EnviroSim CONSULTING

Safety and Environmental Compliance Assessment of the

Sibambene Mining Supplies Rock Filla Product

for use as Stemming Material in Blasting.

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Report

Report Title: Safety and Environmental Compliance Assessment of the Sibambene Mining Supplies Rock Filla Product for use as Stemming Material in Blasting.

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DECLARATION OF INDEPENDENCE

I, Nardus Potgieter, declare that;

- I act as the independent Consultant in this safety and environmental compliance assessment;
- I do not have any vested interest (either business, financial, personal or other) in the successful certification of the stemming product for use in blasting, other than remuneration for work performed in terms of this evaluation;
- I will perform the work relating to the safety and environmental compliance evaluation in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting human and environmental toxicity and impact assessments, including knowledge of the Acts, Regulations and guidelines that have relevance to the assessment;
- I will comply with the Acts, Regulations and all other applicable legislation in performing the evaluation;
- I have no, conflicting interests in the undertaking of the activity;
- I undertake not to disclose to any party, other than the laboratories appointed to perform analysis of the stemming material and the sub-consultant appointed to perform assessment of the downstream impacts, of the material any material information in my possession that reasonably could have bearing on intellectual property held by the applicant.

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1 INTRODUCTION

1.1 BACKGROUND

The use and requirements for safety of stemming materials in blasting activities, is governed under the following National Acts:

- Explosives Act, 2003 (Act No. 15 of 2003);
- Occupational, Health and Safety Act, 1993 (Act No. 85 of 1993);
- Mine Health and Safety Act, 1996 (Act No. 29 of 1996); and
- Mine Health and Safety Amendment Act, 2008 (Act No. 74 of 2008).

The requirements for stemming materials in terms of these Acts involves compliance with regard to the application of stemming materials as well as aspects relating to the health and safety of workers involved in the use and manufacture of the stemming materials. Manufacturers of stemming materials, as well as the mines that use the materials, have to comply with national legislation in this regard.

EnviroSim Consulting was appointed by Sibambene Mining Supplies to evaluate its Rock Filla product in terms of these requirements.

1.2 REGULATORY FRAMEWORK

Section 4.14(2) of the Regulations Relating to Explosives, published as Government Notice R.584 under the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) states:

The employer must take reasonable measures to ensure that no explosives contained in a shot hole are initiated unless the portion of the shot hole between the explosives and the collar is stemmed and tamped by means of a material determined for that purpose by the employer after consultation with explosive manufacture or supplier.

Consequently, any mine that makes use of explosives as part of its mining operations must apply stemming in its blasting activities. Although the type of product or material used as stemming can be selected from any material agreed upon by the mine and its explosives supplier, the material used must be deemed safe to use and must not pose a risk to the health and safety of workers.

Section 21(1)(a)(i and ii) of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996) states:

Any person who designs, manufactures, repairs, imports or supplies any article for use at a mine must ensure, as far as reasonably practicable that the article is safe and without risk to health and safety when used properly, and that it complies with all the requirements in terms of this Act.

Although Section 21 places the responsibility on the manufacturer to ensure the safety of the stemming material there is also a broader responsibility on a mine to identify and manage potential health and safety hazards in the workplace. This is in accordance with Section 11(1)(a, b, & c) of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996):

Every manager must identify the hazards to health or safety to which employees may be exposed while they are at work, assess the risks to health or safety to which employees may be exposed while they are at work, record the significant hazards identified and risks assessed.

Consequently, a mine applying stemming material in its operations has a responsibility to be aware of all potential hazards associated with the use, storage or disposal of the material, and to manage these hazards in accordance with its responsibility towards the health and safety of its workers.

In order to assist mines and manufacturers of stemming material, guidance with regard to the specific requirements for stemming materials in terms of the Acts listed in Section 1.1, is provided in the South African National Standard for Stemming for Use in Blasting (SANS 120:2009). The SANS 120:2009 document includes guidance and requirements with regard to Materials Safety, Usage Safety and Environmental Compliance. Although SANS 120:2009 is in process of being withdrawn, the guidance provided in this standard can be applied in order to demonstrate compliance with regard to the requirements of the Acts listed in Section 1.1.

1.3 Objective and Scope of the Evaluation

The objective of this report is to provide Sibambene Mining Supplies (hereafter referred to as Sibambene) with referenceable proof of the safety and environmental compliance evaluation performed on its Rock Filla product. The assessment is presented in terms of the requirements stipulated in the SANS 120:2009 document, which was applied as guidance in compilation of the assessment to ensure all requirements of the Acts listed in Section 1.1 are addressed.

