

# **APPENDIX 8: MAJOR HAZARDOUS INSTALLATION ASSESSMENT**



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**MHI SCREENING**  
**of the**  
**SODIUM DICHROMATE PROCESS IN MIDDELBURG**  
**for**  
**ENVIRONMENTAL SCIENCE ASSOCIATES**  
**(Revision 2)**  
**December 2007**

Prepared by:


A handwritten signature in black ink, enclosed in an oval. The signature appears to read "H F B Minnaar".

Dr H F B Minnaar  
Managing Director

### Report Summary Sheet

<b>Client:</b> Environmental Science		<b>Client Contract No.</b>
<b>Title of Report:</b> MHI Screening on the Sodium Dichromate Process in Middelburg for Environmental Science Associates		
<b>Summary:</b> (Brief description of report) This report deals with the possible risks associated with the proposed Sodium Dichromate process in Middelburg		
<b>Indexing Terms:</b> (keywords) Environmental Science Associates MHI Screening SO <sub>2</sub> NH <sub>3</sub> H <sub>2</sub> SO <sub>4</sub>		
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## TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY .....	1
1.0 INTRODUCTION .....	2
2.0 PROCESS DESCRIPTION .....	2
3.0 RISK ASSESSMENT .....	8
3.1 Definitions.....	9
3.2 Sulphur Dioxide .....	10
3.3 Consequence Analysis .....	11
4.0 CONCLUSION .....	21

## EXECUTIVE SUMMARY

The purpose of this document is to present the results of a Major Hazardous Installation screening exercise on the proposed Sodium Dichromate process in Middelburg.

From the process description the flowing hazardous chemicals could be identified:

- SO<sub>2</sub> (storage of 2 x 25 tonnes containers)
- H<sub>2</sub>SO<sub>4</sub> (storage of 2 x 150tonnes tanks)
- NH<sub>3</sub> from (NH<sub>4</sub>)<sub>2</sub>SO<sub>4</sub> (approximately 0.5tonnes/hour)
- Cr-6

Since NH<sub>3</sub> is not stored on site the volume which can be released due to a process upset or failure of equipment should be evaluated once the hardware design is completed. At present this is not seen as a substance which would result in the facility having an MHI status.

Although Cr-6 is carcinogenic (due to the reduction product Cr-5) and contact with the skin will result in skin ulcers, this substance should be handled with the necessary precautions but would not result in the facility having MHI status.

The accidental release of H<sub>2</sub>SO<sub>4</sub> could result in multiple fatalities to employees and damage to the environment if not contained and dealt with properly. This substance could contribute to the MHI status of the facility but should be re-evaluated once the hardware design is completed.

SO<sub>2</sub> is a toxic substance which could lead to multiple fatalities when released in large quantities to the atmosphere. At this stage the mechanism for release is not considered; however, for screening purposes worst case scenarios were analysed, where the total quantity of a storage container is released to atmosphere in a relative short period of time.

From the above analyses, it follows that the accidental release of H<sub>2</sub>SO<sub>4</sub> and SO<sub>2</sub>, would render the facility an MHI. The mechanisms for the different scenarios should be evaluated once the hardware design is completed.

## 1. INTRODUCTION

The purpose of this document is to present the results of a Major Hazardous Installation screening exercise on the proposed Sodium Dichromate process in Middelburg.

## 2. PROCESS DESCRIPTION

Chromite is taken from nearby existing stock pile and stored in a 700m<sup>2</sup> concreted storage area. From there it is lifted by a bucket wheel loader into a 5m<sup>3</sup> hopper feeding a continuous buckets elevator that leads to the feed silo of the grinding unit. Chromite must be conveyed to the feed silo of the grinding unit at the rate of 80t.p.h.

The chromite is dried and ground to the required size in a closed circuit air-swept ball mill. The mill is heated by a gas burner (natural gas).

The chromite is pneumatically transported to the mixing unit silos. Powdered soda ash is pneumatically unloaded from road tankers into a storage silo.

The mixing unit is fed from three, silos :

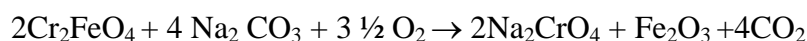
- Chromite received from milling
- Soda ash received from truck
- Recycle received from drying section.
- 

The materials are fed to an additive weighing belt, or similar device, by screw feeds and drop into a continuous mixer.

It is anticipated that all emissions of Chrome ore milling and Mixing section, will be treated in the bags filter.

The mixture containing chromite powder and soda ash, prepared in stage is fed in metered quantities, to a refractory lined rotary kiln with direct gas firing, The material flow is counter to that of the hot gases and the temperature of the material may reach up to 1200°C.

The overall reaction may be represented by the equation:



The lumps of hot material discharged from the kiln are crushed, in a wet ball mill or grizzly mill, and then ground in a mixture of sodium chromate and sodium dichromate solutions. Lixiviation is continued in the quench tank, where the rest of the soluble matter goes into solution.

Dust is removed from the off-gases leaving the kiln at a temperature of 600-800°C by means of a settling chamber. The gases are cooled to a temperature of 250°C by passage through a recuperator and stripped of remaining dust by an electrostatic precipitator.

The kiln is fired by Sasol gas, and may also be fed by furnace gas.

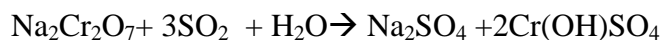
The slurry formed when the product of chromite roasting is lixiviated with a mixture of sodium chromate and sodium dichromate solutions is held in a stirred vessel until it is vacuum belt filtered.

Vapours from the belt filters will be passed through condensation units, and scrubbed before venting to atmosphere.

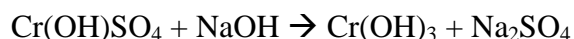
The cake coming from the belt filters is conveyed to two repulpers, one feeding the residues treatment section for disposal and a second feeding the residues drying section for recycling to raw material feed.

In front of the residues drying section a rotary drum filter is installed to obtain a cake that flows directly to the dryer. The dry residue is discharged in the off-gas stream and carried to cyclone separators at the top of the recycle ore main feed silos. The whole drying unit is kept under reduced pressure by means of a controlled exhaust fan at the air-outlet side of the cyclone, and the air is purified by a well oversized bag filter. The treated gases will be conveyed to the stack C-3 by a suitable duct, the dust content in the stream will be continuously recorded.

