to the high blending temperatures and continuous stirring (agitating) of the tank contents, H_2S is readily liberated and the gas accumulates in the vapour space above the liquid PmB. Studies have shown that H_2S concentrations well above the OEL may be present in PmB blending and storage tanks. One such study, conducted in New Zealand [1], found life threatening concentrations of H_2S (≥1000 ppm) were present in the headspace of PmB blending tanks and road tankers! Several other similar studies across the globe have confirmed these potentially extremely hazardous conditions.

4.3.2.1 Assessment of employee exposure

Readers are reminded of the "employers" obligations and duties in accordance with the Regulations for Hazardous Chemical Agents and in particular Regulation 5; ***"cause an assessment to be made immediately"*** **and** ***"thereafter at intervals not exceeding two years".*** For assessment of H_2S exposure, the services of a registered/accredited Occupational Hygienist may be required to ensure that the correct measurement procedures and instruments are applied.

4.3.2.2 Controlling H_2S generation in PmB manufacturing

There are various proven methods for removal/reduction of naturally occurring H_2S in crude oils, mainly, during the refining stage. The techniques involved are very capital intensive (plant, time and energy) and therefore not suitable for application in downstream manufacturing processes. However, there are cost-effective solutions available for smaller-scale operations such as, typically, a PmB manufacturing setup.

Research on the subject has revealed that H_2S levels in PmB can be effectively reduced *(some studies claim complete elimination)* to acceptable concentrations by adding specifically formulated liquid H_2S 'scavengers' during the blending process. In a nutshell, the solution requires that an 'in-line scavenger injection system' be installed to feed the liquid scavenger into the blending mixture in the correct "dosage" as indicated by the scavenger supplier. ***Figure 1 provides a glimpse of a scavenger addition system setup which has proved to be very effective.***

For obvious reasons (protection of proprietary information and registered patents) the actual design and integration of the injection system cannot be discussed in this publication however, a quick internet search will supply a host of information related to suppliers and other useful information.

In accordance with the steps of the Hierarchy of Controls the first priority and ultimate goal should be complete elimination of the (induced) hazard (H_2S) from the final product. Relevant studies suggest that this is achievable however, if for some practical reasons it cannot be done, the goal should at least be to reduce exposure to below the maximum permissible OEL (*10 PPM*) by whatever means possible. Specifics will not be discussed here because local controls are dependant on the outcome of examination and analysis of site-specific conditions. In paragraph 4.4 below some generic advice is offered in this regard.

[1] https://www.linkedin.com/pulse/hydrogen-sulphide-emissions-elimination-nik-vishwanath/

Figure 1. A permanent scavenger addition system with two drums of scavenger attached to a drum pump within stationary containment. ***(Image supplied and published with the kind permission of Road Science, Bay of Plenty, New Zealand)***

4.4 Controlling the health hazards

Legal responsibilities

Over and above the general requirements to *"provide and maintain, as far as is reasonably practicable, a working environment that is safe and without risk to the health of employees"* the Regulations for Hazardous Chemical Agents, 2021of the Occupational Health and Safety Act, prescribes specific actions that *apply to an "employer" or a "self-employed person" who carries out work at a workplace which may expose any person to the intake of a Hazardous Chemical Agent at the workplace"*

It is not practical to copy or discuss the detailed requirements of the HCA Regulations in this guide. South African users of this manual must however be aware that these regulations are the MINIMUM mandatory requirements for control of HCA at the workplace. Therefore, take cognisance of the fact that the generic controls provided or discussed in this document will not necessarily mean that full legal compliance is achieved.

General control measures for health hazards and effects of bituminous products
Administrative controls

- ✍ Perform an Assessment of Exposure (AOE) as required by the HCA regulations. The AOE will also guide the implementation of adequate control programs to minimise the potential exposure to bitumen hazards, the identification of Personal Protective Equipment (PPE) that should be worn and the development of training programs for bitumen workers;
- ✍ Where indicated by the AOE, implement Air Monitoring and Medical Surveillance programs. *(This should only be done by a registered Occupational Hygienist and Occupational Health Practitioner respectively)*;

Engineering controls

- ✍ Design plant, equipment and processes to minimise the likelihood of personal contact with hot bitumen or components of storage and distribution systems;
- ✍ Storage tanks and pipelines containing hot bitumen and heated by steam, hot thermal oil or petroleum fired burners must be shielded or lagged with a suitable thermal isolation material;
- ✍ Where hot bituminous products, containing hazardous flammable or toxic gasses, are present in processes and in places with restricted ventilation, e.g., indoors, effective local exhaust ventilation (LEV) should be used to reduce exposure as far as is practicable;

Procedural controls

- ✍ Always carry out bitumen operations at **as low a temperature as possible** to minimise potential exposure to bitumen vapours or fumes. REMEMBER, the evolution of vapour and fume increases with increase in temperature;
- ✍ Confined space entry and work MUST BE STRICTLY CONTROLLED by a Permit to Work (PTW) system to eliminate exposure to oxygen deficient atmospheres and hazardous concentrations of harmful chemical agents;

- Internal tank cleaning and repair operations should only be entrusted to competent specialist contractors with a proven track record;

Personal hygiene precautions

- Good personal hygiene in respect of hands and inner clothing must be maintained in the course of work. Under NO CIRCUMSTANCES should a person who has been handling bituminous products eat, drink, smoke or go to the toilet before first washing their hands;
- The application of suitable barrier creams to exposed parts of the skin, prior to working with the bitumen, assists in subsequent cleansing should contact occur. REMEMBER, barrier creams are not adequate substitutes for gloves or other impermeable clothing and should not be relied upon as the sole form of protection;
- Petroleum products such as petrol, paraffin or diesel should never be used for skin cleansing purposes because they damage the skin;

Personal protective equipment (PPE)

REMEMBER!
Legally, and pursuant to the Hazard Control Hierarchy, the prescription of PPE should not be the sole measure for controlling hazards. In order to assure effectiveness of PPE, personnel should be trained in the correct use of PPE and arrangements must be in place for routine inspection and maintenance. Adequate facilities for storage should also be provided.

The objective of PPE is often stated as "to prevent exposure" but it is actually a "recovery or mitigating measure"; If controlled adequately however the correct use of PPE can be an effective "last barrier" to prevent or minimise **the potential consequences** (effects) of a hazard.

Whilst the task specific risk assessment will determine PPE requirements, the typical PPE requirements for a bitumen worker should be as follows:

Protective clothing for Torso, Arms and Legs:


Overalls appropriate to the hazard e.g., acid resistant or heat resistant should be the standard choice. These should have close-fitting cuffs and trouser leg-ends capable of overlapping footwear. Added protection is offered by wearing a leather apron when there is a HIGH likelihood of coming into contact with hot bitumen;

Face, Neck and Eye protection:



As the minimum an approved face shield **AND** suitable eye protection (goggles) should be worn. A heat resistant (racing type) balaclava will provide added protection for the exposed neck area and should be considered for certain tasks as identified in the AOE;

Hand protection:


Heat-resistant/Chemical-resistant gloves with close-fitting cuffs;

Foot protection:

Heat-resistant heavy duty safety boots with close fitting at the top, such that overall leg-ends are capable of overlapping them. Under no circumstances should light shoes or sandals be worn;

Respiratory protection:

Besides the obvious respiratory protection needed for Confined Space Entry/Work there may be other tasks (as identified in the AOE) that require the use of respirators to protect workers from toxic vapours or fumes. These would typically be situations where it is not "practicable" to entirely eliminate the existence of vapours or fumes, i.e., loading/off-loading bitumen cutbacks and emulsions, production of PmB, etc. A half-face or full-face respirator with an approved P100/OV/AG filter is suitable for most applications however in some cases (i.e., H_2S vapour) a full face-mask respirator with a Type AX filter is recommended. ***(ALWAYS consult with your PPE supplier for the correct filter as per their filter selection guide).***

4.5 Recovery measures for the consequences of bitumen health hazards

Emergency response planning – Bitumen burns

Bitumen burns require unique treatment. Each location where hot bitumen is handled must have a bitumen specific medical emergency response plan that should as a minimum cover the following:

- Provision of emergency water showers *(it is recommended that a minimum flow of 75 litres a minute at 2.1 bar should be delivered for a minimum of 15 minutes)* and eye bath facilities in close proximity to operational areas where the likelihood of bitumen burns have been identified;
- First-aid workers that are likely to administer emergency treatment MUST be specifically trained for this purpose and available on each shift;
- An adequate number of approved bitumen burns first aid kits ***including a supply of the BitSafe Burns Tag***;
- Arrangements to evacuate burn victims to an "approved" burn/trauma unit. **(Not all emergency medical treatment centres are familiar with the correct methods for treating bitumen burns)**;
- **INFORMATION FOR DOCTORS**
  No attempt should be made to remove firmly adherent bitumen from the skin!

  Once it has cooled, bitumen is not harmful and in fact provides a sterile cover over the burnt area. As healing takes place; the bitumen will detach itself, usually after a few days. If, because of the site of contact it becomes necessary to remove the bitumen, liberal amounts of warm medicinal paraffin can be used. Alternatively, a blend of medicinal paraffin and kerosine may be used; care should be exercised however since kerosine may cause skin irritation.

