APPENDIX 2. HAZARD IDENTIFICATION – BOW TIE DIAGRAMS

A 2.1. Bow Ties

The Bow Tie method was used to identify hazards, determine the loss of control event and subsequent consequences as well as identifying barriers to minimise the risk. The Bow Ties were used purely as a method of clearly defining cause-consequence relationships. As the proposed development is at an early stage, no linkage was made to the company Safety Management System (SMS) and no 'escalation factors' (factors that may reduce the effectiveness of the barrier) were noted.

An example of a Bow Tie is shown in Figure A1.1, illustrating:

- the hazard, e.g. toluene stored in a vessel;
- the top event, e.g. loss of containment;
- the threats, e.g. corrosion
- the consequences, e.g. fire
- the barriers, e.g. Tank designed and maintained to AS
- the recovery measures, eg automatic fire detection and suppression
- Possible linkages to the company Safety Management System

The actual bow ties for each location and top event are shown in the subsequent pages, including:

Location: 1. Warwick Farm - Bulk Storage

Hazard code	Hazard name	Top event
1.01	Stored Toluene	Loss of containment
1.02	Pumped Toluene	Loss of containment
1.03	Toluene in Road Tanker Transfer Lines	Loss of containment

Location: 2. Warwick Farm - VRU

Hazard code	Hazard name	Top event
2.01	Pressurised Steam in Boiler	Loss of containment
2.02	Toluene in Decanting Tank	Loss of Containment from Tank
2.03	Toluene Vapour in Ductwork	Toluene Enters Flammable Region

Location: 3. Warwick Farm - Warehouse

Hazard code	Hazard name	Top event
3.01	Bulk Paper storage in warehouse	Ignition

Location: 4. Warwick Farm - Acid Storage Room

Hazard code	Hazard name	Top event
4.01	Storage Acid	Loss of containment

Location: 5. CO_2 Store

Hazard code	Hazard name	Top event
5.01	CO2 Stored under pressure	Loss of containment