Cake from the filtration stage is treated with SO<sub>2</sub> liquid, in an acidic ambient, to convert residual Cr-six into Cr-three. The overall reaction may be represented by the equation



The modification of pH by NaOH will precipitate the chromium as a hydroxide



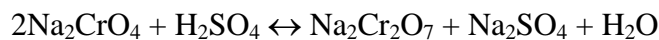
The resulting slurry is press filtered, and the cake recycled to raw material feed. While the filtrate solution is concentrated through evaporation and flashed flash dried to produce sodium sulphate cake. Vapours are passed through a condenser and scrubbed before venting to atmosphere..

Cleaned monochromate filtrate from filtration stage is steam-heated and treated with sodium hydroxide and calcium oxide or hydroxide. The calcium vanadate thus produced, is separated from the sodium chromate solution by a filter system,.

The pH value of the alkaline filtrate is adjusted by addition of sodium carbonate solution to precipitate calcium carbonate. The calcium carbonate formed is filtered from sodium chromate solution, slurried and transferred to the vessel in which the calcium vanadate is collected.

Heat is supplied by steam.

Concentrated sodium chromate solution from the previous stage is treated with concentrated sulphuric acid. Chromate is converted to dichromate with fatal production of Sodium Sulphate in a reversible reaction in accordance with the equation



Sodium monochromate and sulphuric acid are fed into the reactor. The monochromate is changed to dichromate and sodium sulphate is precipitated..

The slurry, dichromate – sodium sulphate produced in the acidifier, is separated by centrifuge. The overflow containing mainly sodium dichromate, is conveyed to a concentration unit.

This cake is conveyed to a dissolver tank from which, the saturated solution, is pumped to the purification.

All the equipment in the separation process is gas tight under reduced pressure and finally the off-gas stream is washed in a scrubber system and released to atmosphere.

The sodium sulphate solution contains Cr-six that must be reduced to Cr-three and separated from the sodium sulphate solution.

Cr-six reduced by a feed of Sulphuric acid together with sodium bisulfite. Once that Cr-six is converted to Cr-three the solution of sodium sulphate is conveyed to a precipitation reactor, fed with sodato precipitate Cr (OH)<sub>3</sub>.

The slurry is fed to a press filter where the wet cake of Cr hydrate is eliminated and can be transported to the chromite stock pile.

The solution of white sodium sulphate is firstly concentrated in an evaporation system. The resulting oversaturated solution of sodium sulphate is centrifuged to obtain sodium sulphate.

The cake is dried in a flash dryer system and finally conveyed to silos from which a big bags packing system or trucks are fed.

Sodium dichromate solution is concentrated in a two stage vacuum evaporation unit,

Concentrated sodium dichromate solution is fed to a continuous vacuum evaporator. The mother liquor is separated from the crystals in a continuous centrifuge and returned to the feed tank of the crystallizer.

The moist crystals of sodium dichromate anhydrous produced are dried in a rotary dryer through which hot air is passed. The air may be preheated in a steam heat-exchanger or by a gas heater.

The hot crystals discharged from the dryer are cooled in counter stream of cold, dry air and directed to the feed silo of the packaging unit.

The drying and filling systems are maintained under reduced pressure to prevent the escape of particulates .

The exhaust air (from both the drying and filling units) is scrubbed before being discharged to atmosphere. The contaminated water is pumped to a process water storage tank.

Basic chrome sulphate will be obtained from sodium dichromate from the first concentration unit.

SO<sub>2</sub> is obtained in a sulphur burner, to obtain a 10-12% gaseous stream of SO<sub>2</sub> which, is cooled down by water quenching.

The columns work in counter current SO<sub>2</sub> from one side and solution of dichromate from the other side.

The process begins with the production of ammonium dichromate. The reaction is made between the sodium dichromate solution continuously fed to a reactor, and ammonium sulphate solid. The reaction products are ammonium dichromate and sodium sulphate.

The sodium sulphate is almost completely dissolved in the ammonium dichromate solution. This solution is fed to a concentration unit where, due to water evaporation, sodium sulphate precipitates as crystals.

The concentrated slurry is conveyed to a centrifuge which separates sodium sulphate cake from ammonium dichromate solution. The sodium sulphate cake is repulped and conveyed to the sodium sulphate purification unit.

The sodium dichromate solution is filtered, in a press filter to get rid of the last fines of sodium sulphate. The ammonium dichromate is obtained solid from the solution via a crystallizer. From the crystallizer the slurry is conveyed to a centrifuge from which ammonium dichromate is obtained as cake, while mother liquors are recycled.

The cake of ammonium dichromate is fed to two kilns where ammonium dichromate is calcined to  $\text{Cr}_2\text{O}_3$ . From the calciner the chrome oxide is piped into a frit tank and from that processed with one/two washing steps each made by drum filter and repulping.

A water collection system will be installed with the intent to neutralize any possible contaminated stream coming from first flush of rainy water or accidental leakages. The system will be designed for a 1 in 100 years maximum rain event.

The water treatment is done in a reduction reactor where in an acid ambient, via sodium bisulphite or  $\text{SO}_2$  the Cr-six is reduced to Cr-three. Following this step a second reactor will be installed to modify the pH, with lime or soda, in order to precipitate Cr-three.

The precipitated Cr-three sludge will be thickened in one specific thickener from which the slurry is conveyed to a press filter, while the decanted water clean is stored for production requirement or discharged to the local stream.

The slurry will be press filtered, and sent to the residue treat.

### 3. RISK ASSESSMENT

From the process description the following hazardous chemicals can be identified:

- $\text{SO}_2$  (storage of 2 x 25 tonnes containers)
- $\text{H}_2\text{SO}_4$  (storage of 2 x 150 tonnes tanks)
- $\text{NH}_3$  from  $(\text{NH}_4)_2\text{SO}_4$  (approximately 0.5 tonnes/hour)
- Cr-6

Since  $\text{NH}_3$  is not stored on site, the volume which can be released due to a process upset or failure of equipment should be evaluated once the hardware design is completed. At present this is not seen as a substance which would cause the facility an MHI status.

Although Cr-6 is carcinogenic, by the respiratory route (due to the reduction product Cr-5), and contact with the skin may result in skin ulcers or allergic reactions, it would not result in the facility being MHI status, but this substance should be handled with the necessary precautions but.