  After any solvent treatment the skin should be washed carefully with soap and water followed by the application of a proprietary defatting agent or skin cleansing cream. Only medically approved solvents should be used to remove bitumen from burns as other solvents could cause further skin damage.

In situ treatment of bitumen burns

- Burns to the skin or eyes should be immediately cooled by drenching the burnt area of the body under clean cold, preferably running, water. Continue this treatment until the bitumen has cooled. (This should take no less than 15 minutes);

- ✍ **DO NOT** break blisters or remove solid bitumen from the skin or area of the eye as it forms a sterile barrier to the affected part and will protect against infection. A bitumen plaque will normally detach itself within a few days;
- ✍ **DO NOT**, under any circumstances, apply ointments, oils, butter, solvents or other substances to a burn;
- ✍ If available apply a BURNSHIELD ® dressing over the affected area and secure the dressing lightly with a sterile bandage;
- ✍ **DO NOT** remove or cut away clothing over burnt areas;
- ✍ **DO NOT** pull away clothing which has stuck, this may cause further injury;
- ✍ Keep the victim warm and provide plenty of fresh air;
- ✍ Attach a "Bitumen Burns" tag to the patient's clothing in a prominent position before transport to doctor or hospital;

4.6 Managing the Safety aspects of bitumen storage and handling

Hazards arising from the combustible and flammable nature of bituminous products

It is important to understand the various "components" that, potentially, could combine to cause explosions and/or fires in the bitumen storage and handling processes.

Combustion of liquids occurs when ***flammable vapours*** released from the surface of the liquid ignite. Hydrocarbon vapour becomes flammable when its percentage in air is generally at about 1% by volume. This is known as the ***Lower Flammable Limit (LFL)*** and below this the mixture is said to be 'to lean to burn' or 'below the lower flammable limit'. The flammable range continues until the percentage reaches a higher level of about 8% by volume, when it is said to be 'above the ***Upper Flammable Limit' (UFL)*** or 'too rich to burn'.

The amount of ***flammable vapour*** given off from a liquid, and therefore the extent of the fire or explosion hazard, depend largely on the ***temperature*** of the liquid, its ***volatility***, how much of the surface area is exposed, how long it is exposed for, and air movement over the surface.

Other physical properties of the liquid, such as ***flashpoint, auto-ignition temperature, viscosity***, give further information as to how vapour/air mixtures may develop and also on the potential hazards.

Some examples of the typical properties of the hydrocarbons that may be present in bituminous products (or used in bitumen operations) are illustrated in the following table:

Table 1 Typical flammable properties of hydrocarbons

Product	LFL/UFL (%/Vol)	Flashpoint	Auto ignition temperature
Petrol	1.4% - 7.6%	< -40°C	370°C
Diesel (AGO)	1.3% - 6%	> 55°C	225°C
Kerosene's	0.6% - 6.5%	>43°C	205°C
LPG (n-Butane)	1.9% - 8.5%	-60°C	287°C
LPG (Propane)	2.3% - 9.5%	-104ºC	460 - 580°C
H_2S (Hydrogen Sulphide)	4% - 45%	-82 C	260°C
Toluene	1.3% - 7%	4°C	536°C

Mechanism of the ignition of bitumen

The key to understanding the mechanism of ignition of bitumen is wrapped up in the phrases highlighted in bold italics above. For effective blending and application in paving operations bitumen binders need to be in a liquid state. In order to improve the ability of bitumen to flow ***(lower viscosity)*** the product is heated to produce a molten liquid ***(very high temperature)*** and in some cases diluted with ***(volatile)*** solvents ***(that release flammable vapours)*** i.e., cutback bitumen's and some bitumen emulsions; and all of this results in the following:

- Product is at a high temperature above its flashpoint and contact with an ignition source (flame) can ignite the flammable vapour released from the surface of the bitumen;
- Increase in temperature also increases volatility (the ability of the bitumen to release flammable vapours). Flammable vapours are therefore released more readily from heated bitumen. Bitumen and its derivatives contain hydrocarbons in various concentrations depending on the

blend/mixture. Small quantities of the vapours of hydrocarbons in air can form a flammable mixture that can be ignited by a flame, hot surface or heating element, spark or other source of ignition ***(particularly in the vapour space of storage tanks, road tankers and other confined spaces where bitumen may be stored or handled)***.

- Bitumen foams in presence of water as the temperature of bitumen is usually above the boiling point of water. Bitumen heated in the presence of small quantities of water forms foam that can quickly expand and cause the tank to overflow. The expanding foam can quickly reach hot objects or burners, and cause the bitumen ***(flammable vapours)*** to ignite.

Control of flammable atmospheres in bitumen operations

At this point it is useful to briefly review the "anatomy" of a fire as it provides a "decision making framework" for developing controls for the hazards. The fire triangle illustrates the necessary elements that must be combined in order for a fire to start and be sustained:

Figure 2. The Fire Triangle

A combination of the three elements fuel, oxygen and heat will, under ideal conditions, result in ignition causing a fire or explosion.

It therefore follows that, by *excluding* any of the three elements, a fire cannot start and; by *removing* one of the three elements from a fire the fire cannot be sustained and will be extinguished.

Controlling flammable atmospheres in bitumen operations will therefore be a function of effectively ***excluding*** and/or ***removing*** one or more of the three essential elements of fire. Fuel (bitumen's) is obviously the essence of our business and cannot be removed or excluded. Oxygen is ever present in the air that we breathe and in the atmospheres of the containment systems of our bitumen storage and handling processes. Oxygen can therefore also not be excluded or removed.

HEAT (the source of ignition) is the only element that could possibly be excluded or removed in order to control fire and explosion threats. We know that heating (temperatures between 100°C – 230°C) of most bituminous products is also an essential requirement for ease of handling and application and can therefore also not be excluded or entirely removed. However, we can control the heating of bitumen and also effectively control other ignition (heat) sources in our operations.

The relationship between the ***flashpoint/ignition temperature/flammable range*** and the ultimate formation or existence of flammable atmospheres in bitumen operations is very complex and is grade dependant. As can be seen from **Table 1 Typical flammable properties of hydrocarbons,** bitumen's are invariably stored and handled at temperatures above the flashpoints but, in most cases, below the auto ignition temperatures of the hydrocarbon components of bitumen blends. In some cases, the auto ignition temperatures can actually be lower than the flashpoint of a bitumen blend/mixture.

Furthermore, because of operational requirements ("pumpability" and application) not much can be done about lowering heating temperatures. However, in practice there are some fundamental rules that can be applied to minimise the risk of ignition of potentially flammable atmospheres in bitumen operations:

❒ Maximum storage and handling temperatures

The first rule of temperature control should be to **CONTROL THE MAXIMUM TEMPERATURE** at which bitumen's are stored and handled. ***Bitumen should be stored and handled at the lowest temperature commensurate with efficient use*****,** as recommended in the table below.

Table 2 Recommended bitumen storage and handling temperatures

Grade	Minimum pumping temperature (°C)	Typical bitumen temperature at time of application (°C)		Maximum storage and handling temperature (°C)
		Mixing	Spraying	
Paving grades				
250/330 pen	100	135	165	19
160/220 pen	110	140	175	190
100/150 pen	110	150	190	190
70/100 pen	120	160	-	190
50/70 pen	125	165	-	190
40/60 pen	125	165	-	200
35/50 pen	130	170	-	200
30/45 pen	130	175	-	20
20/30 pen	140	185		200
Hard paving grades				
15/25 pen	145	190	-	200
10/20 pen	150	190	-	200
Hard grades				
H80/90	160	200	-	230
H100/120	190	230	-	230
Oxidised grades				
75/30	150	195	-	230
85/25	165	210	-	230
85/40	165	210	-	230
95/25	175	220	-	230
105/35	190	230	-	230
115/15	205	230	-	230
Cutback grades				
50 secs	65	105	150	160
100 secs	70	110	160	170
200 secs	80	120	170	180

Temperature control measures in bitumen operations will include the following:

✍ Engineering controls incorporated in the design of bitumen storage tanks:

- heating element temperature controls;
- tank maximum working temperature controls;
- warning (alarms) for high temperatures in tanks;

Note: A planned inspection/maintenance program should be in place to assure the integrity of control instrumentation.

✍ Procedural controls:

- safe work practices to avoid excessive local heating (i.e., spraying operations; clearing of pipeline blockages; bitumen decanting; laboratory testing);

❒ Control of sources of ignition

Pursuant to the Hazard Control Hierarchy, ignition sources in the presence of potential flammable atmospheres can generally be controlled in two ways:

- by complete elimination; or
- isolating the source (e.g., electrical sparks) by installing approved electrical protection equipment in hazardous areas;

Although very important for total and effective control purposes the selection and installation of electrical protection equipment in hazardous areas is not discussed in this document. Design personnel can obtain detailed information on the subject by referring to various appropriate national (SANS), and international codes of practice. The Bitumen Safety Code, 4th edition, September 2005, published by the Energy Institute, London UK, is an excellent general reference for this purpose.