The evaluation is based on information presented to EnviroSim by a representative of Sibambene. The information received include laboratory test reports, analytical reports and evaluations previously conducted of the Rock Filla product. Copies of this information is attached as Annexures to this report, as required to substantiate data and findings presented.

2 MATERIALS SAFETY

2.1 Description of the Product

The Sibambene Rock Filla product is a self expanding polymer foam, packaged in a 750 ml pressurised aerosol can. The product is presented as a capped, labelled, metal, aerosol can with a separate plastic applicator nozzle attached (see Figure 2.1)

The Rock Filla product consists of a Polyurethane/Diphenylmethane Diisocyanate (MDI) polymer mixture which is a viscous liquid while under pressure inside the aerosol can. As the polymer is extruded from the can, the sheer-stress inside the spray nozzle lowers the liquid viscosity to allow application. Once exposed to moisture in the atmosphere the polymer expands, cures and hardens. The Rock Filla product makes use of a mixture of dimethyl ether, butane and propane as propellant to extrude the polymer liquid from the aerosol can.

Figure 2.1 Sibambene Rock Filla product with applicator nozzle attached.

2.2 PRODUCT MANUFACTURE

The Rock Filla product is fully imported to South Africa from a manufacturing facility in China. Raw materials used in the manufacture of the Rock Filla product are sourced internationally and is handled only at the manufacturing facility. Assessment of worker exposure to the constituents of the Rock Filla product during manufacture is therefore excluded from this evaluation. The manufacturing facility is ISO 9001:2008 certified, thus assuring consistent composition and quality of the Rock Filla product. A copy of the ISO9001 certificate for the manufacturing facility is attached as Annexure A.

2.3 Product Application

Sibambene markets the Rock Filla product for application as stemming in blast holes as well as continuous applications such as sealing of ventilation ducts. The safety and environmental compliance evaluation presented in this report, is limited to the non-continuous application of the Rock Filla as stemming in blast holes.

2.4 Flammability and Combustion Properties

2.4.1 Flame Resistance

Evaluation of the small scale fire properties of the Sibambene Rock Filla foam product was performed by the Firelab laboratory in Pretoria. The testing was commissioned by Sibambene, who made the Firelab reports available to EnviroSim for review and inclusion in this assessment.

The flammability testing was performed on two separate occasions. The flame resistance testing, conducted in August 2020, was performed in accordance with the method prescribed in Section 5.2 of the SANS 120:2009 standard. The flammability test involves suspending a cured cylinder of the Rock Filla foam product in a clamp, at a distance of 19 mm above a Bunsen burner, which is used to apply a flame, at an angle of 25°, to the bottom of the sample. The flame is to be applied for a period of 12 seconds. Firelab tested ten separate samples of cured Rock Filla foam.

The Firelab report indicates that on application of the flame, all the cured Rock Filla foam samples tested was ignited, but 8 of the 10 self-extinguished in less than 2 seconds. The Firelab report further indicates no flaming droplets were observed from any of the samples tested. Based on the reported results, the Rock Filla foam product meets all the criteria for flame resistance, as set out in the SANS 120:2009 standard. A copy of the Firelab report is attached as Annexure B.

Firelab previously conducted testing of the Rock Filla foam in accordance with a method specified in the SANS 10177-9 standard for small scale fire properties. The testing was conducted in September 2016 and is concerned with the use of sprayed plastic foam products in a continuous application, such as in the sealing of ventilation ducts.

The small scale fire properties test involves covering the surface of a 1.5m by 0.15m concrete slab with the sprayed foam product, and suspending this vertically on a test frame. A flame is applied to the bottom end of the slab for a period of 10 minutes and measuring the temperature above the sample and observing the flame-spread. The test showed that the Rock Filla foam ignites immediately and burns for a period of 2 minutes after the flame is removed. A copy of the Firelab report, which also include the results from smoke toxicity testing conducted on the Rock Filla foam (Section 2.4.2), is attached as Annexure B.

The report concludes that the Rock Filla foam product is suitable for underground use in a small scale application such as stemming, but that the containers (whether full or empty) are combustible and must be managed in accordingly.

2.4.2 Combustion Product Toxicity

The SANS 120:2009 standard does not specify requirements for any other fire or flammability related properties of stemming products. However, on most stemming products further testing is conducted to determine the toxicity of combustion products generated during the flammability testing.

This further testing involves the determination of the Smoke Toxicity Index and is performed according to the procedure prescribed in Naval Engineering Standard 713 (NES713). The NES713 involves measuring the concentration of specific products of combustion from a small (1g) specimen of materials. The test uses the known lethal concentration in air (in units of parts per million) of a group of 14 gasses to derive a toxicity index from the measured concentrations of these gasses when a sample of the material is burned.