The accidental release of H<sub>2</sub>SO<sub>4</sub> could result in multiple fatalities to employees and damage to the environment if not contained and dealt with properly. This substance could contribute to the MHI status of the facility but should be re-evaluated once the hardware design is completed.

SO<sub>2</sub> is a toxic substance which could lead to multiple fatalities when released in large quantities to the atmosphere. At this stage the mechanism for release is not considered and for screening purposes a worst case scenario was analysed where the total quantity of a storage container is released to atmosphere in a relative short period of time. This analysis is discussed in the following sections.

### 3.1 Definitions

The TLV-TWA-RL value (Threshold Limit Value-Time Weighted Average-Risk Limit value) is the concentration of an airborne substance, average over a period of 8 hours, at which, according to current knowledge, there is no evidence that it is likely to be injurious to employees if they are exposed by inhalation, day after day, to that concentration.

The TLV-STEL (Short Term Exposure Limit) value (short term (Occupational Exposure Level) OEL-RL) is the concentration of an airborne substance, averaged over a period of 15 minutes, at which, according to current knowledge, there is no evidence that it is likely to be injurious to employees if they are exposed by inhalation to that concentration.

The IDLH (Immediately Dangerous to Life and Health) value is the airborne concentration where humans will experience immediate danger to life or health after an exposure time of 30 minutes.

The ERPG-1 (Emergency Response Planning Guideline) is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1h without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour.

The ERPG-2 is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1h without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.

The ERPG-3 is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.

### 3.2 Sulphur Dioxide (SO<sub>2</sub>)

SO<sub>2</sub> is a colourless gas with pungent, irritating odour similar to burning sulphur, from lighting a match for example. It is generally considered to be primarily toxic by inhalation of the vapour. The degree of irritation is dependent upon the rate of generation of sulphurous acid by dissolution in water. Eyes, mucous membranes of the nose and the lining of the throat and lungs are all affected by sulphur dioxide inhalation. High concentrations can cause choking, respiratory paralysis and sometimes death.

Chronic exposure to sulphur dioxide can increase the risk of respiratory impairments, such as bronchitis, and increased sensitivity to SO<sub>2</sub> exposure in the future. There is evidence of a link between emphysema and the occupational exposure of smelt-house workers to SO<sub>2</sub>.

It is further considered that members of the public or workers with existing respiratory impairments, such as asthma or bronchitis, exhibit more adverse reaction to SO<sub>2</sub> exposure than persons without these factors. Whilst these factors can be screened for in workers, residential populations cannot be assessed in this way.

Sulphur dioxide is considered to be a major chronic source of environmental pollution from the combustion of fossil fuels containing sulphur. Such SO<sub>2</sub> is catalysed into sulphur trioxide in the upper atmosphere and dissolves in atmospheric moisture to form 'acid rain'.

SO<sub>2</sub> is extremely irritating to the eyes and may result in fatalities if inhaled. The NFPA hazard index for SO<sub>2</sub> is as follow:

Health:	3
Flammability	0
Reactivity	0

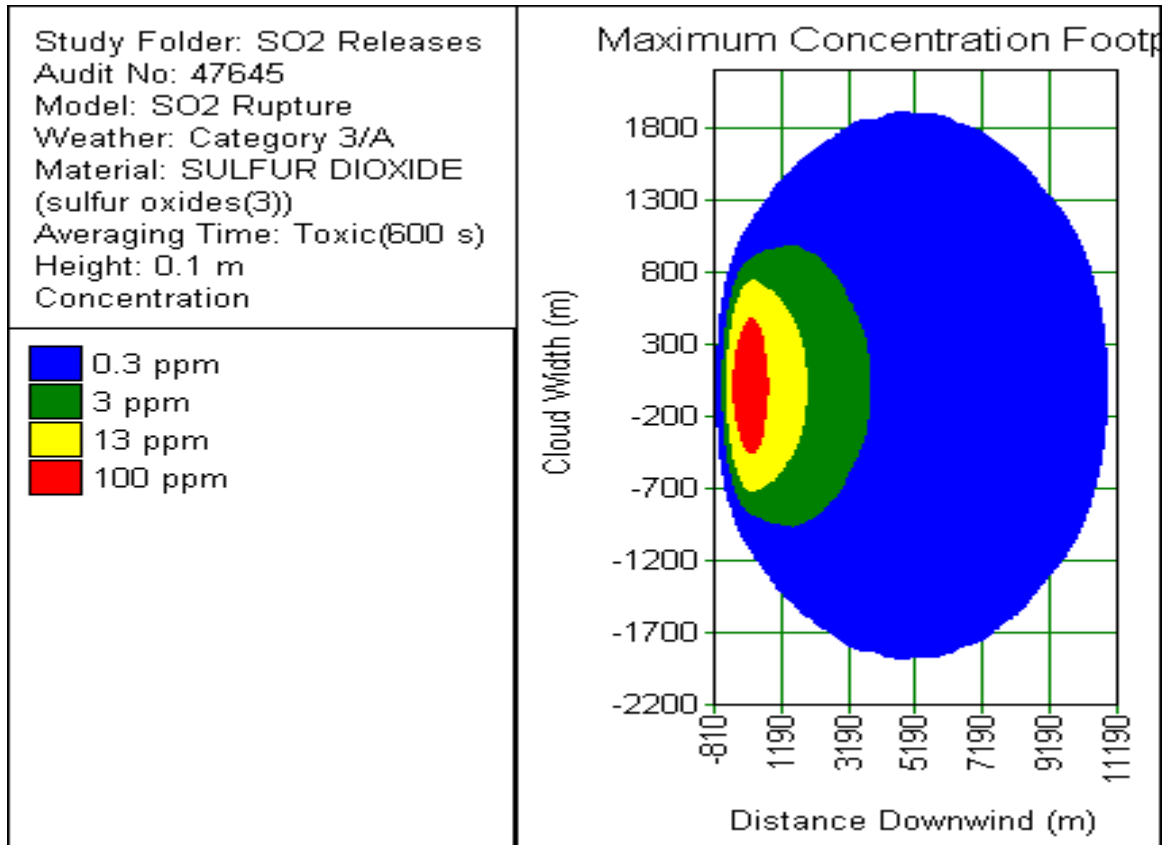
SO<sub>2</sub> has a TLV-TWA value of 2 ppm, a TLV-STEL value of 5 ppm, an IDLH value of 100 ppm, ERPG values of:

- ERPG-1: 0.3ppm
- ERPG-2: 3.0ppm
- ERPG-3: 13.0ppm

### 3.3 Consequence Analysis

### 3.3.1 Scenario 1: Rupture of a vessel containing 25 tonne of SO<sub>2</sub> at 25 °C at ground level.

Sulphur Dioxide is toxic and in the event of a release may affect people exposed to the toxic vapours. SO<sub>2</sub> reacts with moisture in the air to form sulphuric acid vapours. Figure 3.1a presents the Maximum Concentration Footprint vs Distance at ground level for the release of 25 tonne SO<sub>2</sub> vapour instantaneously at 25 °C.