Eliminating potential ignition sources

As the first step in this process a detailed Risk Assessment should be done to identify the hazardous areas in which flammable atmospheres could occur. A handy guideline to assist with identification of hazardous areas is the IP *Area classification code for installations handling flammable fluids.* The code subdivides hazardous areas into zones:

- Zone 0: That part of a hazardous area in which a flammable atmosphere is continuously present or present for long periods (e.g., the vapour space of a cutback bitumen storage tank);
- Zone 1: That part of a hazardous area in which a flammable atmosphere is likely to occur in normal operation (e.g., immediately above/around/below the compartment hatch during bitumen road tanker loading);
- Zone 2: That part of a hazardous area in which a flammable atmosphere is not likely to occur in normal operation, and if it occurs, will only exist for a short period (e.g. around the pump seals and flanges of a bitumen pump manifold);

Note: Any area not classified under Zones 0, 1, or 2 may, for ignition control purposes, be classified as a "non-hazardous area". However, caution should be exercised in applying zone classification because operational activities in close vicinity of "designated zones" could under abnormal operating conditions change the status of a "safe" zone to hazardous.

Having identified the hazardous zones in which flammable atmospheres in bitumen operations could occur, the following control measures should be in place:

Engineering controls

- Design and construction of storage and handling facilities and equipment is pursuant to appropriate and approved specifications;

Administrative controls

- The continued operational integrity of electrical protection equipment in hazardous areas is assured by a planned inspection and maintenance program;
- A Permit to Work (PTW) system to control ALL Hot Work in Confined Spaces and other hazardous areas;
- A training program to assure the competence of personnel required to perform work in hazardous areas (Including Emergency Response Training);

Procedural/process controls

Safe work practices, based on site specific Job Hazard Analysis (JHA), include the following:

- Clear definition of what is "routine" and "non-routine" Hot Work;
- ALL "non-routine" Hot Work is subject to a clearance certificate/procedure and subsequent PTW control if the work will be performed in a Hazardous Zone;
- Designated safe areas for performance of all "routine" Hot Work (i.e., welding, cutting, etc.);
- General site safety instructions with regard to:
  - Smoking and the carrying of matches, lighters, etc.;
  - The use of spark or flame producing equipment on site;
- Clear procedures and instructions for loading and off-loading of bitumen's to prevent loss of containment and contact with potential ignition sources;
- To prevent "frothing/boil over" instructions MUST include inspection to ensure all tanks are free of water before loading bitumen. Additives and extender oils must also be checked for the presence of water before adding to bitumen;
- The application of excess heat (e.g., welding torch) on bitumen can cause thermal cracking and the evolution of flammable vapour. Open flame heating should only be used to free plugged bitumen valves as a last resort, and the vehicle must be in a "safe zone" area. Spray bars should be heated with caution and under supervision;
- The vapour in the closed space above a hot cutback is flammable, but almost always in too high a concentration (above the upper explosive limit) to be ignited. However, where escaping vapour mixes with air extreme care must be exercised since this is where the mixture may become explosive. Consequently, whenever practical during transfer operations, tank hatch covers should be kept closed, or at least lowered, to preserve the vapour-rich atmosphere above the binder;

*(*For more detailed information on the safety aspects of cutback bitumen refer to the following publication available on the SABITA website: *Guide for the control of HSE hazards associated with the field production of medium curing cutback bitumen)*

- No surface of the heating flues should be exposed in the vapour space as this could cause a dangerous explosion. Always dip tanks before lighting burners and make sure there is a minimum of 200 mm of bitumen above the burner flues or heating coils;

4.7 Recovery measures for fires involving bituminous products

Introduction

This section provides general guidance for bitumen fires in normal day to day storage and handling activities and the scope is not intended to cover the protection of large fixed storage installations or bitumen loading facilities at refineries. The scope is therefore limited to cover immediate response to "small" fires and Management must ensure that a comprehensive fire risk assessment is performed to cover all potential fire scenarios on a particular plant or site. **(*Note: Large bitumen fires can be difficult to extinguish and this task is best left to competent professional fire-fighting services)***

Types of fires

For fire-fighting purposes, fires are grouped in various classes as an aid to identification of the most appropriate extinguishing medium. The fire types most commonly encountered in our industry are class A, B and C. Class D fires involve metals such as magnesium, aluminium, titanium and potassium, and require special knowledge, skills and extinguishing equipment. As it is not commonly encountered no further discussion of class D fires is necessary in this guide.

Class A Fires

The combustible materials involved in this class of fire are usually organic materials such as grass, wood, paper, textiles, etc.; This class of fire is usually extinguished by either quenching or cooling with water.

Class B Fires

Flammable liquids such as petroleum products (petrol, diesel oil, paraffin, lubricants, bitumen etc.), and flammable and combustible chemicals, are involved in this class of fire. When fighting Class B fires the exclusion of oxygen by smothering is usually employed.

Class C Fires

This class of fire is essentially either a Class A or B fire in the presence of live electrical equipment. The reason for the separate classification is that no extinguishing agent containing water can be used to fight a fire involving electricity. Generally, CO_2 (Carbon Dioxide) extinguishers are recommended as first choice to fight these fires, however Dry Chemical Powder (DCP) extinguishers can also be applied effectively but may damage sensitive electronic components.

General principles to consider when fighting bitumen fires

- When on fire bitumen becomes a mobile liquid that can readily flow, spreading the fire;
- Large bitumen fires are difficult to extinguish because of the high heat content of the liquid;
- Direct application of water to the surface of a bitumen pool on fire produces a froth of bitumen due to expansion of the water to steam which is likely to boil-over, spreading the fire and endangering personnel. Straight water jets should never be used; application of water should only be by fog or spray nozzle and only performed by competent fire fighters;
- Un-burnt liquid bitumen can be heated by the fire to a temperature well above its ignition temperature, making it necessary not only to extinguish the flames and cool the surroundings but in order to prevent re-ignition, to cool the product bulk before leaving it in contact with air;
- Bitumen burns with a dense brown or black smoke, severely reducing visibility downwind of the fire;
- As an initial measure to limit propagation of fire, (particularly for large fires) the heating circuits or appliances to tanks and kettles should be switched off as soon as is practicable;

Fighting small bitumen fires

Small bitumen fires from leaks or spills can be extinguished using DCP, foam, water spray, carbon dioxide or (where available) steam lances. *The use of foam, water spray and steam must be avoided where it is not practicable to isolate the electrical supply from equipment near the fire.*

REMEMBER!
Legally, fire extinguishers should be serviced by an accredited service provider, at intervals of not less than once per year. It is also good practice to have an inspection regime in place to perform in situ visual inspections of all fire equipment at least monthly.

Provision and maintenance of first attack equipment:

- Generally, portable (typically 9 kg) DCP extinguishers are preferred for first attack on small bitumen fires. Alternatively semi-fixed portable (wheeled) installations (typically 50kg Trolley Units) may also be considered;
- When planning the placement of first attack equipment fire risk assessments should assure that the correct extinguisher is placed in the location where the fire potential has been identified. This takes the "guess work" of selecting the appropriate extinguisher out of the equation when an emergency arises;
- There should be a minimum of two extinguishers at each location (including road tankers and spray vehicles) in case one fails;
- In addition, road tankers and spray vehicles should also carry at least one shovel, and at each static loading/discharge, point a shovel and a supply of clean loose sand should be readily available for emergency spill containment;

First attack training for personnel:

- All personnel involved in work where the likelihood of bitumen fires exist, must be trained in the correct use of fire extinguishers. It should not be taken for granted that the instructions on the extinguisher body are sufficient for correct application. (Local authority fire services usually have fire training programmes that can be customised to accommodate specific needs)
- Regular fire drills should be executed and planned to simulate realistic fire scenarios; (Although it is prudent to protect trainees against injury during training exercises it must also be borne in mind that in a real-life fire emergency the "fireman's PPE" will not be available and therefore training should be as realistic as is practicable)
- A training program for first attack firefighting should include the visual inspection requirements to ensure that fire extinguishers are checked before the start of a shift or activity where the potential for a fire exists (i.e., road tanker drivers, plant operators, laboratory staff, etc.)

Fire Emergency Plans

A fire emergency plan should be in place at every site/workstation where the potential of a bitumen fire has been identified. The plan should include procedures for:

- Raising the alarm in case of fire;
- Evacuation of affected personnel and vehicles;
- Calling local authority emergency response teams (i.e., fire brigade and if necessary, an ambulance and the police);
- First "attack" on the fire (i.e., availability and strategic placement of suitable fire extinguishers, training of personnel in use of extinguishers, maintenance of fire extinguishers, etc.);
- Handing over fire-fighting command to the local authority fire chief;
- Mitigating damage and in particular managing fire-fighting water run-off in order to prevent pollution;
- Signalling the end of the emergency;

REMEMBER! The best way to fight fires is to prevent them!
Management must insist on, and enforce, good housekeeping practices and adherence to safe work procedures. Fires and explosions have devastating destructive power and the time and effort spent on fire prevention IS ALWAYS a good investment!

4.8 Managing the Environmental aspects of bitumen storage and handling

Introduction

The main environmental hazards related to bitumen are associated with atmospheric discharges and the impact on the water environment of loss of containment from manufacturing, storage, transport or handling and use; particularly of cutback bitumen's and emulsions.

Air pollution
The key emissions from bitumen processes that warrant control are bitumen fume, odour, PAH's (Polycyclic Aromatic Hydrocarbons), hydrogen sulphide (H_2S) volatile organic compounds, and particulate matter.