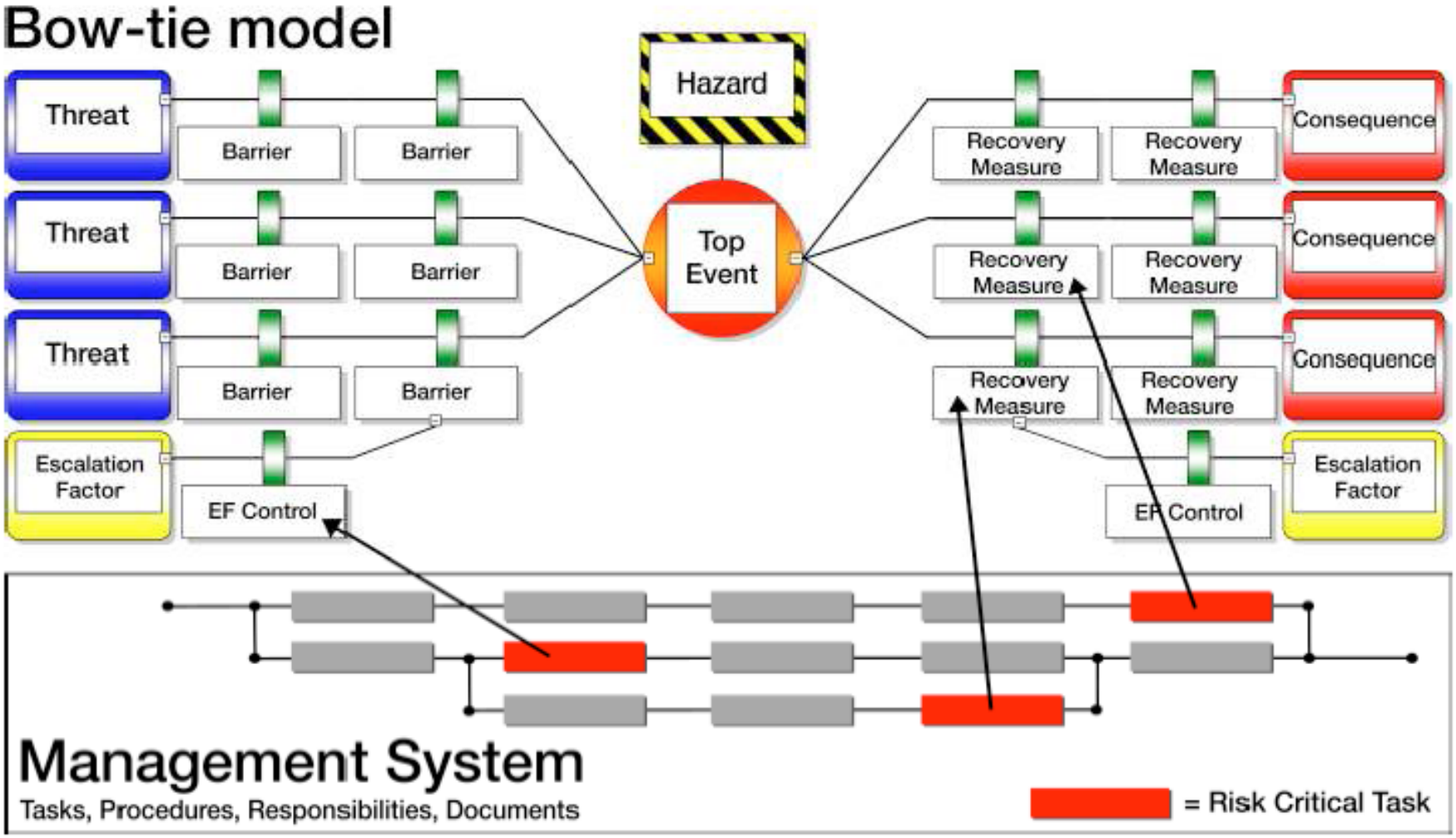
Location: 6. Printing Area

Hazard code	Hazard name	Top event
6.01	Toluene Based Ink	Ignition Source Introduced

Location: 7. Warwick Farm - General

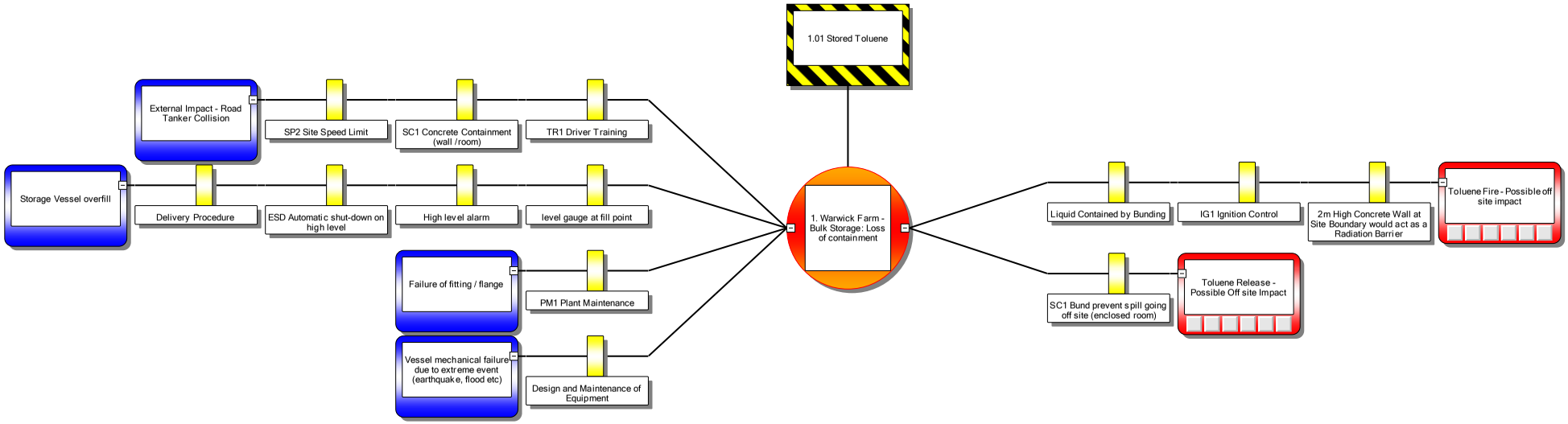
Hazard code	Hazard name	Top event
5.01	Toluene Road Tanker	Loss of containment