**Figure 3.1a: Maximum Concentration Footprint vs Distance of the SO<sub>2</sub> Cloud during a Vessel Rupture at Weather Stability Class A with a Wind Speed of 3 m/s.**

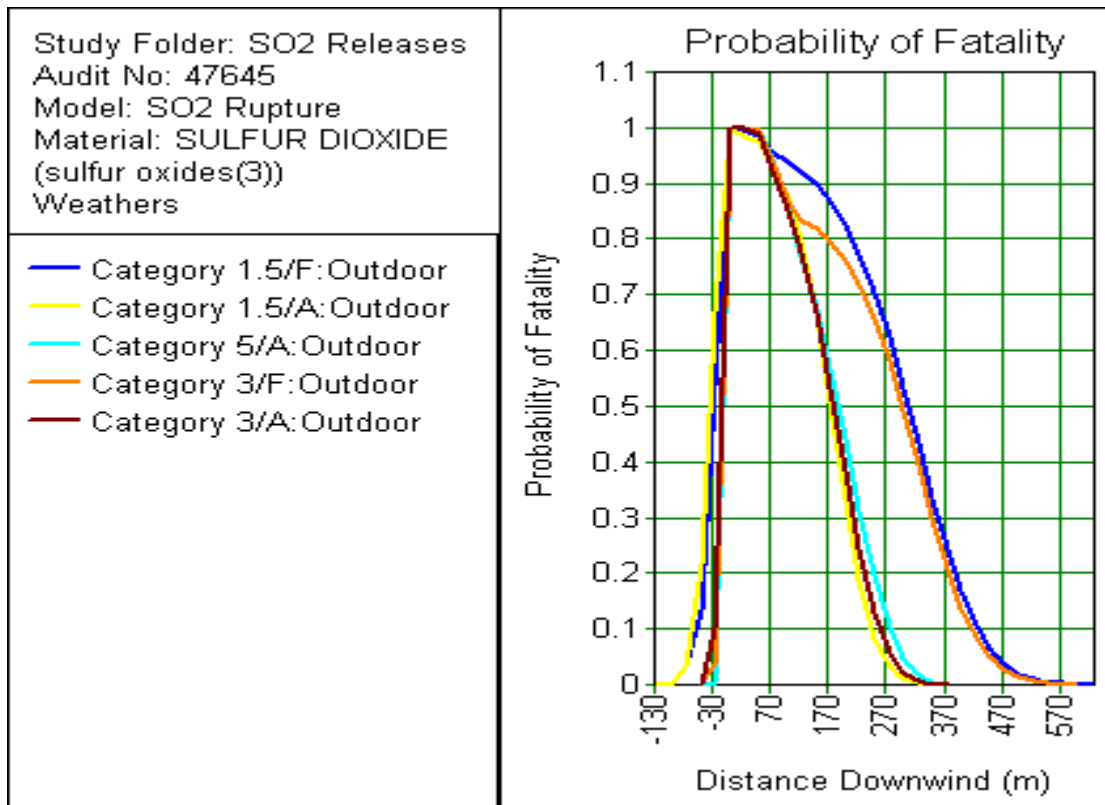
It follows from Figure 3.1a that:

- The ERPG-1 value (0.3ppm) will be present at ground level at a distance  $\pm 10878\text{m}$  away from the point of release at weather stability class A with a wind speed of 3 m/s. The ERPG-1 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clear defined objectionable odour.

- The ERPG-2 value (3ppm) will be present at ground level at a distance  $\pm$  3865m away from the point of release at weather stability class A with a wind speed of 3 m/s. The ERPG-2 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.
- The ERPG-3 value (13ppm) will be present at ground level at a distance  $\pm$  2011m away from the point of release at weather stability class A with a wind speed of 3 m/s. The ERPG-3 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- The IDLH value (100ppm) will be present at ground level at a distance  $\pm$  803m away from the point of release at weather stability class A with a wind speed of 3 m/s. The IDLH value is the maximum airborne concentration where humans will experience immediate danger to life or health after exposure time of 30 minutes.

Note should be taken that the above definitions are based on an exposure of 1 hour for ERPG and 30 minutes for the IDLH value. For this scenario the identified airborne concentrations mentioned above will last for a short period. Therefore it is also important to consider the graph below to determine the probability for fatalities when people are exposed to the above release scenario. **Note should also be taken on how wide the cloud is at different airborne concentration levels.**

Figure 3.1b presents the probability for fatality in case of a rupture of the SO<sub>2</sub> vessel at different weather stability classes and wind speeds.