Smoke Toxicity Index testing was performed on a sample of the Rock Filla foam product in May 2017. The results reported by Firelab shows that the Rock Filla foam achieves a Total Toxicity Index of 4.01 and can be considered a 'Intermediate Smoke Toxicity Material'. According to the SANS 1867:2003 standard, the Total Toxicity Index of a plastic foam must be below 5 to be safe for use in underground mining. A copy of the Firelab report is attached as Annexure B.

2.5 Human and Environmental Toxicity

2.5.1 Introduction

In order to determine whether a substance or material poses a toxic risk to humans or the environment, the basic paradigm for human health risk assessment is used. This paradigm was developed by the USA National Research Council and has been adopted and refined by, among other, the US Environmental Protection Agency.

This paradigm is widely applied for risk assessment and involves four interrelated steps namely; a hazard identification, a toxicological assessment, a source-pathway-receptor analysis and risk characterisation. In order to determine the potential for environmental contamination, assessment of the environmental fate and eco-toxicity of the materials investigated is also performed.

In the sections that follow, the potential for human (worker) exposure and environmental contamination from the use of the Rock Filla product in a blast hole tamping application is discussed, and the risk of toxic effects occurring is assessed. Manufacturing of the product is excluded from this assessment as the Rock Filla product is not manufactured in South Africa. The evaluation presented here is qualitative in nature as there are no measured data of exposure available to allow for quantitative assessment. In this case a qualitative assessment is appropriate, as the purpose is to determine whether potential risks of health impacts to workers exist and not to quantify these risks in the working environment.

2.5.2 Hazard Identification

The hazard identification step is essentially a review of available information for the purpose of identifying all contaminants suspected to pose hazards to human health. The characterisation of source materials for assessment is generally based on chemical and physical analysis of representative samples of the materials. However, in the case of the Rock Filla product, the product is manufactured from synthetic compounds and the composition is known. Information on the composition of the product is taken from a Materials Safety Data Sheet (MSDS), prepared by Sibambene.

Based on the information contained in the MSDS, the Rock Filla product has the following composition:

- 4,4'-Diphenylmethane Diisocyanate (MDI) 7-13%
- Higher oligomer of MDI (polymeric MDI) 7-13%
- Urethane pre-polymer blend 40-70%
- Dimethyl ether 5-15%
- Butane 5-15%
- Propane 5-15%

As in many other polyurethane products, the main component of the Rock Filla product is a blend of proprietary chemicals that provide unique properties to the product. The blend of chemicals can typically include flame retardants, blowing agents, catalysts, surfactants and a group of chemicals known as polyols. Polyols are compounds that contain multiple alcohol groups (OH), and compounds often used for this purpose are polyether polyols, which are polymers formed from cyclic ethers. Polyether polyols are high molecular weight polymers that have a wide range of viscosity and can include polyethylene glycol, polypropylene glycol, and polytetramethylene glycol. The polyol is used to react with MDI to form a pre-polymer, polymethylene plyphenylisocyanate (PAPI). PAPI is a thick non-volatile polymer gel with low toxicity.

In terms of exposure to isocyanates, the potential to occur directly relates to the volatility and molecular weight of the compounds. Isocyanates such as PAPI have low vapour pressure and because exposure mainly occurs through inhalation, the potential for exposure is significantly lower than for the other more volatile components such as MDI (Sullivan and Krieger 2001). The focus of toxicological evaluations performed on polyurethane foam products is therefore largely on the diisocyanate polymers used in polyurethane foam preparations. In the case of the Rock Filla product this is a Methylenediphenyl Diisocyanate (MDI).

In application of the Rock Filla product, the propellant allows extrusion of the polymer mixture from the pressurised can, while itself being dispersed in the atmosphere as a gas. The viscous mixture of polymer is in the form of a liquid which cures to a solid on contact with moisture. Fine droplets of the polymer mixture may remain suspended in the air, curing to fine polymer particulates following contact with moisture in the atmosphere. However, the application of the Rock Filla product to a blast hole will most likely limit the formation of airborne droplets as the product is applied in a confined space as opposed to being applied to an exposed surface.

Exposure to the Rock Filla product will therefore most likely occur during application when the polymer mixture and propellant exits the can. The most likely routes of exposure is inhalation and dermal exposure. The most likely receptors for dermal exposure to the un-cured polymer mixture is a worker applying the Rock Filla product to the blast holes. The same worker would also be exposed to the highest concentrations of airborne propellant and possibly polymer mixture droplets. Other workers located downwind of the area where the Rock Filla product is applied, may be exposed only to airborne propellant through the inhalation route.