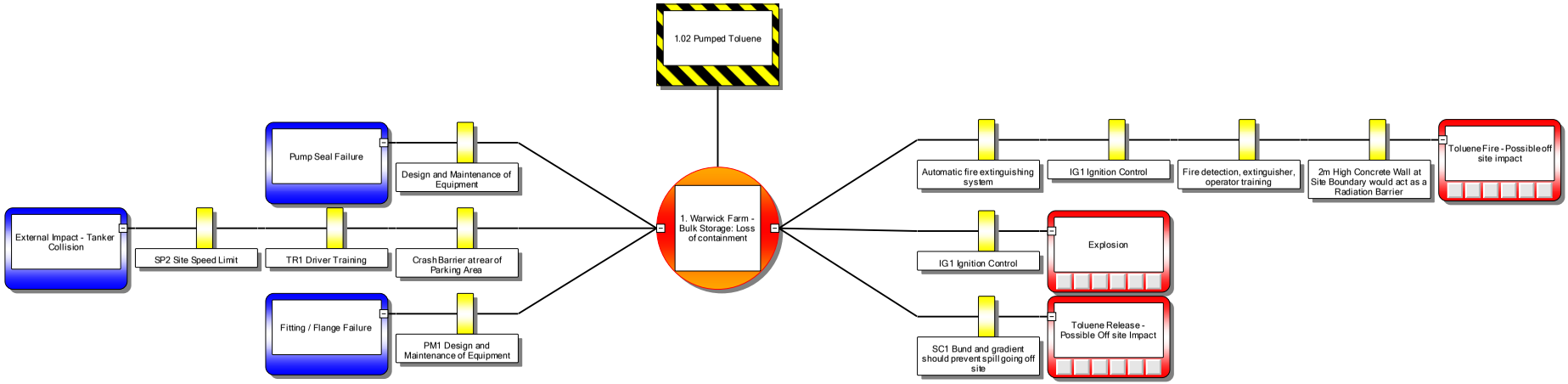
IPMG has stated that all equipment will be designed and constructed to the relevant standard, which in the case of Toluene storage would be AS1940. However, due to the early stage of the design, the barriers are coloured yellow (to be confirmed). Once the design is finalised, the barriers will be re-checked and coloured green (final).