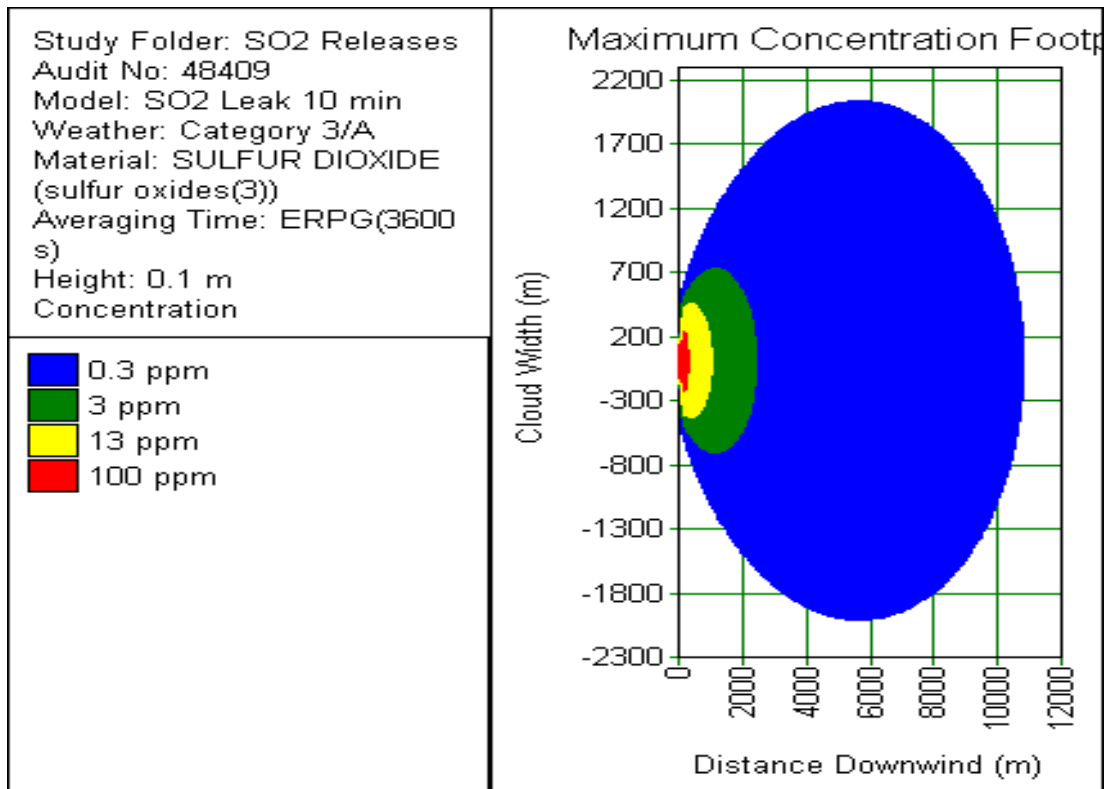
**Figure 3.1b: Probability for Fatality for a Rupture of the SO<sub>2</sub> Vessel containing 25 tonne SO<sub>2</sub> at different Weather Stability classes and Wind Speeds.**

It follows from Figure 3.1b that:

- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 1 (100 %) at a distance of 30m from the point of release at different weather stability classes and wind speeds.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.5 (50 %) at a distance 178m to 304m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.1 (10 %) at a distance 250m to 431m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.01 (1.0 %) at a distance 304m to 530m from the point of release depending on the weather condition.

### 3.3.2 Scenario 2: Release 25 tonne of SO<sub>2</sub> in 10 minutes at 25 °C at ground level from the SO<sub>2</sub> vessel.

Sulphur Dioxide is toxic and in the event of a release may affect people exposed to the toxic vapours. SO<sub>2</sub> reacts with moisture in the air to form sulphuric acid vapours. Figure 3.2a presents the Maximum Concentration Footprint vs Distance at ground level for the release of 25 tonne SO<sub>2</sub> vapour in 10 minutes at 25 °C.



**Figure 3.2a: Maximum Concentration Footprint vs Distance of the SO<sub>2</sub> Cloud during a 10 minute Release of the content of the Vessel at Weather Stability Class A with a Wind Speed of 3m/s.**

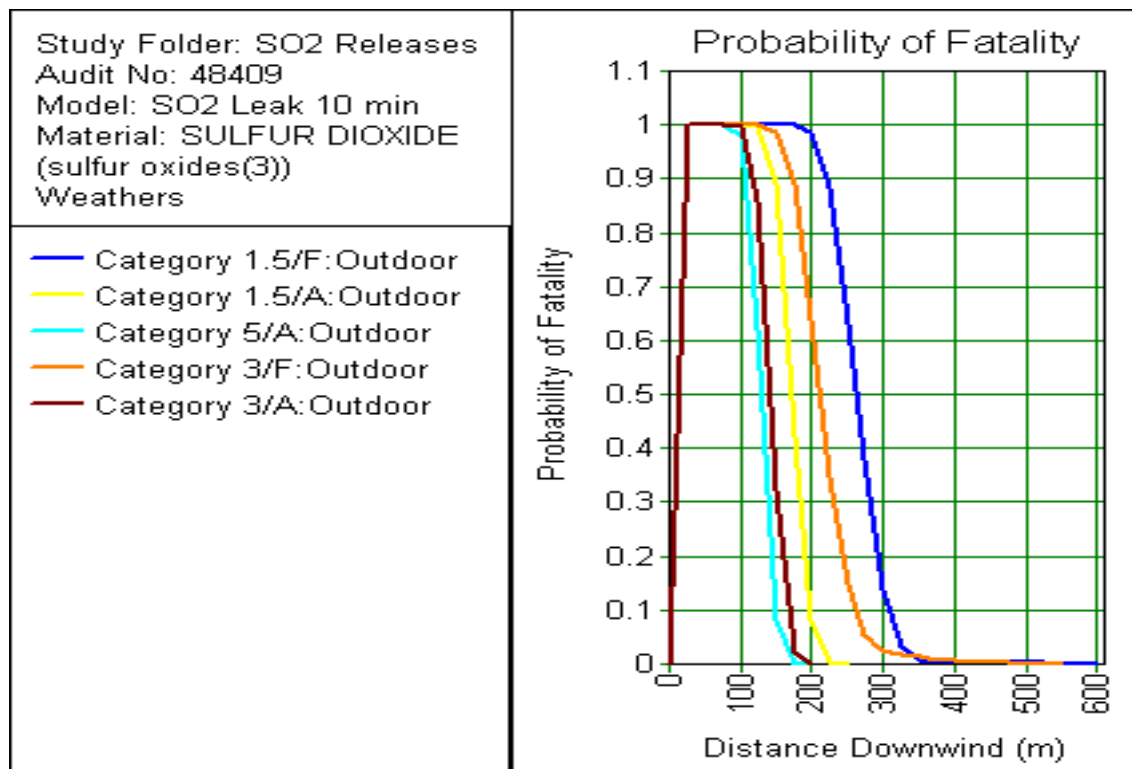
It is clear from Figure 3.2a that:

- The ERPG-1 value (0.3ppm) will be present at ground level at a distance  $\pm$  10792m away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-1 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clear defined objectionable odour.
- The ERPG-2 value (3ppm) will be present at ground level at a distance  $\pm$  2496m away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-2 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.
- The ERPG-3 value (13ppm) will be present at ground level at a distance  $\pm$  1127m away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-3 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

- The IDLH value (100ppm) will be present at ground level at a distance  $\pm 403\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The IDLH value is the maximum airborne concentration where humans will experience immediate danger to life or health after exposure time of 30 minutes.