Emissions could arise as result of the following activities or processes:

Activity/Process	May give rise to
Delivering, storing, heating, mixing and cooling of bitumen	Bitumen fume, odour and PAH's
Storage and delivery of solvents and blending them with hot materials	Volatile organic compounds and odour
The oxidising of bitumen	Hydrogen sulphide, bitumen fume, odour and PAH's

Water pollution
Because of the viscous nature of paving grades, hard and oxidised bitumen's, it is extremely unlikely that they could cause water pollution as a result of failure of storage systems. Cutback bitumen's and emulsions however have the potential to cause serious environmental harm if they reach water courses or ground water.

In most cases hydrocarbons will form a layer at the surface of any water body. However, emulsions by their nature, incorporate a range of additional emulsification agents, acids and bases that are harmful in the aquatic environment and will emulsify the bitumen, distributing it throughout the water body and increasing the potential hazard.

Preventing air pollution and monitoring emissions
Environmental protection in South Africa is regulated under a myriad of Laws, Regulations, Codes of Practice and Standards. Full legal compliance is not within the scope of this guideline and only a general discussion of generic prevention measures is included. However, SABITA members must ensure that the requirements of the National Environmental Management: Air Quality Act, 2004 (Act no. 39 of 2004 effective from 1 April 2010) and Waste Act 59 OF 2008 are taken into account when assessing environmental risk and impact of their operations. In particular, the SCHEDULE of "listed activities and minimum emission standards identified in terms of section 21 of the Act" is of importance to establish monitoring programs and plans to manage emissions.

General pollution prevention measures in bitumen storage and handling processes
Plant operations

- Processes which involve the use of bituminous binders at elevated temperatures release vapours and fumes. Therefore, an important way of reducing emissions is to keep the bitumen temperature as low as possible;
- To prevent/limit the emission of vapours during storage, manholes must be kept closed;
- All site static tanks should be inspected on a daily for possible subsidence or leaks. When not in use the valves should preferably be locked;
- Regular tank gauging and stock reconciliation should be standard practice as a measure to detect possible tank floor leaks;
- Contaminated materials should be removed from site and disposed of in an environmentally acceptable manner;
- Cleaning of contaminated equipment must be done under controlled conditions to prevent seepage of washing and flushing materials into water sources. Where possible make use of a certified wash bay;

Transport, and spray operations *(Refer to SABITA manual 23, Code of Practice: Loading bitumen at refineries, for safe loading procedures.)*

- To minimise the risk of pollution of natural resources, i.e., rivers, dams, groundwater or wildlife during transportation, select, as far as reasonably practicable, a route with the lowest possible pollution impact. This can be done by researching knowledge of the area, or consulting with local authorities and emergency services. Inform them of your presence and the nature of your operation;
- During long trips the driver should stop periodically to do necessary in-transit vehicle inspections (at least every 2 hours if practicable);

- Spray bars on spraying vehicles must be covered when lifted, and the covers must have designated storage positions when the bars are down and the vehicle is spraying;
- Transfer lines (flexible hoses) contribute toward leakages and spillage. Where practicable, reverse the sprayer pump, leaving all lines empty, prior to storage;
- Pressure and nozzle checks are usually conducted next to the road to be sprayed. This must always be done using drip pans or paper, which can be picked up for safe disposal;
- All flexible discharge hoses must be stowed in designated positions. Ensure the hoses have been emptied before uncoupling. A procedure should be in place for collection and disposal of all hose draining's;
- All flanges, nozzles and pumps must be maintained in good condition to prevent spillage. Where necessary drip trays must be used to contain leakage;
- At the end of each day's spraying the spray bar system must be flushed with cleaning solvent. All flushing fluids must be collected in secure containers and returned to the base plant for recycling or safe disposal;

Temporary storage of bituminous products on construction sites

To prevent pollution, the establishment of static tanks on sites must be planned properly. Consideration must be given to:

- The hardness or firmness of the surface;
- The gradient;
- The drainage;
- Position of adjacent water sources and sensitive environmental areas;
- Accessibility;
- A bund wall around the tanks;

Bituminous waste disposal

Although Paving Grade bitumen has been "declassified" as a hazardous substance for packaging and transport purposes other bituminous binder waste (i.e., cutbacks, emulsions, etc.) contain hazardous substances. Care should therefore be exercised when bituminous waste is classified for disposal purposes.

Waste derived from bituminous binder applications may only be disposed of at approved waste disposal sites. Under no circumstances must waste be disposed of in any other manner or without the necessary written authority. Bituminous binder waste includes spills, scrapings, flushing residue, contaminated product and bituminous mixtures. Ensure that a certificate of safe disposal is obtained from the disposal site.

REMEMBER!

The National Environmental Management Act No 107 of 1998 holds the polluter accountable for any incident where environmental degradation has occurred.

5. General guidance for specific bitumen storage, handling and distribution activities

5.1 Vehicles, transport and transfer of bituminous products

General transportation requirements

Transportation of bituminous products must be conducted in accordance with legislation on the transportation of dangerous goods. Some bituminous products are classified as "Dangerous Goods" and all vehicles carrying such products must display hazard warning placards, which are used to provide the emergency services with information on how to handle the cargo being carried in the event of an accident or other emergency. These placards indicate the nature of the product, its UN number and telephone numbers of the transporter and a specialist response advisor, who should ideally be able to provide prompt physical assistance in cleansing and rehabilitation of the area. Regulations based on various codes of practice set out by the SABS govern the use of these warning panels.

All relevant documents must be carried in the vehicle, including:

- SDS, route plan, tremcards, licences and permits;
- Dangerous goods transportation documents, supplier's commercial documentation;
- PrDP licence and any relevant medical documentation;
- To assist emergency services, Transport Emergency Cards (Tremcards) must be available and stored in the designated space i.e., orange coloured box.

The driver must ensure that emergency breakdown triangles, fire extinguishers, flashing lights, first aid kit etc. are available. It is recommended that a first aid kit containing the minimum items listed in Annex D is carried on each vehicle. Refer to Annex F for a pro forma aid memoir that can be used by drivers to check on availability of essential equipment before departure on a delivery trip.

Legally, drivers must undergo the prescribed annual medical examination.

Care of vehicles and equipment

All bitumen equipment must be kept in good condition at all times. Hoses, fittings and threads in particular should be thoroughly cleaned after each delivery or transfer. Product lines, hand sprays, pumps, valves and hoses should be flushed after use to avoid bitumen slugs. Bitumen slugs blocking partially closed valves or leaking hoses may remain undetected until the bitumen is too hot to approach with safety.

Flexible hoses should be used under suction rather than under pressure. Hose assemblies should be inspected regularly for defects or holes. Defective hoses and fittings must be withdrawn and destroyed. Hose assemblies should be stored flat in such a way as to ensure that no residual binder is left in the line. When carried on items of plant or stored at the depot, both hose ends should be fitted with dust caps to prevent entry of foreign material (e.g. stones) that may jam or damage the bitumen pump.

Operators should inspect all equipment required for the transport and delivery of bitumen products before leaving the filling point. Faults should be reported and rectified before any further deliveries are permitted.

All ladders, catwalks, safety rails and grab points must be maintained in a good and clean condition. Accumulation of bitumen must not be allowed.

All vehicles, tanks and equipment should be maintained in accordance with acceptable practices, maintenance schedules and procedures.

Equipment checks

Vehicle checks must be carried out on a scheduled basis. In addition, operational inspections should be done on a daily basis. Checklists must be completed and maintained by the responsible personnel i.e., the driver.

Regular checks on internal overflow and breather valves must be carried out to ensure they are in proper working order.

All delivery hoses must be inspected regularly, be in good condition and free of bitumen residue. All connections and hoses must be cleaned thoroughly after each delivery. Residual bitumen in hoses must be allowed to drain into suitable trays after use.

Spray nozzles must be inspected daily to ensure that they are undamaged and correctly fitted. The bitumen pump must be turned off before any attempt to inspect, replace or maintain spray nozzles, or any part of the spray bar or its fittings.

Product sampling

Binder samples should preferably be taken from purpose-designed sample cocks. Most tankers and sprayers are fitted with a sampling device and this should be used at all times. If a sampling device is not fitted, the sample may be taken, with great care and under supervision, from a valve or single jet in the spray-bar.

Stand clear and wear the recommended PPE to avoid being burnt during sampling or while handling the hot sample. Always operate the binder pump at the lowest speed when taking a sample to minimise pressure in the system. The recommended method is to have sample cocks fitted to sprayers or storage tanks. In the event that the sample is drawn from the manhole, a sample thief should be used.

Take care to allow the sample to cool in a safe place where it does not present a danger to other people in the area. Cool the sample before putting the lid in place.

Heating

Important!

Heating flues should be designed such that:

- **the flues do not pass through the vapour space above the product;**
- **the surface temperature will not exceed 350 ºC on any part of the heating flue;**
- **the flame tube insert can be easily removed for service or replacement;**
- **the inlet or exhaust flues will not be closer than 1.5m horizontally from any manhole or vent pipe;**
- **the flues are not in direct contact with the tank.**

- Bituminous material must be at least 200 mm above heating flues. Parking of vehicles on sloping ground may cause heating flues to become uncovered and therefore dangerous during heating;
- When discharging a tank, burners must be turned off. Fire extinguishers must be removed and placed in a position ready for use before heating commences. Manhole covers must be open;
- Appropriate PPE must be worn during heating operations;
- Under no circumstances should burners be used whilst travelling. This is prescribed by legislation;
- No source of ignition should be permitted within 3m of the vehicle when loading or discharging. The operations must be supervised constantly;
- Sufficient ullage must be left in a loaded vehicle or tank to allow for expansion of the bitumen when heated;
- Gas cylinders must be stored and secured in an upright position. When turning off gas supply after use, close the valve on the cylinder first and thereafter the valve at the nozzle;
- Ensure that only required personnel are in the vicinity during the heating operation;
- A product should never be heated above the recommended temperature required for transporting, pumping and spraying. Thermometers should be checked regularly and any malfunctioning thermometer reported immediately;
- Cutbacks must only be heated in tankers with circulation facilities.