2.5.3 Toxicological Assessment

The toxicological assessment addresses the relationship between levels of exposure and the manifestation of adverse health effects in humans. Toxicological information for the Rock Filla product is taken from a MSDS prepared by Sibambene, as well as on-line resources, and is summarised for each of the major components listed. It should be noted that there is no information available on the Rock Filla product as a mixture but only for the components individually. Synergistic effects of the components is therefore only considered qualitatively.

Urethane pre-polymer blend

For the purpose of the evaluation it is assumed that the urethane pre-polymer blend in the Rock Filla product consist mainly of polyols, specifically polyether polyols, reacted with diisocyanate polymers to form a pre-polymer compound. Available information describes the family of compounds identified as polyether polyols, as a colourless to amber viscous liquid with a slight sweet odour. Indications are that oral toxicity in general, is extremely low, with oral LD_{50} in rats reported >10,000 $mg.kg^{-1}$ for the family of compounds.

In general large molecular weight compounds are not readily absorbed through the skin. Polyether polyols are described as essentially non-irritating to skin and a single prolonged dermal exposure is reportedly not likely to result in absorption. Contact with eyes may cause temporary sensitisation, irritation and blurry vision, permanent injury is considered unlikely. The respiratory system is the main target organ for isocyanate toxicity, which occurs via inhalation of particles or vaporisation. Although volatilisation can occur with increasing temperature, it is unlikely that the Rock Filla product will reach a high enough temperature during conditions of normal usage to allow volatilisation of the pre-polymer compounds before the polymerisation reaction occurs.

Diisocyanate polymer

Methylene isocyanates can cause moderate irritation to the skin as well as skin sensitisation, in sensitive individuals, resulting in contact dermatitis. Long term exposure to methylene isocyanates can lead to discoloration and hardening of the skin. A dermal exposure LD_{50} (rabbit) of >5 000 $mg.kg^{-1}$ is reported (PubChem, 2005a).

Liquid methylene isocyanates can cause mild eye irritation and watering of the eyes, with similar effects observed from exposure to airborne mist or aerosol. Respiratory sensation has been observed among workers exposed to methylene isocyanate aerosols. Sensitised individuals can react to very low

levels (0.001 ppm) of airborne methylene isocyanate experiencing symptoms ranging from runny or congested nose to difficulty breathing, coughing and shortness of breath. Sensitisation can occur from a very large, or by multiple exposures (PubChem, 2005a).

Long term inhalation exposure to methylene isocyanates may cause impaired lung function, and is likely to aggravate existing respiratory disease. The Occupational Safety and Health Administration (OSHA) has set a legal limit of 0.02 parts per million (ppm) for TDI and MDI in workplace air; these are "not-to exceed" levels. The National Institute for Occupational Safety and Health (NIOSH) has set a recommended limit of 0.005 ppm for monomeric 4,4' MDI in workplace air during a 10-hour workday, 40-hours workweek.

There is inadequate evidence for the carcinogenicity of methylene isocyanates in humans. There is limited evidence in experimental animals for the carcinogenicity of a mixture containing monomeric and polymeric diisocyanate. Overall, methylene isocyanates (industrial preparation) is not classifiable as to its carcinogenicity in humans (Group 3). Under U.S. EPA's 1996 Guidelines for Carcinogenic Risk Assessment, monomeric or polymeric methylene isocyanates would be classified as not classifiable or a Group D chemical (PubChem 2005a).

Propane/Butane/Dimethyl Ether Propellant Mixture

All three components of the Rock Filla propellant mixture are described as a colourless gas with a faint petroleum-like odour. The gases are easily ignited and its vapours are heavier than air. The primary route of exposure to all three components, and presumably also the mixture, is by inhalation.

The target organ following inhalation exposure is the central nervous system. For butane and propane the main symptoms of inhalation exposure include, dizziness, disorientation (confusion), excitation (hallucinations, euphoria); nausea, vomiting and unconsciousness. For dimethyl ether (DME) an anaesthetic effect (depression of the central nervous system) is mainly observed, with associated symptoms of dizziness, lack of coordination and unconsciousness.

Data from both human and experimental animal exposure studies are available. Human exposure data for butane and propane is derived largely from case studies of volatile substance abuse. According to the data, the safety margin between anaesthetic and lethal concentrations appears to be very narrow. Sudden death may occur when butane or propane is inhaled at high concentrations. Data from both human and experimental animal exposure studies indicate that chronic exposure has been reported to cause some symptoms in the central nervous system.