Note should be taken that the above definitions are based on an exposure of 1 hour for ERPG and 30 minutes for the IDLH value. For this scenario the identified airborne concentrations mentioned above will last for a short period. Therefore it is also important to consider the graph below to determine the probability for fatalities when people are exposed to the above release scenario. **Note should also be taken on how wide the cloud is at different airborne concentration levels.**

Figure 3.2b presents the probability for fatality in case of a 10 minute release of the content of the 25 tonne SO<sub>2</sub> vessel at different weather stability classes and wind speeds.



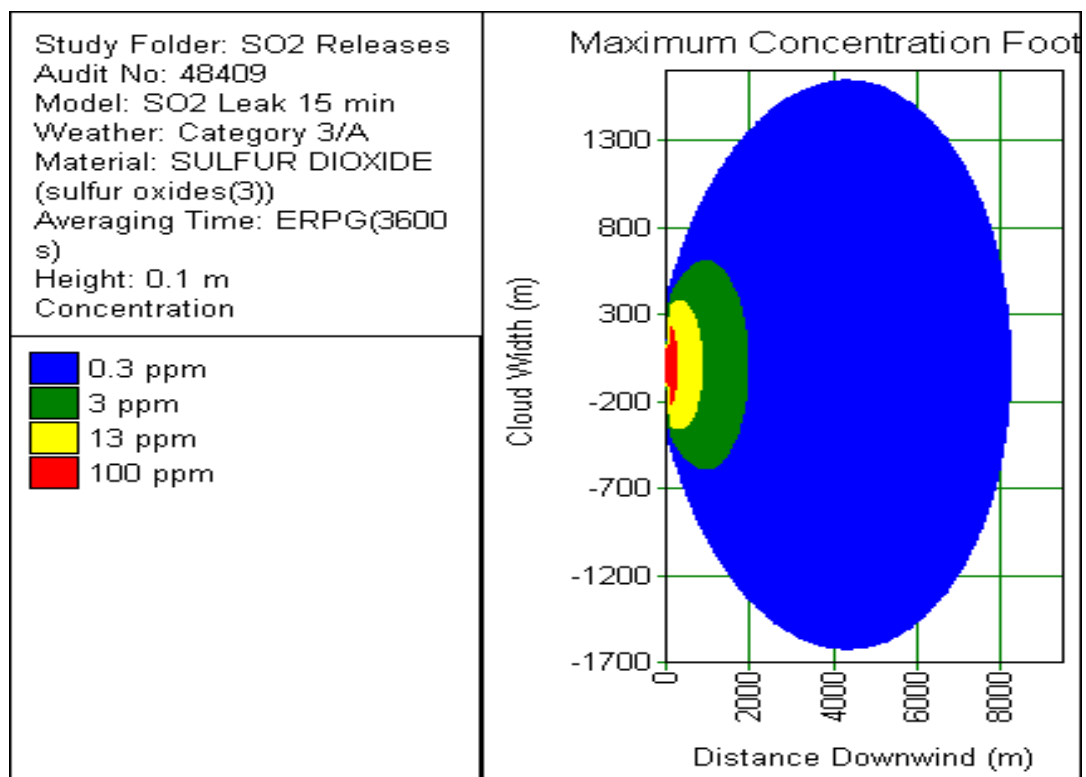
**Figure 3.2b: Probability for Fatality for a 10 minute Release of the SO<sub>2</sub> Vessel containing 25 tonne SO<sub>2</sub> at different Weather Stability classes and Wind Speeds.**

It follows from Figure 3.2b that:

- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 1 (100 %) at a distance 0m to 175m from the point of release at different weather stability classes and wind speeds.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.5 (50 %) at a distance 127m to 262m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.1 (10 %) at a distance 146m to 307m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.01 (1.0 %) at a distance 168m to 363m from the point of release depending on the weather condition.

### 3.3.3 Scenario 3: Release of 25 tonne of SO<sub>2</sub> in 15 minutes at 25 °C at ground level from the SO<sub>2</sub> vessel.

Sulphur Dioxide is toxic and in the event of a release may affect people exposed to the toxic vapours. SO<sub>2</sub> reacts with moisture in the air to form sulphuric acid vapours. Figure 3.3a presents the Maximum Concentration Footprint vs Distance at ground level for the release of 25 tonne SO<sub>2</sub> vapour in 15 minutes at 25 °C.



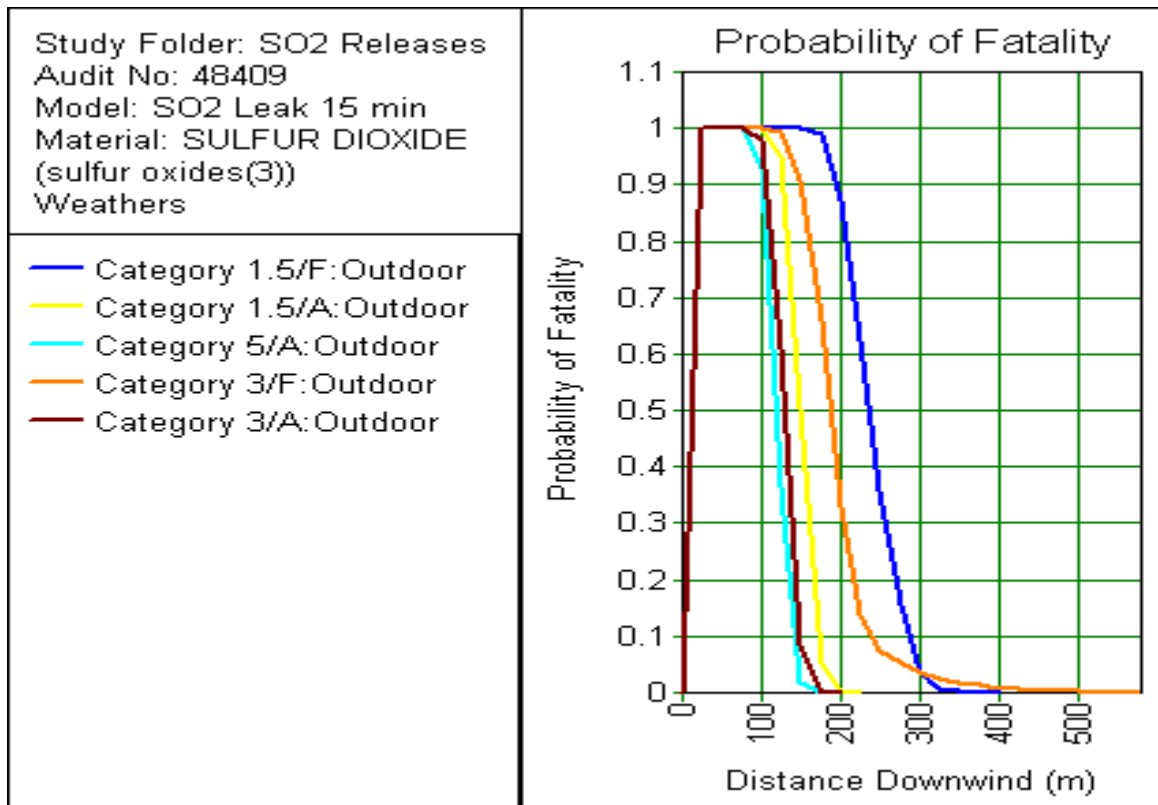
**Figure 3.3a: Maximum Concentration Footprint vs Distance of the SO<sub>2</sub> Cloud during a 15 minute Release of the content of the Vessel at Weather Stability Class A with a Wind Speed of 3m/s.**