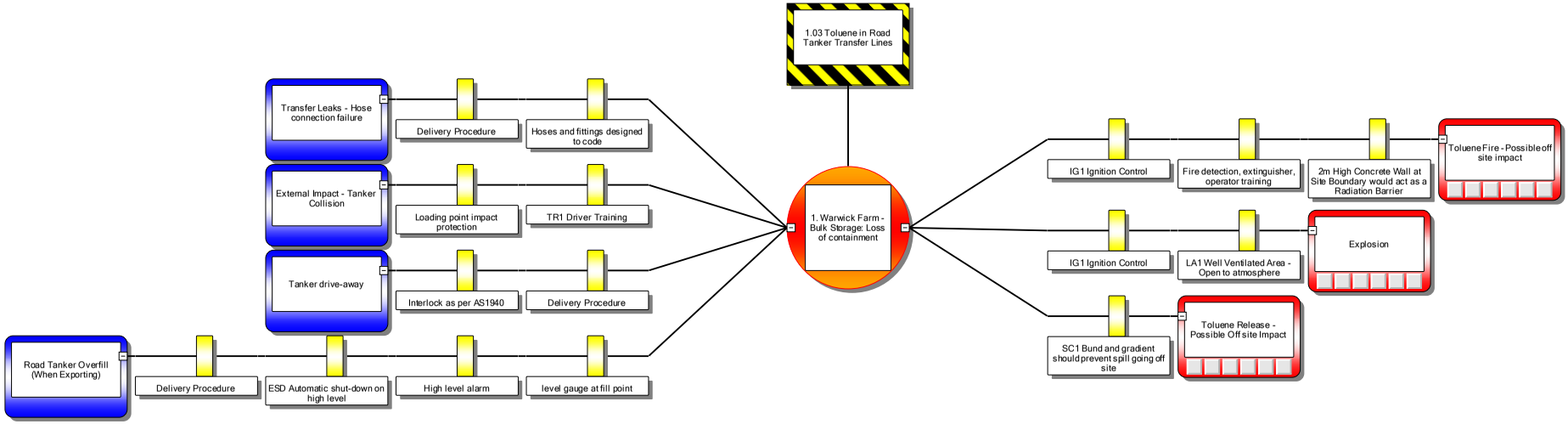


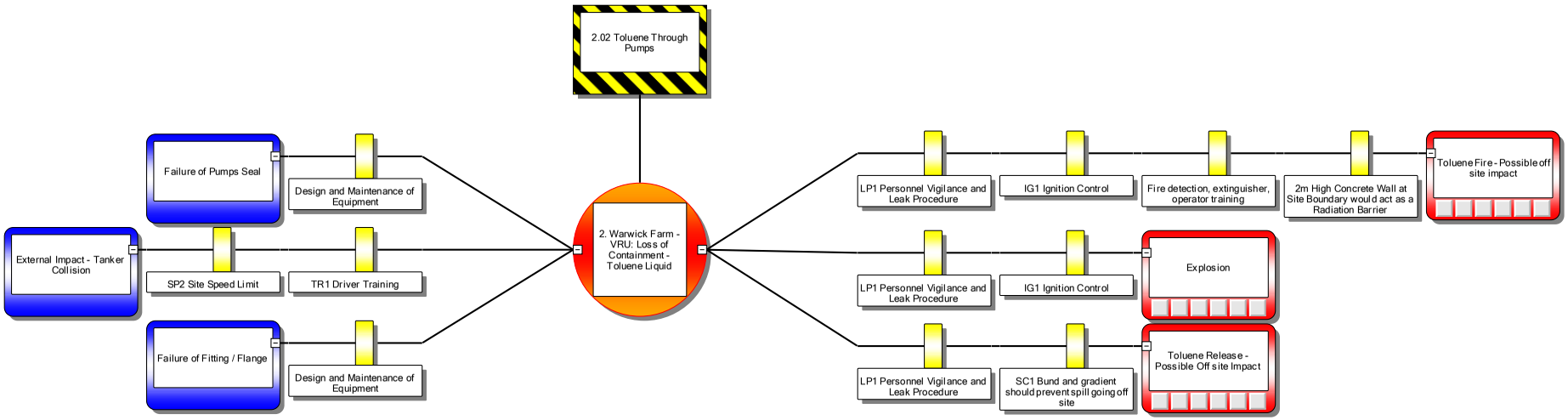
Source: STRATEGIC RISK, NOVEMBER 2005, BOW-TIE AN ELEGANT SOLUTION?