Dermal exposure to the components, or mixture, in liquid form can cause severe frostbite. Propane, when used as an aerosol propellant with butane in deodorant and antiperspirant products (65 to 70%), has not been shown to cause skin irritation in 125 human volunteers who applied the aerosol products twice daily for 12 weeks (PubChem 2005b).

No studies on carcinogenicity, reproduction toxicity and teratogenicity, immunotoxicity or allergy from exposure to butane or propane were located in the available literature (PubChem 2004, 2005b). With

regards to cancer classification, dimethyl ether is listed as Group D, Not Classifiable as to Human Carcinogenicity (PubChem 2005c).

2.5.4 Source-pathway-receptor analysis

The purpose of the Source-pathway-receptor analysis is to evaluate whether a complete human exposure pathway exists under reasonably anticipated conditions of use. Information presented in the toxicological evaluation of the Rock Filla product indicated that the most prominent health effects are likely to result from inhalation exposure to aerosol and gasses emitted to the atmosphere during use. Among the major components of the Rock Filla product, the methylene diisocyanate polymer and the propellant gas mixture present the primary components of concern for these health effects.

With the source of the potential hazard and the pathway of its propagation identified, the question becomes whether workers can be exposed to concentrations of the components of concern, significant enough to cause health effects.

With regard to the diisocyanate polymer, medical literature reporting human exposure to MDI, mainly site cases of exposure to the monomeric form. Clinical and experimental evidence shows that exposure to MDI monomers produce the health effects noted in Section 2.5.3. In spite of this, medical literature further reflect that both monomeric and polymeric MDI has a good industrial safety record. Even where direct chronic and long term exposure occurred in the workplace, the expected pulmonary effects on workers were not observed where adequate safety controls are in place (Sullivan and Krieger 2001).

Industrial hygiene work on human exposure standards for MDI has been focussed on the monomeric form. The limits noted in Section 2.5.3 is therefore applicable only to volatile diisocyanate monomers. Exposure limits for the pre-polymeric diisocyanate do not exist, because their volatility is so low and toxicity hazard is minimal (Sullivan and Krieger 2001). In polyurethane foam spray products, such as the Rock Filla product, MDI is largely present in pre-polymeric form. Upon application of the product, the polymerisation reaction (curing) occurs rapidly, binding any free MDI in the polymer matrix. In a bulk application it can be expected that some volatilisation of diisocyanate monomer can occur, as curing times are generally longer. However, where small quantities of the product is discretely applied, curing is expected to occur faster and the potential for volatilisation of MDI is likely to be considerably lower.

In order to determine whether the use of the Rock Filla foam product in an underground scenario could expose workers to diisocyanates, Sibambene had a test performed by the Armscor Protechnic Laboratories. The test was performed in August 2020 and involved spraying the contents of a can of Rock Filla foam product for a period of 20 seconds onto a cardboard surface suspended at a height of 1.75m above the floor of a small, unventilated, closed room (3.43mx2.46mx2.4m) while measuring airborne concentrations of diisocyanates. The measurement was collected at a distance of 1m from the cardboard surface. The test was performed three times, each time using a new can of Rock Filla foam product

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The Armscor test measured no diisocyanates in the air during use of the Rock Filla product. A copy of the test report is attached as Annexure C.

Based on this result it is considered unlikely that worker exposure to isocyanates suspended in air can occur from use of the Rock Filla product in a tamping application.

Where the propellant mixture is concerned, in application of the Rock Filla product the propellant will be dispersed in the atmosphere as a gas following release from the pressurised aerosol can. Workers involved in the application of the product will be directly exposed, however it is expected that the concentrations of the propellant gasses released during the recommended 1 second application of the Rock Filla product for tamping blast holes, will be very low.

Other routes of exposure likely under normal conditions of use include dermal exposure and potentially accidental eye contact to the Rock Filla product. These exposures should be easily avoidable and can be managed through the correct application of personal protective equipment.

2.5.5 Environmental Fate

Evaluation of the behaviour and fate of potentially hazardous compounds in the environment is essential to determine whether use or disposal of a product which contain these compounds could result in the contamination of environmental media. The following information presented for the major components of the Rock Filla product is summarised from the PubChem (https://pubchem.ncbi.nlm.nih.gov/compound/) database entries for each compound.

Diisocyanate polymer

Methylene diisocyanate polymer has a vapor pressure of 5.0E-6 mm Hg at 25 deg C, which indicates that in air the polymer may exist in both the vapor and particulate phases. Vapor-phase polymer is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals. The half-life for this reaction is estimated to be 11 hours. In the solid (particulate-phase) methylene isocyanate polymer will be removed from the atmosphere by wet or dry deposition.