It is clear from Figure 3.3A that:

- The ERPG-1 value (0.3ppm) will be present at ground level at a distance  $\pm 8237\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-1 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clear defined objectionable odour.
- The ERPG-2 value (3ppm) will be present at ground level at a distance  $\pm 2013\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-2 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.
- The ERPG-3 value (13ppm) will be present at ground level at a distance  $\pm 906\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-3 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- The IDLH value (100ppm) will be present at ground level at a distance  $\pm 342\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The IDLH value is the maximum airborne concentration where humans will experience immediate danger to life or health after exposure time of 30 minutes.

Note should be taken that the above definitions are based on an exposure of 1 hour for ERPG and 30 minutes for the IDLH value. For this scenario the identified airborne concentrations mentioned above will last for a short period. Therefore it is also important to consider the graph below to determine the probability for fatalities when people are exposed to the above release scenario. **Note should also be taken on how wide the cloud is at different airborne concentration levels.**

Figure 3.3b presents the probability for fatality in case of a 15 minute release of the content of the 25 tonne SO<sub>2</sub> vessel at different weather stability classes and wind speeds.



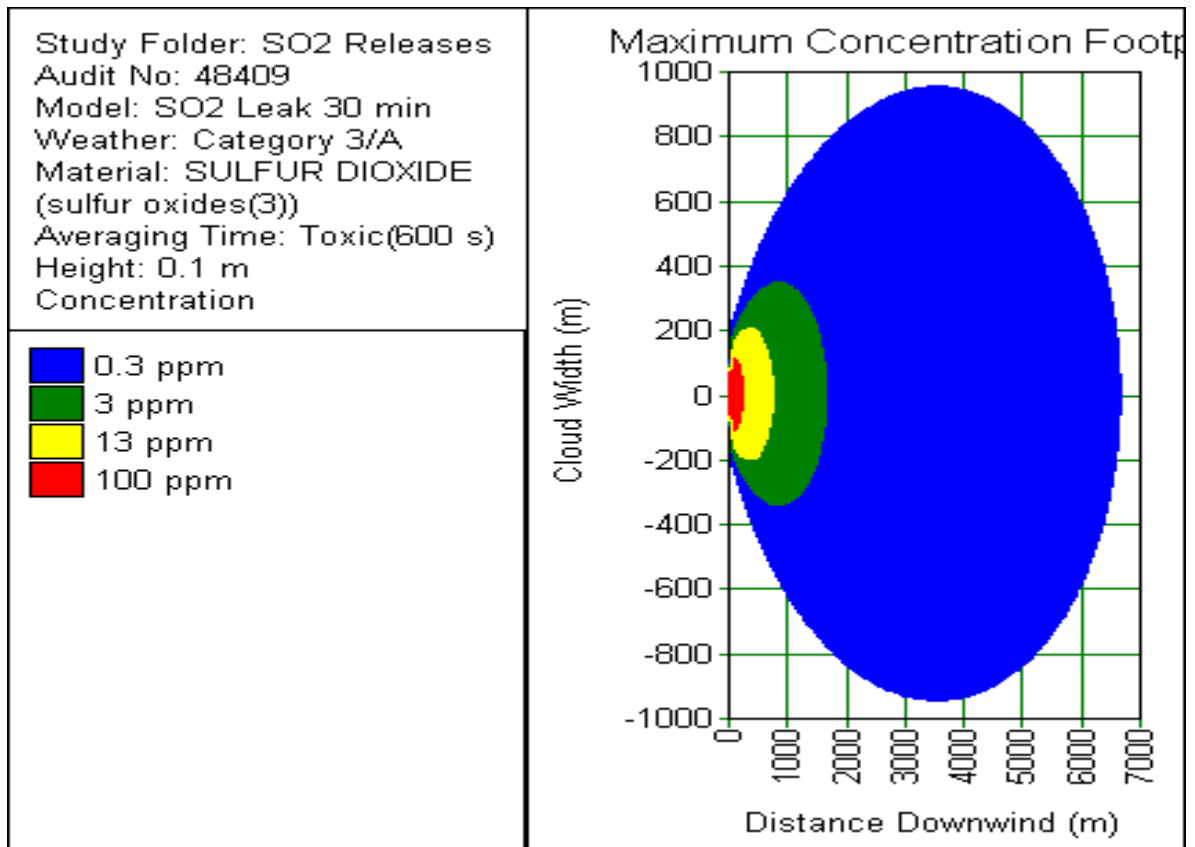
**Figure 3.3b: Probability for Fatality for a 15 minute Release of the SO<sub>2</sub> Vessel containing 25 tonne SO<sub>2</sub> at different Weather Stability classes and Wind Speeds.**

It follows from Figure 3.3b that:

- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 1 (100 %) at a distance 0m to 148m from the point of release at different weather stability classes and wind speeds.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.5 (50 %) at a distance 117m to 235m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.1 (10 %) at a distance 138m to 290m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.01 (1.0 %) at a distance 145m to 380m from the point of release depending on the weather condition.