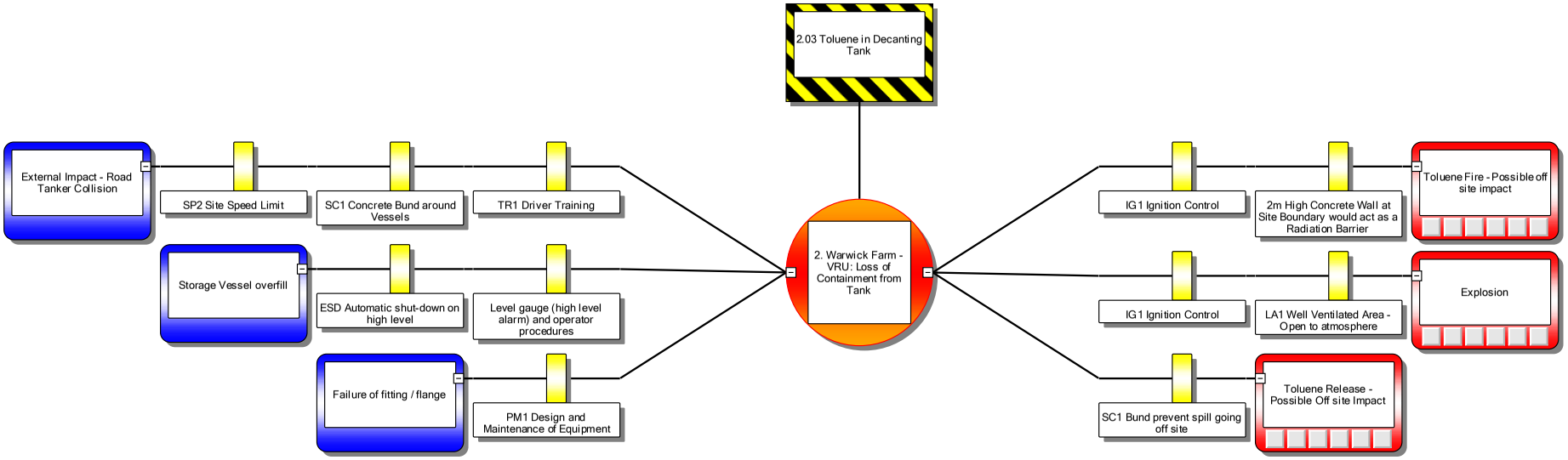
Figure A1.1: Bow Tie Model

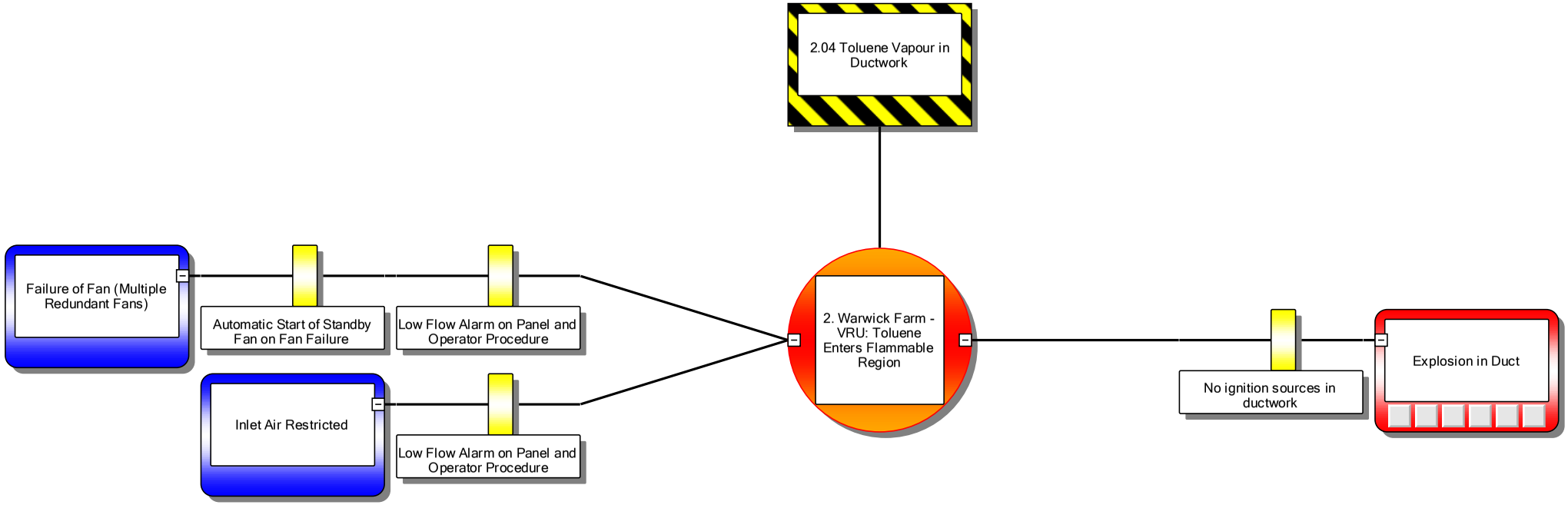

1.01 Stored Toluene
External Impact - Road Tanker Collision
SP2 Site Speed Limit
SC1 Concrete Containment (wall /room)
TR1 Driver Training
Storage Vessel overfill
Delivery Procedure
ESD Automatic shut-down on high level
High level alarm
level gauge at fill point
Failure of fitting / flange
PM1 Plant Maintenance
Vessel mechanical failure due to extreme event (earthquake, flood etc)
Design and Maintenance of Equipment
1. Warwick Farm - Bulk Storage: Loss of containment
Liquid Contained by Bunding
IG1 Ignition Control
2m High Concrete Wall at Site Boundary would act as a Radiation Barrier
Toluene Fire - Possible off site impact
SC1 Bund prevent spill going off site (enclosed room)
Toluene Release - Possible Off site Impact