Precautions during heating:

- **Do not leave the tanker unattended when burners are on;**
- **Position tankers so that the wind will carry vapours away from the burners;**
- **Do not stand on top of the tank during heating;**
- **Discharge product from the tanker only when the burners have been turned off;**
- **Only heat product if heating tubes are covered by at least 150 mm;**
- **Do not use burners if any heating equipment has fuel leaks;**
- **Do not stand directly behind burners when lighting or adjusting;**
- **Do not store open solvent or fuel containers near heating operation;**
- **Do not smoke or use cell phones during the heating operation**

Transfer (loading and offloading) of bitumen

The reader's attention is drawn to the SABITA Manual 23: *Loading bitumen at refineries* which offers guidelines for procedures and safety requirements for hauliers collecting bitumen from refineries.

General considerations for transfer of hot bitumen are as follows:

- It is recommended that two persons be in attendance during loading and offloading of bulk bitumen carriers. When loading, one person should be so positioned that he can clearly observe the product level to prevent the likelihood of spill over;
- Fire extinguishers must be removed from storage and placed in a suitable area ready for use;
- ***Tanks must not be offloaded during heating;***
- Flexible hoses and couplings must be inspected before use, and unsafe hoses must not be used;

- Always check the type and level of material in both the supply and receiving tanks. If the receiving tank contains some material ensure that it is the same as or compatible with, the material being delivered and that there is sufficient space for the quantity being delivered;
  Beware: Ensure that there is no water in the tank prior to loading as this could cause a violent explosion, frothing or boiling over.
- Operators should be aware at all times of the potential dangers when transferring hot bitumen, and remain at a safe distance from the hose during transfer. All personnel not required for the operation should keep well away and not stand near or over the hose while it is in use. Do not leave the equipment unattended at any time during the transfer operation;
- When loading is carried out using a discharge extension through the manhole, the free end of the extension must be below the opening of the manhole;
- Before loading commences a check must be made to ensure that all discharge valves on the receiving tank are closed. Care must be taken to ensure that no valves are plugged with solidified bitumen, giving the impression of being in the closed position;
- The safest method of clearing plugged valves, on an empty tank, is to heat a steel bar to a temperature sufficient to melt the bitumen and no more, and to insert the heated bar into the plug;

  The use of gas burners or other open flame methods to free plugged valves must only be considered as a last resort. If this method is to be used the vehicle must be moved to a clear safe area with fire extinguishers on hand.
- During loading no source of ignition should be allowed in the vicinity of the receiving tank;
- Earthing the vehicle to eliminate the accumulation of electrostatic charge is necessary during the loading or offloading of cutback bitumen e.g. MC 30. This is done by making sure that the metal of the loading pipe is in electrical contact with the metal at the manhole by means of an earth cable. The simple act of a material flowing through a pipe or hose may generate sufficient static electricity to cause a spark when connecting/disconnecting hoses unless there is a continuous connection;
- Ullage of at least 10% should be left after loading to allow for expansion resulting from any subsequent heating;
- After completing the transfer of materials check that the valves on both the supply and receiving units are closed and the bitumen pump is turned off;
- Carefully undo the hose. The bottom must first be loosened slightly. A small amount of material may run out of the hose coupling into a drip tray, indicating that it is empty, that there is no pressure, and that it is safe to remove. If there is a large amount of material, or residual pressure in the hose, possibly due to a valve not having closed properly, this procedure will ensure that the product squirts onto the ground rather than into the operators' face or over his body;
- Keep the free end of the hose clear of the ground to avoid dirt, stones etc. lodging in the hose. There are special hose chairs available to plug and hold the end clear off the ground. Common practice is to turn the end of the hose up and over so that it will remain in that position. This procedure will also prevent entry of rainwater into the hose. Failure to do this could cause a dangerous boil over of hot material loaded next into the tank;
- After loading, empty the pump lines by sucking back into the tank. On completion of discharge, pump, pipelines and hoses must be flushed out with paraffin or diesel and cleared of product. Hose couplings must also be thoroughly cleaned;
- Flushing fluids must be collected for re-use, and disposal must be in accordance with statutory requirements and best practice procedures;
- The manhole cover must be securely fastened before departure after loading;
- In the event of any spillage of bitumen during delivery or transfer (such as by hose failure or tank overflows), all valves should be closed, hoses disconnected, all caps screwed down and the customer or his representative informed of the spillage. The area should be cleaned and

authorities must be informed so that they can certify that the site has been restored to its former condition.

REMEMBER!

After the unloading of cutback bitumen that has been heated to spraying temperatures, the tank will contain a gas/air mixture that may be in the explosive range. This is the time when the product is most hazardous. All sources of ignition and heat must be prevented from coming into contact with this explosive mixture.

Loading of different products

Change of product should be carried out only when approved and supervised. When loading the next product, due consideration must be given to the previous content of the vessel to avoid contamination or boil-over. Generally, this requires draining the tank lines and flushing the system with appropriate fluid compatible with the new product being loaded. All flushing and other residue must be collected and disposed of in accordance with best practice procedures and the requirements of the relevant legislation.

When bitumen emulsion is to be loaded into a tank that has contained bitumen, it is necessary to drain out as much bitumen as possible. The tank and pipeline should be flushed out with MC 30 or similar material to remove any remaining bitumen. All flushing solvents must be collected in a manner which complies with both best practice and statutory regulations.

Centrifugal or low shear gear pumps are preferred for pumping emulsions as some emulsions may be shear sensitive, especially latex modified emulsions. Positive displacement pumps suitable for Paving Grade bitumen, cutbacks and modified binders have a tendency to shear emulsions after excessive circulation unless the emulsion is hot, i.e. above 50ºC. When loading emulsion ensure that the emulsion is discharged into the bottom of the tank and not allowed to free fall from the top of the manhole.

There are two forms of emulsion - ANIONIC (basic) and CATIONIC (acid). If these are mixed, almost instantaneous ”breaking” of the emulsion will take place in the tanker. The load will solidify and the tank will become difficult to clean. If it is necessary to change tank contents from one to the other product, the tank must be flushed out.

At the completion of discharge of emulsion, the pump, tank and lines must be thoroughly cleaned with MC 30 or similar material to ensure that all emulsion is removed from the system. Any emulsion left in the unit could result in a boil-over when hot bitumen is next loaded into the vehicle.

5.2 Blending

Cutting back hot binders

On-site cutting back of hot binders with volatile solvents is undesirable and is not recommended, either from quality or safety perspectives. Best practice dictates that all blending operations using cutters be carried out at fixed facilities under controlled conditions with the recommended safety and quality measures in place.

Blending of modified binders

Blending of polymer modified binders and bitumen rubber must only be conducted in tanks and blending units designed for this purpose and must be carried out in accordance with supplier’s method statements. Due to the limited shelf life of some modified binders such as bitumen rubber, the blending of these materials must be done on site. The digestion of rubber in hot bitumen could cause an increase of 10 to 25% in volume. Sufficient ullage must be allowed for this increase to avoid boil over.

Polymers and rubber crumb must be stored in a dry place and away from any source of heat. The addition of rubber crumb to a blending tank should be done by mechanical means that is earthed to prevent the build-up of static electricity.

Adhesion agents should only be added to binders shortly before spraying unless they are temperature storage stable. The contents must be circulated for 15 minutes before spraying. Gloves and eye protection must be worn and care should be taken to avoid inhalation of fumes.

Compatibility with water should be established before dilution. When mixing water with emulsions, always add water to the emulsion and not emulsion to water.

5.3 Storage and storage temperatures

If binders are stored for long periods above their application temperatures, a loss in quality may occur. This is more likely in the case of cutback bitumen’s as considerable cutter can be lost. With

modified bitumen, degradation of the modifier will occur, resulting in the subsequent loss of product quality. For safety reasons the listed maximum storage and spraying temperatures should not be exceeded.

Emulsions should only be heated prior to application. Heating should be gradual to reduce the possibility of deposits forming on the burner flues. Emulsions stored in bulk should be circulated for 30 minutes every second day. Drums containing emulsions should be rolled before use.