#### 3.3.4 Scenario 4: Release of 25 tonne of SO<sub>2</sub> in 30 minutes at 25 °C at ground level from the SO<sub>2</sub> vessel.

Sulphur Dioxide is toxic and in the event of a release may affect people exposed to the toxic vapours. SO<sub>2</sub> reacts with moisture in the air to form sulphuric acid vapours. Figure 3.4a presents the Maximum Concentration Footprint vs Distance at ground level for the release of 25 tonne SO<sub>2</sub> vapour in 30 minutes at 25 °C.



**Figure 3.4a: Maximum Concentration Footprint vs Distance of the SO<sub>2</sub> Cloud during a 30 minute Release of the content of the Vessel at Weather Stability Class A with a Wind Speed of 3m/s.**

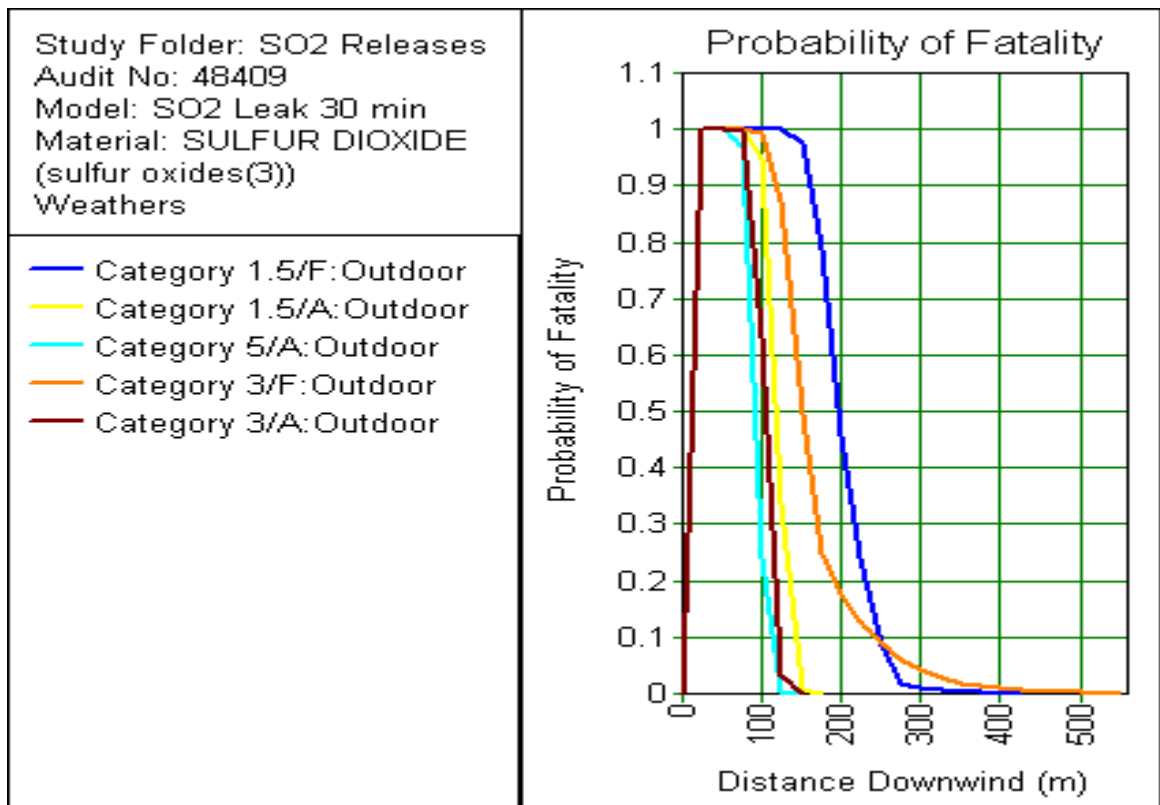
It follows from Figure 3.4a that:

- The ERPG-1 value (0.3ppm) will be present at ground level at a distance  $\pm 5261\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-1 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clear defined objectionable odour.
- The ERPG-2 value (3ppm) will be present at ground level at a distance  $\pm 1410\text{m}$  away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-2 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.

- The ERPG-3 value (13ppm) will be present at ground level at a distance ±669m away from the point of release at weather stability class A with a wind speed of 3m/s. The ERPG-3 value is the maximum airborne concentration below, which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.
- The IDLH value (100ppm) will be present at ground level at a distance ±253m away from the point of release at weather stability class A with a wind speed of 3m/s. The IDLH value is the maximum airborne concentration where humans will experience immediate danger to life or health after exposure time of 30 minutes.

Note should be taken that the above definitions are based on an exposure of 1 hour for ERPG and 30 minutes for the IDLH value. For this scenario the identified airborne concentrations mentioned above will last for a short period. Therefore it is also important to consider the graph below to determine the probability for fatalities when people are exposed to the above release scenario. **Note should also be taken on how wide the cloud is at different airborne concentration levels.**

Figure 3.4b presents the probability for fatality in case of a 30 minute release of the content of the 25 tonne SO<sub>2</sub> vessel at different weather stability classes and wind speeds.



**Figure 3.4b: Probability for Fatality for a 30 minute Release of the SO<sub>2</sub> Vessel containing 25 tonne SO<sub>2</sub> at different Weather Stability classes and Wind Speeds.**

It follows from Figure 3.4b that:

- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 1 (100 %) at a distance 0m to 124m from the point of release at different weather stability classes and wind speeds.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.5 (50 %) at a distance 89m to 196m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.1 (10 %) at a distance 113m to 247m from the point of release depending on the weather condition.
- A probability for fatality for personnel exposed to the SO<sub>2</sub> release is 0.01 (1.0 %) at a distance 120m to 388m from the point of release depending on the weather condition.

#### 4. CONCLUSION

From the above analyses and discussions follow that the accidental release of SO<sub>2</sub>, would render the facility an MHI. The accidental release of H<sub>2</sub>SO<sub>4</sub> could contribute to the MHI status of the facility. The mechanisms for the different scenarios should be evaluated once the hardware design is completed.