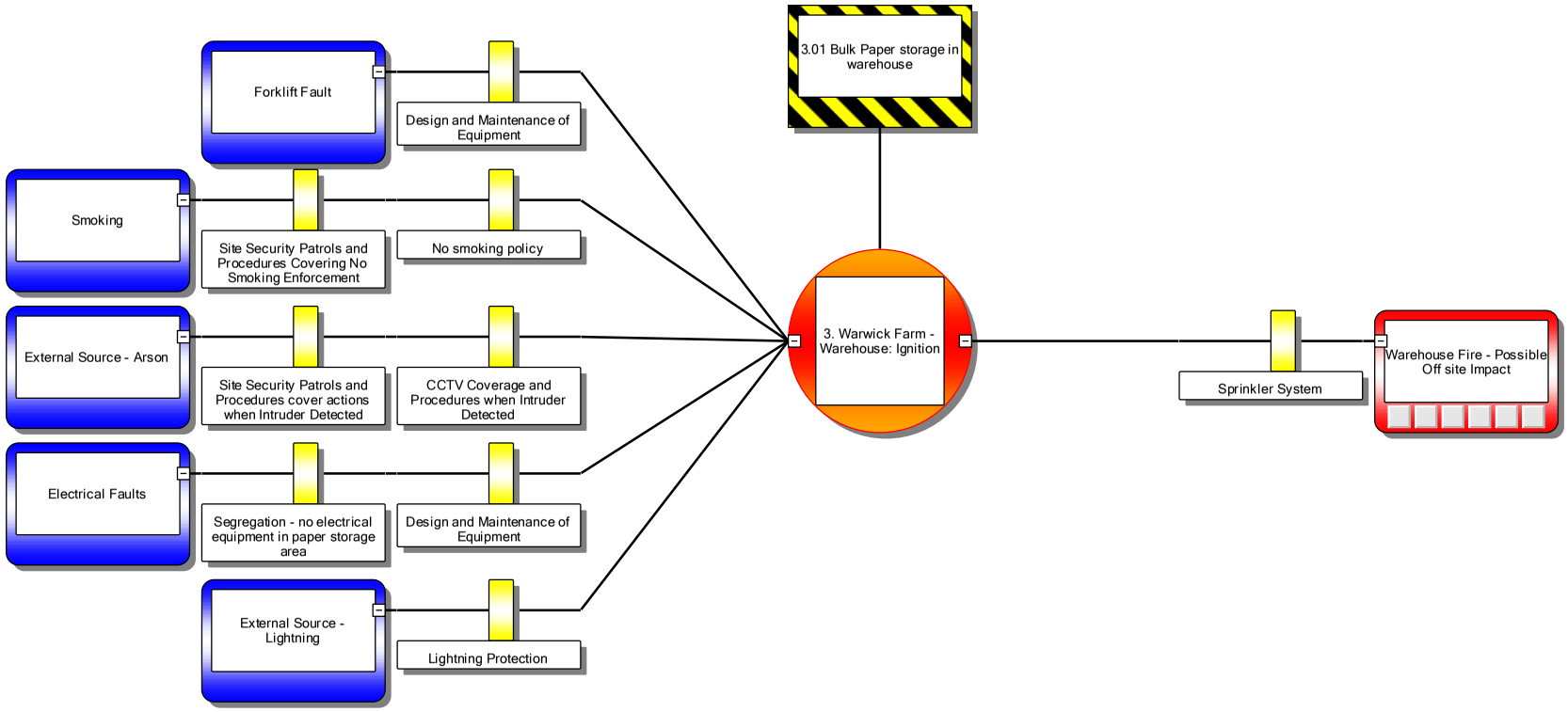

1.02 Pumped Toluene
External Impact - Tanker Collision
SP2 Site Speed Limit
Pump Seal Failure
TR1 Driver Training
Design and Maintenance of Equipment
Crash Barrier at rear of Parking Area
Fitting / Flange Failure
PM1 Design and Maintenance of Equipment
1. Warwick Farm - Bulk Storage: Loss of containment
Automatic fire extinguishing system
IG1 Ignition Control
Fire detection, extinguisher, operator training
2m High Concrete Wall at Site Boundary would act as a Radiation Barrier
Toluene Fire - Possible off site impact
IG1 Ignition Control
Explosion
SC1 Bund and gradient should prevent spill going off site
Toluene Release - Possible Off site Impact