Table 3 Time and temperature limits for binders

Typical Temperature / Time Limits for Binders					
Binder Class	**Short Term handling**		**Storage**		**Max. Spraying Temp. (°C)**
	Max. Temp. (°C)	**Max. Holding Time (hrs)**	**Max. Temp. (°C)**	**Max. Holding Time (hrs)**	
80/100	**180**	**24**	**130**	**240**	**190**
150/200	**170**	**24**	**120**	**240**	**180**
MC30	**65**	**24**	**30**	**240**	**65**
MC70	**80**	**24**	**50**	**240**	**80**
MC800	**110**	**24**	**60**	**240**	**130**
MC3000	**130**	**24**	**90**	**240**	**155**
Emulsions (not modified)	**80**	**24**	**50**	**240+**	**80**
S-E1; S-E2	**180**	**24**	**150**	**240**	**200**
C-E1	**160**	**24**	**140**	**240**	**-**
SC-E1; SC-E2	**70**	**24**	**Ambient**	**240+**	**80**
CC-E1	**Ambient**	**240+**	**Ambient**	**240+**	**-**
S-R1	**165**	**24**	**140**	**72**	**210**

6. Training

All personnel involved in the handling, storage blending or spraying of bituminous binders must receive training in the safe handling of these products and the relevant legal requirements. HSE Critical Positions and Tasks should be identified, documented and an appropriate training program should be developed to assure the competence of personnel.

A typical training (competence assurance) program could include the following:

- Task risk assessment training;
- Managing of task specific hazards as identified in the site risk assessments;
- Fire-fighting;
- Procedures to follow in case of emergencies;
- Treatment of bitumen burns;
- The use of protective clothing and safety equipment;
- Sampling procedures;
- Safe operation of bitumen handling equipment such as pumps, burners and compressors;
- Advanced driver training for Bulk Vehicle Operators;
- Incident investigation;

SABITA has developed a basic bitumen safety training program called ***BitSafe.*** The implementation of the BitSafe Course is done through the recruitment and training of selected employees of SABITA member companies as trainers. After completing a “Train the trainer” course the trainers conduct the training at their respective places of work.

The course has been designed in a modular format which allows for short interventions of approximately two hours, thereby minimizing the impact on operations. The course consist of 13 training modules which covers all the activities normally associated with the handling of bituminous binders.

Module 1 (a): Understanding the industry
Module 1 (b): The Certification Process
Module 2 (a): Hazards: General
Module 2 (b): Hazards: Fire Prevention
Module 3: Health and safety awareness
Module 4: Reducing the Risk
Module 5: Treatment of Bitumen Burns

Module 6: Our Environment
Module 7: Loading of Liquid bitumen
Module 8: Transport of Bitumen
Module 9: Sampling and Testing
Module 10: Storage
Module 11: Disposal of Bitumen Waste
Module 12: Application of Bituminous Binders

For more details contact SABITA on 021 5312718 or email info@sabita.co.za

Annex A - Hazards and Effects Management Process

A.1 Brief introduction to the HEMP

The Hazards and Effects Management Process (HEMP) entails a detailed analysis and documentation procedure using four basic steps:

- **IDENTIFY** the hazards (what can cause harm), the top event and threats (under what circumstances can the hazard be released) and the potential consequences (injury, damage, etc) if the hazard is released;
- **ASSESS** (1) Consider the LIKELIHOOD of the occurrence of the potential consequences and classify the risk using a Risk Assessment Matrix; and (2) Analyse the threats and determine the necessary controls (barriers) to prevent the release of the hazards;
- **CONTROL** – Document existing controls (barriers) and develop new/additional controls that are necessary to manage the risk to ALARP;
- **RECOVER** – Develop comprehensive reaction plans to mitigate the adverse effects of potential consequences.

A.2 Suggested strategy for establishing a site HEMP program

To assure full compliance with Legal and HSE Management System requirements the HEMP must be organisation and site specific.

- Select, train and appoint a HEMP facilitator; (ideally an HSE practitioner)
- Establish a site HEMP team consisting of experienced personnel from each department/business function i.e., admin., engineering, production, laboratory, transport, etc.;
- Provide basic HEMP methodology training for team members;
- Prepare a project plan with scheduled HEMP workshops;
- Conduct HEMP workshops under guidance of the HEMP facilitator;
- Record/document the results of the HEMP in a Hazard Register similar to the format suggested in Annex C of this manual;
- Compile a register of HSE Critical Activities (processes) and Positions (jobs) for the site and assure competence of HSE Critical Positions;
- Conduct further detailed analysis of HIGH-RISK hazards and demonstrate ALARP (using BowTie or similar methodology);
- Get Management sign-off for hazard register;
- Communicate contents of hazard register as widely as necessary;
- Establish a procedure for maintenance of the Hazard Register including:
  - Management of change;
  - Regular review to check “barrier” efficiency;
  - Compliance auditing;
  - Follow up on remedial action, etc.

SABITA members are encouraged to establish their own site-specific HEMP programmes to ensure that a detailed analysis of all HSE Critical operational activities and associated hazards is completed.

A.3 Table of Hazards, Potential Consequences and Recommended Controls

For purposes of this guideline a simple generic "high level" assessment has been prepared to illustrate how the HEMP is applied. Annex C provides an example of a suggested structure and format for documenting the HEMP results in a Hazard Register.

As an example, the table below provides an overview of the most common hazards and effects associated with the types, properties and characteristics of bitumen's and bitumen derivatives and also a brief summary of the general precautionary measures that should be applied to control these hazards.

(Please note that threats are not included here and ONLY product related hazards are discussed in this model)

Hazard	Consequence/Effect	Recommended controls
Hazard group: THERMAL Plant/Equipment/Liquids at elevated temperatures Hazard source: Bitumen binders stored, transported and handled at temperatures between 100°C - 210°C; Bitumen heating and application equipment/tools	People: Severe burns and shock, potentially fatal Assets: Damage to equipment, tools, structures not designed to resist high temperatures Environment: Destruction of sensitive flora	▪ Thermal insulation: shielding, cladding, lagging of plant and equipment; ▪ Avoid contact of hot Bitumen with water to eliminate potential of "boil over"; ▪ Proper design and maintenance of plant and equipment to prevent leaks/spillage; ▪ Competent personnel follow correct operating procedures; ▪ Provide, maintain and use appropriate PPE as prescribed; ▪ Medical, fire and spill emergency response plans
Hazard group: CHEMICAL Flammable and toxic vapours or fumes (Kerosene, CO^2, Hydrogen Sulphide (H_2S), Bitumen Fume, Nitrogen Oxide, Carbon Monoxide, Polycyclic Aromatic Hydrocarbons) Hazard source: Cutback Bitumen's and other bitumen derivatives that contain volatile organic compounds	People: Fires/explosions cause severe injury or death; Acute health effect: (asphyxiation) could be fatal; Chronic health effects: Long-term regular and repeated exposure (skin contact) may cause skin cancer. Assets: Fire or explosion results in severe damage or destruction Environment: Air pollution; ground water contamination; destruction of sensitive habitat	▪ Substitute Cutback Bitumen with a less hazardous derivative; ▪ Proper design and maintenance of plant and equipment to prevent leaks/spillage; ▪ All hot work and confined space work is strictly controlled by a Permit to Work (PTW) system; ▪ Where practicable provide adequate local exhaust ventilation at source of exposure; ▪ Provide, maintain and use appropriate PPE (respiratory protection) as prescribed; ▪ Personal health monitoring programs ▪ Medical, fire and spill emergency response plans ▪ Air quality monitoring ▪ Engineering controls to limit emission of noxious vapours

Annex B - Example of A Risk Assessment Matrix

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
	PEOPLE	ASSETS	ENVIRONMENT	REPUTATION	A	B	C	D	E
					Never heard of in **Industry**	Heard of in **Industry**	Has occurred more than once per year in **Industry**	Has occurred at least once in **our Company**	Has occurred more than once per year in **our Company**
0	No health effect	No damage	No effect	No impact					
1	Slight health effect	Slight damage	Slight effect	Slight impact					
2	Minor health effect	Minor damage	Minor effect	Minor impact					
3	Major health effect	Moderate damage	Moderate effect	Moderate impact					
4	Permanent Disability	Major damage	Major effect	Major impact					
5	1 or more fatalities	Massive damage	Massive effect	Massive impact					

Application of the RAM

The three coloured areas describe the level of control required to manage risk:

Blue: Manage for continuous improvement through the effective implementation of the HSE MS.

Yellow: Identify and implement controls and recovery measures to reduce Risk to ALARP.

Red: Significant risks - Identify and implement Controls and Recovery Measures to reduce the Risk to ALARP and provide a documented demonstration of ALARP by a Bow Tie or equivalent methodology.

Likelihood Scale

The scale of increasing Likelihood is intended to represent a range from highly unlikely to frequent. It is expressed in terms of frequency of events per period per Location (Site). These descriptions should be used in every application of the RAM so as to promote consistent assessment of risk.

Increasing Likelihood				
A	B	C	D	E
Never heard of in **Industry**	Has occurred in **Industry**	Has occurred more than once per year in **Industry**	Has occurred at least once in **our Company**	Has occurred more than once per year in **our Company**

RAM Consequence and Severity Categories
The following tables contain the description and definition of the Severity levels in each of the P-A-E-R categories, followed by examples as bullet points.

Harm to People	
Level	**Definition**
0	**No injury or health effect**
1	**Slight injury or health effect** – Not affecting work performance and not affecting Daily Life Activities. Examples: • First aid cases and medical treatment cases. • Exposure to health hazards that give rise to noticeable discomfort, minor irritation or transient effects reversible after exposure stops.
2	**Minor health effect** – Affecting work performance, such as restriction to work activities or need to take up to 5 days to fully recover. Or affecting Daily Life Activities for up to 5 days. Or reversible health effects. Examples: • Restricted work day cases or lost work day cases resulting in up to 5 calendar days away from work. • Illnesses such as skin irritation.
3	**Major health effect** – Affecting work performance in the longer term, such as absence from work for more than 5 days. Or affecting Daily Life Activities for more than 5 days. Or irreversible damage to health. Examples: • Long term disabilities (previously called Permanent Partial Disabilities). • Illnesses such as noise induced hearing loss or stress.
4	**Permanent disability** – resulting from injury or occupational illness. Examples: • Serious burns sustained in an explosion or fire • Illnesses such as corrosive burns, silicosis. • Serious burns sustained in an explosion or fire • Non-fatal exposure to oxygen deficient atmosphere
5	**1 or more fatalities** – resulting from ANY injury or occupational illness.