If released to water or moist soil, methylene diisocyanate polymer is not expected to leach or adsorb to solids. This is due to the rapid hydrolysis (curing) that takes place when the polymer is in contact with moisture. Furthermore, because the reaction of methylene isocyanate polymer with water forms amines and urea, accumulation in the food chain should be low or non-existent.

Propane/Butane/Dimethyl Ether Propellant Mixture

The vapour pressure of all three components of the Rock Filla product propellant mixture imply that it will exist solely as a gas in the atmosphere. In the gas-phase all three compounds will degrade in the atmosphere by reaction with photochemically-produced hydroxyl radicals, with half-lives for this reaction estimated at 14 days for propane, 6 days for butane and 5.4 days for dimethyl ether. The compounds does not does not contain chromophores and thus is not expected to be susceptible to direct photolysis by sunlight.

If released to soil, butane and dimethyl ether is expected to have very high mobility based upon a reported log K_{oc} of 40 and 27, respectively, while a log K_{oc} of 460 for propane implies only moderate mobility in soil. Volatilisation from both dry and moist soil surfaces is expected to be the primary fate process for all three compounds. In soil biodegradation of both propane and butane occurs readily while biodegradation of dimethyl ether is a slow process.

If released into water, propane is expected to adsorb to suspended solids and sediment, while butane and dimethyl ether will not. Volatilisation from the water surface the most likely fate for all three compounds with modelled half-lives for this process estimated to range from 1 hour to 3 days. While both butane and propane are expected to biodegrade in water, dimethyl ether will not. Based on a published bio-concentration factor (BCF) of 40, the potential for bio-concentration of butane in aquatic organisms is considered moderate while BCF values of 3 and 13 imply that the potential for bioaccumulation of dimethyl ether and propane is low.

2.5.6 Risk characterisation

Risk characterisation involves the integration of the components described above, for the purpose of determining whether adverse health effects are likely to occur under the evaluated conditions of use or exposure. The most important aspect of this process is the source-pathway-receptor analysis, which determines whether a complete human exposure pathway exists under reasonably anticipated conditions of use.

Based on the information presented in Section 2.5.4, it is concluded that worker exposure to small quantities of the propellant mixture is possible from use of the Rock Filla product in a tamping application. However, under reasonably expected conditions of use, as recommended by Sibambene, concentrations of the chemicals in air are expected to be low as the application of the Rock Filla product is in the form of small discrete quantities released over a short period of time (1 second). Propellant released during the 1 second application period is expected to be readily dispersed in air. Inhalation exposure to the components of the Rock Filla product, even of workers directly involved in the application of the product, is consequently expected to be limited and no adverse health effects are expected to occur. Furthermore, based on the references consulted, none of the major components of the Rock Filla product are classified as carcinogenic, mutagenic or teratogenic.

With regards to other routes of exposure (e.g. dermal exposure or eye contact), the available toxicological data indicate that for all major components of the Rock Filla product, only mild eye irritation and watering of the eyes can result from contact with the methylene isocyanate polymer, while long term dermal exposure to the polymer could lead to dermatitis through sensitisation of the skin. Neither of these are considered serious health effects and both routes of exposure are effectively managed through application of personal protective equipment, as recommended by the supplier. The only other potential risk noted is the occurrence of frostbite from dermal exposure to the propellant mixture. This is likely to occur due to exposure to the pure liquid form of the propellant and no information is available for mixtures of the propellant with other substances. It is accepted that once released from the aerosol can, most of the propellant is in the gas phase and no longer a liquid. It is therefore assumed that the quantity of the propellant which can be applied to the skin from the Rock

Filla product is unlikely to result in exposure significant enough to cause frostbite, under normal conditions of use.

With regards to toxic risks posed to the environment, the information available on the environmental behaviour and bioavailability of the major components of the Rock Filla product indicates that the propellant and diisocyanate polymer are unlikely to accumulate in the natural environment and will either form inert suspensions or volatilise to the atmosphere from soil or water. While the propane component of the propellant is likely to accumulate in soil or sediment, its reported low bioavailability precludes uptake into the aquatic or terrestrial food chain. Toxic effects as a result of the presence of this compound in the environment is therefore unlikely due to the low probability of exposure.

Based on the evaluation of the available information, it can be stated with a reasonable level of confidence that the Rock Filla product does not pose a toxic risk to humans or the environment under normal conditions of use, as prescribed by the supplier. This is in accordance with the requirement stipulated under Section 4.2.3 of the SANS 120:2009 standard.

2.5.7 Materials Safety Data Sheet

A further requirement of the SANS 120:2009 standard is that all potential risks to health and safety associated with the stemming material must be presented in a MSDS. The SANS 120:2009 standard does not provide guidance on the contents of the MSDS required for compliance. However, there are two other SANS standards (SANS 11014:2010 and SANS 10234:2008), which can be consulted in this regard.