Asset Damage and other Consequential Business Loss	
Level	**Definition**
0	**No damage**
1	**Slight damage** - Costs less than ZAR 5,000. Example: • No disruption to operation.
2	**Minor damage** - Costs between ZAR 5,000 and 20,000. Example: • Brief disruption to operation.
3	**Moderate damage** - Costs between ZAR 20,000 and 50,000. Example: • Partial shut-down.
4	**Major damage** - Costs between ZAR 50,000 and 200,000. Example: • Up to two week's shut-down.
5	**Massive damage** - Costs in excess of ZAR 200,000. Example: • Substantial or total loss of operation.

Environmental Effect

The bullet points in the environmental effect table are a mixture of:

- Effects, e.g., groundwater contamination.
- Events with the potential for environmental effect, e.g., exceeding a limit.
- Indicators of potential effects, e.g., complaints.

Level	Definition
0	**No effect.**
1	**Slight effect** Slight environmental damage – contained within the premises. Example: • Small spill in process area or tank farm area that is readily contained.
2	**Minor effect** Minor environmental damage, but no lasting effect. Examples: • Small spill off-site that seeps into the ground. • On-site contamination. • Complaints from up to 10 individuals. • Single exceedance of statutory or another prescribed limit.
3	**Moderate effect** Limited environmental damage that will persist or require cleaning up. Examples: • Spill from a pipeline into soil/sand that requires removal and disposal of a large quantity of soil/sand. • Observed off-site effects or damage, e.g., fish kill or damaged vegetation. • Off-site contamination over a small localised area. • Complaints from community organisations (or more than 10 complaints from individuals). • Frequent exceedance of statutory or another prescribed limit, with potential long-term effect.
4	**Major effect** Severe environmental damage that will require extensive measures to restore beneficial uses of the environment. Examples: • Off-site contamination over an extensive area. • Many complaints from community organisations or local authorities. • Extended exceedances of statutory or other prescribed limits, with potential long-term effects.
5	**Massive effect** Persistent severe environmental damage that will lead to loss of commercial, recreational use or loss of natural resources over a wide area. Example: • Persistent regular exceedances of statutory or other prescribed limits, with potential long-term effects.

Impact on Reputation (Business Continuity and Sustainability)	
Level	**Definition**
0	**No impact**
1	**Slight impact** • Local public awareness but no discernible concern. • No media coverage.
2	**Minor impact** • Local public concern. • Local media coverage.
3	**Moderate impact** - Significant impact in region or country • Regional public concern. • Local stakeholders, e.g. community, NGO, industry and government, are aware. • Extensive attention in local media. Some regional or national media coverage.
4	**Major impact** - Likely to escalate and affect Group/Company reputation • National public concern. • Impact on local and national stakeholder relations. National government and NGO involvement. • Extensive attention in national media. Some international coverage. • Potential for regulatory action leading to restricted operations or impact on operating licences.
5	**Massive impact** - Severe impact on Group/Company reputation • Extended national public concern. • High level of concern amongst regulators and potential for plant closure. • Potential for action by international NGOs. • Significant international media attention. • Significant potential for effect on national standards with impact on access to new areas, future grants of licences and/or tax legislation.

Note:

The Organisation defines the parameters and criteria in each of the Consequence and Likelihood categories as well as the process and methodology for determination of ALARP.

Annex C - Suggested format for a hazard register

Hazard No	Hazard & Top Event	Location/Activities	Threats	Controls	Worst-case scenario considered for RAM rating	RISK POTENTIAL				ALARP Documentation
						P	A	E	R	
S-01	**Hazard:** Hydrocarbon's: Cutback Bitumens (Flammable vapour) **Top Event:** Loss of Containment	**Location:** Loading gantries Blending plants Laboratories **Activities:** Bulk loading & deliveries; Bulk storage & handling; Storage and handling of samples; Plant maintenance; Operation of Bitumen heating system Binder spraying operations	• Inadequate design of plant • Equipment Failure • Inadequate Work Procedures • Procedures not followed • Inadequate ventilation	**Note:** **Prevention and Recovery Controls not included here. Follow the Hierarchy of Controls to develop appropriate barriers.** • **Elimination;** • **Substitution;** • **Engineering controls;** • **Admin controls; and** • **PPE.**	Asset damage: Fire in loading gantry	**4B**	**4C**	**2C**	**1C**	Bow Tie Diagram Hazard Control Sheet PTW System EIA Design standards Ops standards and procedures Site ERP
						Comments: Fire partially destroyed loading gantry at the XYZ refinery in April 2009				
H-02	**Hazard:** Hydrogen Sulphide (H_2S) in vapour space of tanks **Top Event:** Release of and Exposure to H_2S	**Location:** Storage tanks in PmB Blending/ & Distribution plants **Activities:** Manufacture, storage and distribution of PmB	• Inadequate plant design (Poor ventilation) • Inadequate work procedures • Work procedures not followed		Injury/fatality: Employee/s exposed to H_2S gas above the OEL	**4C**	**3D**	**1B**	**2B**	Hazard Control Sheet Site work instructions Design standards Site ERP
						Comments:				

Note: The development of Hazard Registers should be done by a carefully selected team with relevant engineering, operational and HSE experience under guidance of a competent HEMP facilitator.

Annex D - Contents of first aid kit

The items below can be ordered from most pharmacists or safety equipment suppliers. Sabita offices also provide complete bitumen first aid kits and refill packs. Order from info@sabita.co.za

BitSafe first aid kit

The following items are in the bitumen first aid kit:

Antiseptic solution
Antiseptic ointment
Assorted packs of sterile burn dressing
Cotton buds
CPR mouthpiece
Elastic bandages
Eye pads
Eye shields
Gauze swabs
Instant cold pack
Latex gloves
Micropore tape
Non-adhesive burn dressing for open burns
Rescue sheet
Safety pins
Scissors
Sterile eye irrigation solution
Triangular bandages
Tweezers
No. 3 wound dressing
No. 5 wound dressing
Burnshield & burnshield liquid
2 plastic interlocking straight splints

NOTE: A 25 litre container of water (minimum) should be kept with the kit for cooling down the patient's burnt section.

Annex F - Pre-trip aid memoir for bitumen road tanker driver

COMPANY/OPERATOR: ..... DRIVER: .....

VEHICLE NO: ..... TRAILER NO: .....

Item	Quantity
Equipment	
Emergency triangle	2
Fire extinguisher (9 kg dry chemical powder)	2
Shovel	1
Water in a robust plastic container	25 litres
The following Personal Protection Equipment is worn or readily available:	
Heat resistant overall and leather apron	1 of each
Face shield, goggles and heat resistant balaclava	1 of each
Heat and chemical resistant gloves	1 pair
Heavy duty safety boots	1 pair
Half Face-piece Respirator with appropriate filter	1
Hazchem decal	1
Elevated temperature warning triangle	1
First aid kit (Checklist for minimum contents inside)	**1**
Documentation	
Operator registration card displayed	
Orange document container mounted in the cab	
Public Driving Permit for Dangerous Goods (Prdp-G)	
Dangerous goods declaration for product on board **(either separate or part of a waybill, consignment or delivery note)**	
Tremcard	
Material Safety Data Sheet relevant to product on board	
Roadworthy certificate	
Medical certificate	

Annex G - Typical content of a transport emergency card (Tremcard)

CARGO: MC30 CUTBACK BITUMEN **UN NO: 1999**

- **BLACK BITUMINOUS PRODUCT**

NATURE OF HAZARD:

- Highly flammable;
- Product may adhere to the skin and cause burns;
- Fumes may cause eye and skin irritation, respiratory irritation, dizziness and nausea.

BASIC PERSONAL PROTECTION:

- Face and eye protection;
- Protective overalls;
- Safety shoes;
- Heat resistant gloves.

IMMEDIATE ACTION BY DRIVER:

- Stop the engine;
- No naked lights, no smoking;
- Mark roads with self-standing warning signs and worn other road users or passers-by. Keep public away;
- Keep upwind;
- Notify emergency services.

SPILLAGE:

- Stop leaks if without risk;
- Prevent material from entering storm-water drains and rivers;
- Vapour may create explosive atmosphere;
- Use sand, earth or spill control material to contain spill.

FIRE:

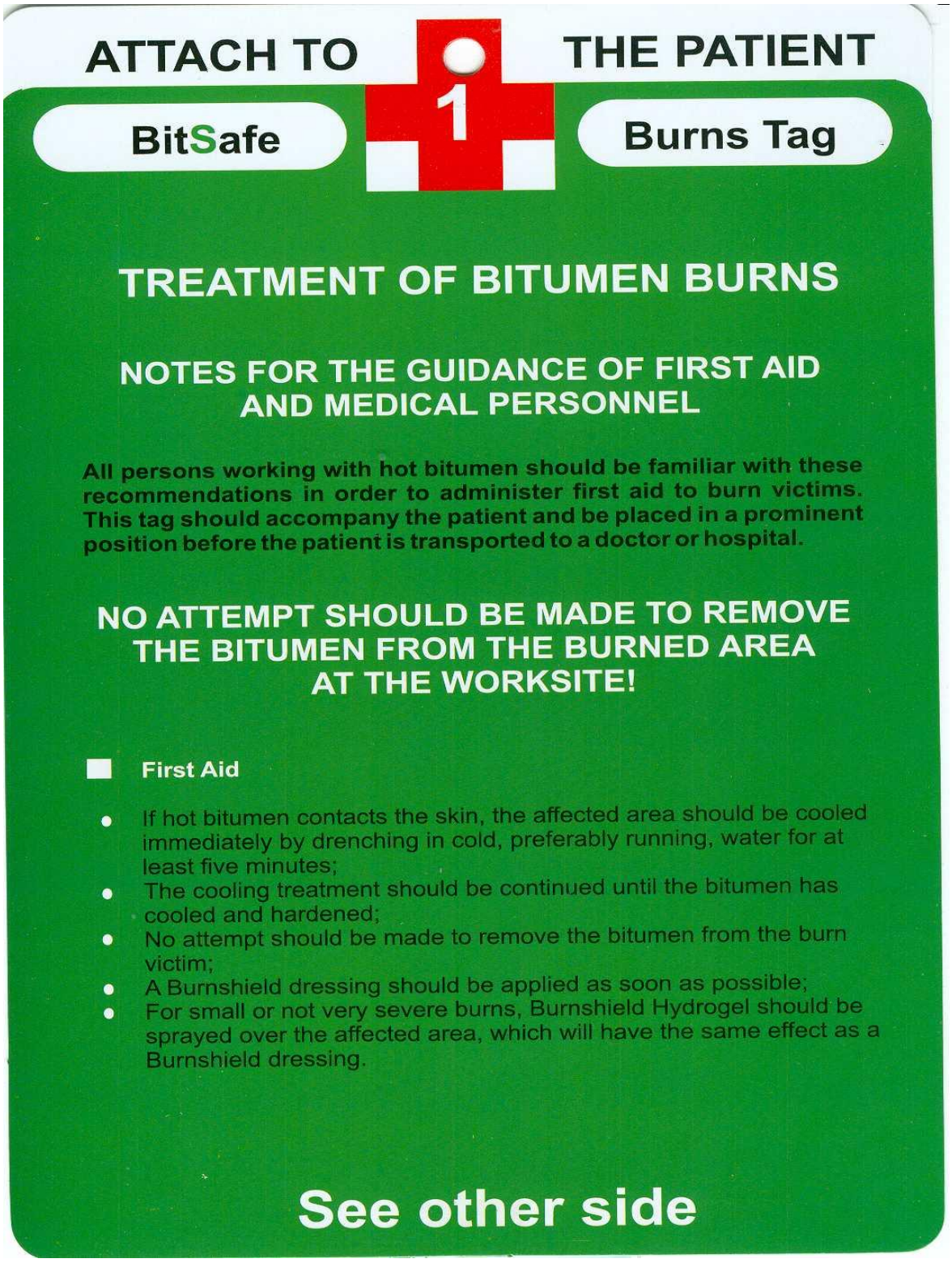
- Extinguish with dry chemical powder or fine water spray;
- Sand or earth may be used for small fires.

FIRST AID:

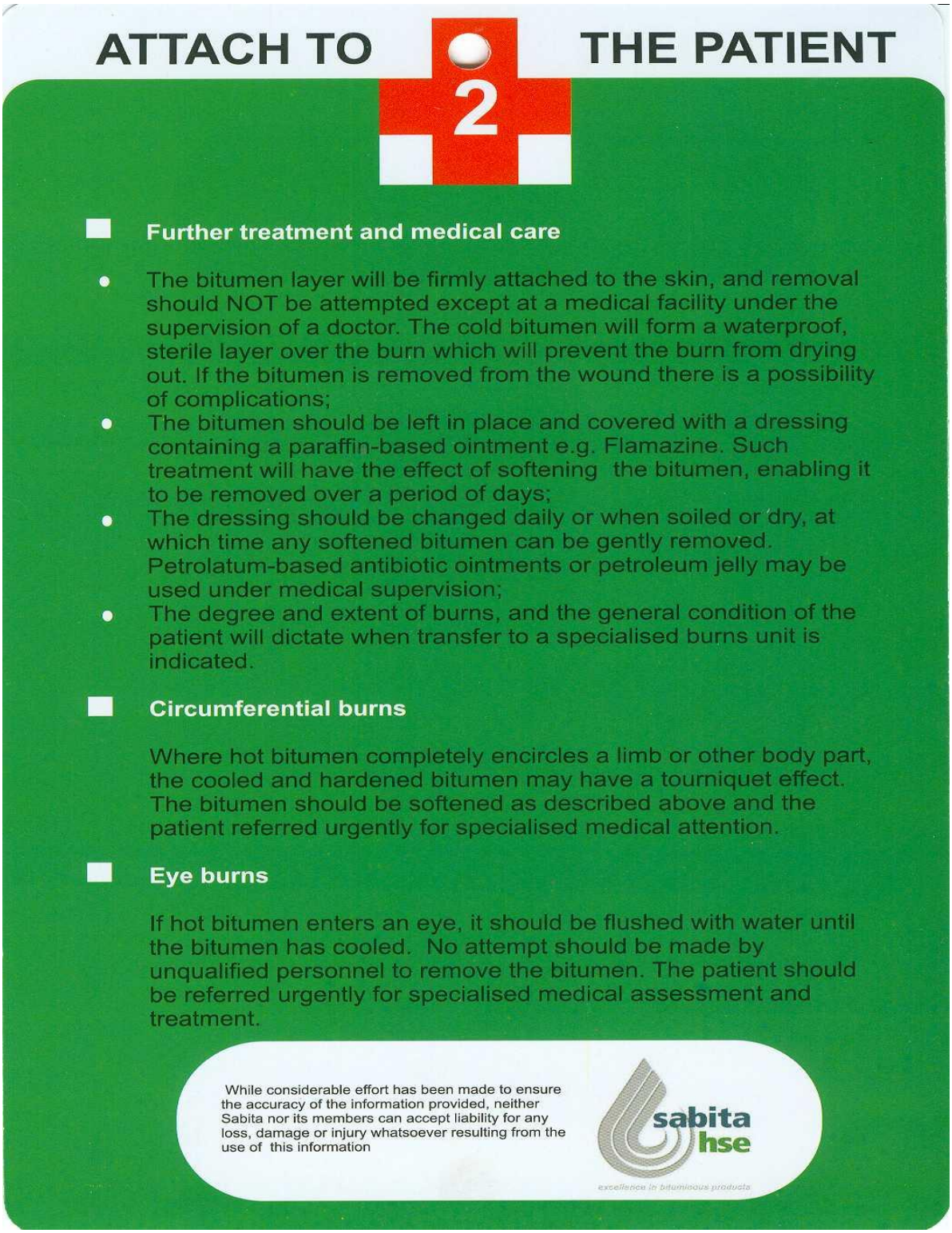
- Remove to fresh air;
- In case of contact with hot bitumen immediately flush skin (or eyes) with large amounts of cold water. ***Do not remove bitumen from skin***!

Annex H - Bitumen burns card

H.1 Front page of the bitumen burns card



H.2 Back page of the bitumen burns card



References

The following documents were specifically consulted to ensure credibility and correctness of information in connection with H_2S:

1. The Bitumen Safety Code, 4th edition, September 2005, published by the Energy Institute, London UK
2. Hydrogen Sulphide, Hazards and Precautions, Shell Safety Committee, 1986
3. Potential Risks of Hydrogen Sulphide through the Bitumen Manufacture and Delivery Process - Eurobitume, March 2021
4. Hydrogen Sulphide Emissions Elimination, Road Science, Bay of Plenty, New Zealand, May 2019 https://www.linkedin.com/pulse/hydrogen-sulphide-emissions-elimination-nik-vishwanath/

The following activity specific documents have been developed by SABITA and can be downloaded by members from the SABITA website:

5. Industry Protocol for Responding to Bitumen Spills on Land and/or Adjacent Water Environments
6. HSE Communication Note # 02/2014 - Design of facilities for the storage and distribution of bitumen and bituminous products in above-ground tanks: Tankage layout – Minimum safety distances
7. HSE Communication Note 01/2017 - Controlling Silica Dust Exposure on Asphalt Pavement Milling Machines
8. HSE Communication Note # 02/2017 - Bitumen paver vehicles - Rear underrun protection device
9. Guide for the control of HSE hazards associated with the field production of medium curing cutback bitumen
10. SABITA Manual 23 - Code of Practice, Loading bitumen at refineries, September 2010
11. SABITA Manual 29 - Guide to the safe handling of solvents in a bituminous products laboratory, September 2010
12. Sabita Manual 38: A Health & Safety Guide for Material Testing Laboratories in the Road Construction Industry
13. Code of Practice: Management of Potential Environmental Impact at Temporary Asphalt Plants
14. Bitumen Import Guide, 2013 (Currently under revision)