An MSDS prepared by Sibambene for the Rock Filla product, was made available to EnviroSim for review. The Sibambene MSDS takes recognition of the abovementioned SANS standards and is sufficient in scope and detail to be considered in compliance with the requirements of the SANS 120:2009 standard. A copy of the Sibambene MSDS for the Rock Filla product is attached as Annexure D.

However, it should be noted that the purpose of an MSDS is simply to identify all potential hazards (that is, physical hazards, health & safety hazards as well as environmental hazards) associated with a particular substance or product, in order to inform users of the substance or product of the potential hazards, or serve as input to an occupational risk management plan. An MSDS is not intended to provide any evaluation of the identified hazards to determine the actual risks associated with the substance or product. Consequently, an MSDS should be used with caution as the mere presence of a potential hazards (for example the presence of a hazardous substance) does not imply that there is a risk of exposure to this hazard.

2.6 Chemical Compatibility

The compatibility of the Rock Filla product with explosive products was tested by two companies, AEL Mining Services and SASOL. Letters from both companies confirming compatibility is attached as Annexure E.

The AECI compatibility testing was performed in November 2016 and involved mixing of the uncured Rock Filla foam with the AEL S100 emulsion product, and heating the mixture to 60 °C while measuring the temperature of the mixture over a period of 3 days. The investigation found that no temperature increase could be detected and that the emulsion retained its physical appearance over the entire testing period. The AEL report concludes that the Rock Filla is non-reactive with AEL's emulsion products and is compatible for use as stemming materials with emulsion products.

The letter from SASOL Chemicals, dated June 2016, confirms that the Rock Filla foam product is compatible with its bulk emulsion explosives and Sasol Expanfo range of explosives.

2.7 Electrostatic Build-up

Based on the understanding of the composition and physical characteristics of the Rock Filla product, as well as information provided (verbally) by a representative of the company supplying the product (Sibambene), it is understood that the Rock Filla foam is not susceptible to electrostatic build-up. This aspect is therefore not assessed as part of this evaluation report.

3 USAGE SAFETY

3.1 Introduction

The evaluation of usage safety for stemming materials is concerned with the damage that application or removal of the stemming could have on the explosives charged to the blast hole, or the blast initiation system. Specific attention is given to misfires where the stemming material have to be removed from the blast hole to allow for removal of initiation devices and explosives. The removal of misfires is a high risk activity and stemming material, ideally, should not be an impediment to the removal or present a risk of initiating an explosion.

The evaluation of usage safety in this assessment is limited to presenting the usage instructions provided by the manufacturer. A copy of the instruction and information documentation distributed by Sibambene with the Rock Filla product is attached as Annexure F.

3.2 Manufacturer's Instructions

Application of the Rock Filla product as stemming is described as follows:

- Rock Filla Tamping foam is a multi-component system and it is imperative to shake the canister before use.
- It is also advisable to connect the applicator nozzle after shaking.
- Once the canister is shaken and the nozzle connected the application of Rock Filla Tamping Foam can commence, there is a safety mechanism built into the canister that requires the canister to be

angled at an angle of at least 0° with the horizon, it can also be used inverse.

- When depressing the trigger attention must be given to the volume of Rock Filla Tamping Foam expelled as the Rock Filla Tamping Foam expands rapidly. The average 34mm hole will require the trigger to be depressed for 1 second to expel enough foam for efficient tamping.

The instructions specify that application of the Rock Filla to blast holes should proceed against the flow of ventilation. This is to prevent inhalation exposure to the uncured product and expelled propellant chemicals.

With regards to removal of the tamp, the usage instructions indicate that the foam plug can be cut and scraped from the hole with an aluminium or copper scraper wire, followed by washing out the hole with water. It is understood that Sibambene presents a course to prospective mining clients on the use of the Rock Filla product. The course is presented to personnel that use, or oversee the use, of the Rock Filla as stemming product.

4 ENVIRONMENTAL COMPLIANCE

4.1 INTRODUCTION

Environmental compliance is a requirement noted in the SANS 120:2009 standard and is not an aspect specifically related to the health and safety requirements of the Acts listed in Section 1.1. However, it is good practice to consider not only immediate exposure of humans in the workplace to the potentially harmful components of a stemming material, but also potential long term effects that use of the materials may have on the environment.

Environmental compliance, as noted in the in the SANS 120:2009 standard, is concerned mainly with the disposal of stemming materials or its packaging and refers to the general environmental performance standard stipulated in SANS-14001. The requirements of SANS-14001 will apply to the mine where the stemming material is used, and as general standard for the performance of the environmental system employed at the mine, refers to the compliance of the mine with the environmental authorisations it has in place for its operations.

In terms of waste management and disposal, the mine will have to comply with the Waste Classification and Management Regulations, developed under Section 69 of the Waste Act (Act 59 of 2008), and has been published under Government Notice R634. In terms of SANS120:2009, the manufacturer of the stemming material will therefore have to demonstrate compliance through classification of the materials and packaging in accordance with the Waste Classification and Management Regulations.

The evaluation of environmental compliance presented here, therefore draws on the toxicity and environmental fate data presented in Section 2.5 to provide a classification of the stemming material in terms of the waste management regulations. Potential risks associated with release of the material

into the environment is also discussed and general precautions with regard to handling and storage are highlighted.

4.2 Material Characterisation and Classification

The approach used for the classification of waste, as prescribed under the National Norms and Standards for the Assessment of Waste for Landfill Disposal (GNR 635), involves the determination of a Risk Profile for the waste, by following prescribed testing and leach testing protocols. Results of the testing and analysis are then assessed against threshold levels for Leachable (LCT) and Total Concentrations (TCT).

Since the Rock Filla foam is manufactured from synthetic compounds, the composition is known making it unnecessary to perform compositional analysis. The major components of the Rock Filla product are also not listed among the LCT and TCT values published in GNR 635. Classification of the Rock Filla product using the standard approach is therefore not possible, and will have to be based on what is known of the toxicity and environmental behaviour of the major chemical components of the product.

The information presented on the environmental fate of the major components of the foam indicate that the cured polymer has a low water solubility and none of the individual components are expected to leach from the cured foam product, should it enter the environment.

In its cured form, the Rock Filla foam product is unlikely to present any risk of exposing humans or the environment to any of its components in a form that is likely to cause any toxic effects. The cured Rock Filla foam product, should it enter the environment, will most likely remain chemically stable, and should it be released into water, is unlikely to leach hazardous compounds to the water. It has also been demonstrated that during combustion of the Rock Filla foam product combustion product toxicity is limited. In its cured form, the Rock Filla foam product is therefore classified as a general, non-hazardous, waste (Type 4), which can be managed and disposed of with other general wastes.

The Rock Filla aerosol can, also becomes waste once it has been used. Since the can is pressurised it has the potential to explode if heated or ruptured. This represents a physical hazard associated with the product. Explosion, as physical hazard, is one of the reasons why aerosol cans are generally managed as potentially hazardous wastes at mining and mineral processing facilities. In according to GNR 635, any waste which have the potential to be explosive under the conditions of a landfill, is prohibited from being disposed at a landfill.

The potential risk of explosion further has an effect on the management, transport and storage of the Rock Filla product, as it presents a risk in the working environment. This is similar to any other pressurised aerosol used in the mine working environment. It is therefore recommended that any mine which decide to implement use of the Rock Filla product, implement the existing procedures for the management, transport, storage and disposal of aerosol cans, as well as the procedures recommended by Sibambene for management and storage of the product (see Annexure F).

5 IMPACTS TO DOWNSTREAM ACTIVITIES

5.1 GENERAL

The purpose of this section is to present information available on the potential physical, chemical and metallurgical impacts that the use of stemming material may have on downstream materials handling and mineral extraction processes. Although this is not part of the health and safety requirements of the Acts listed in Section 1.1, or even an aspect noted in the SANS 120:2009 standard, it is considered good practice to consider all potential impacts relating to the use of the stemming material.

An evaluation of the potential impacts of the Rock Filla product on metallurgical plant processes was performed by Coremet consulting metallurgists. The Coremet (2017) report presents a high level evaluation and considers all major commodities and associated process steps. The potential impacts associated with the physical characteristics of the Rock Filla product on materials handling, recoverability of the foam in separation processes, and chemical influences from the product on hydrometallurgical processes are assessed. A copy of the report is attached as Annexure G.

The Coremet (2017) report concludes that the use of polyurethane foam in larger continuous applications, other than stemming, has the potential to enter the mineral processing chain and cause blockages in process components. However, the discrete use of the Rock Filla product as stemming material is not expected to have any measurable effect on the processing of ore.

6 CONCLUSION

Based on the evaluation presented above it can be confirmed that Sibambene has provided satisfactory proof that its Rock Filla product fulfils the requirements for usage safety and environmental compliance in accordance with Section 21 of the Mine Health and Safety Act, 1996 (Act No. 29 of 1996), as stipulated under the SANS 120:2009 compliance criteria.

7 REFERENCES

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