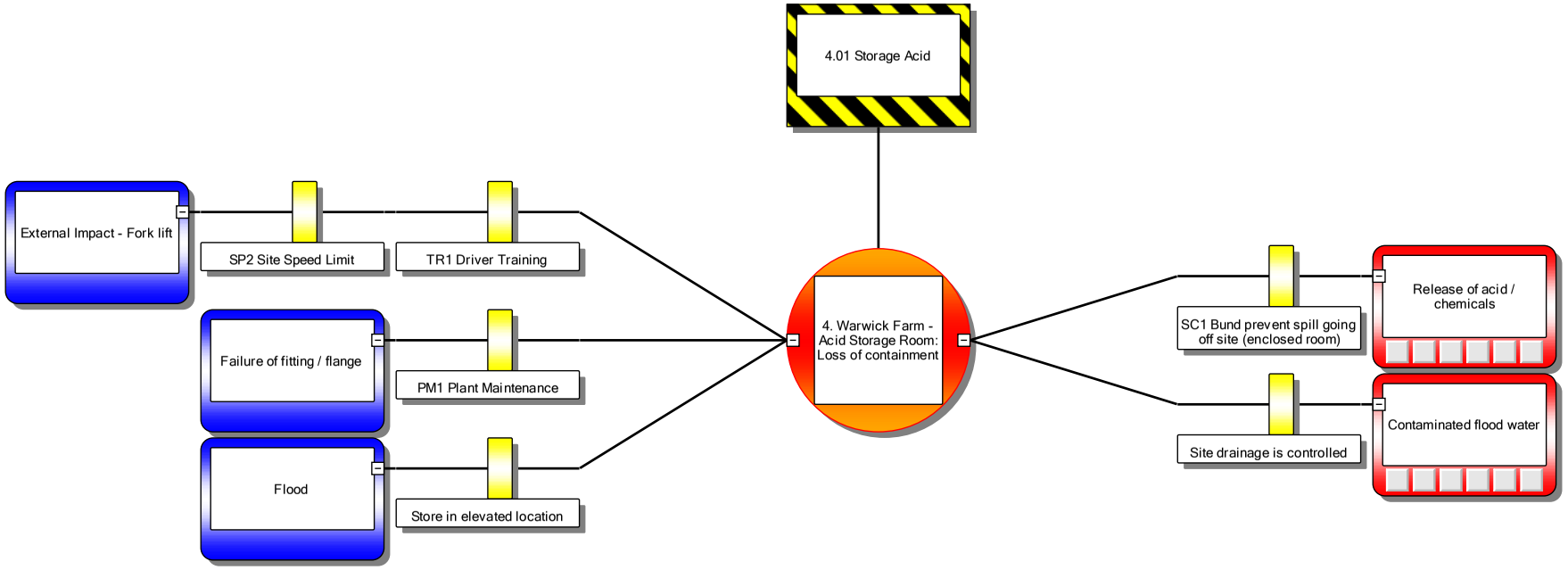

1.03 Toluene in Road Tanker Transfer Lines
Transfer Leaks - Hose connection failure
Delivery Procedure
Hoses and fittings designed to code
External Impact - Tanker Collision
Loading point impact protection
TR1 Driver Training
Tanker drive-away
Interlock as per AS1940
Delivery Procedure
Road Tanker Overfill (When Exporting)
Delivery Procedure
ESD Automatic shut-down on high level
High level alarm
level gauge at fill point
1. Warwick Farm - Bulk Storage: Loss of containment
IG1 Ignition Control
Fire detection, extinguisher, operator training
2m High Concrete Wall at Site Boundary would act as a Radiation Barrier
Toluene Fire - Possible off site impact
IG1 Ignition Control
LA1 Well Ventilated Area - Open to atmosphere
Explosion
SC1 Bund and gradient should prevent spill going off site
Toluene Release - Possible Off site Impact

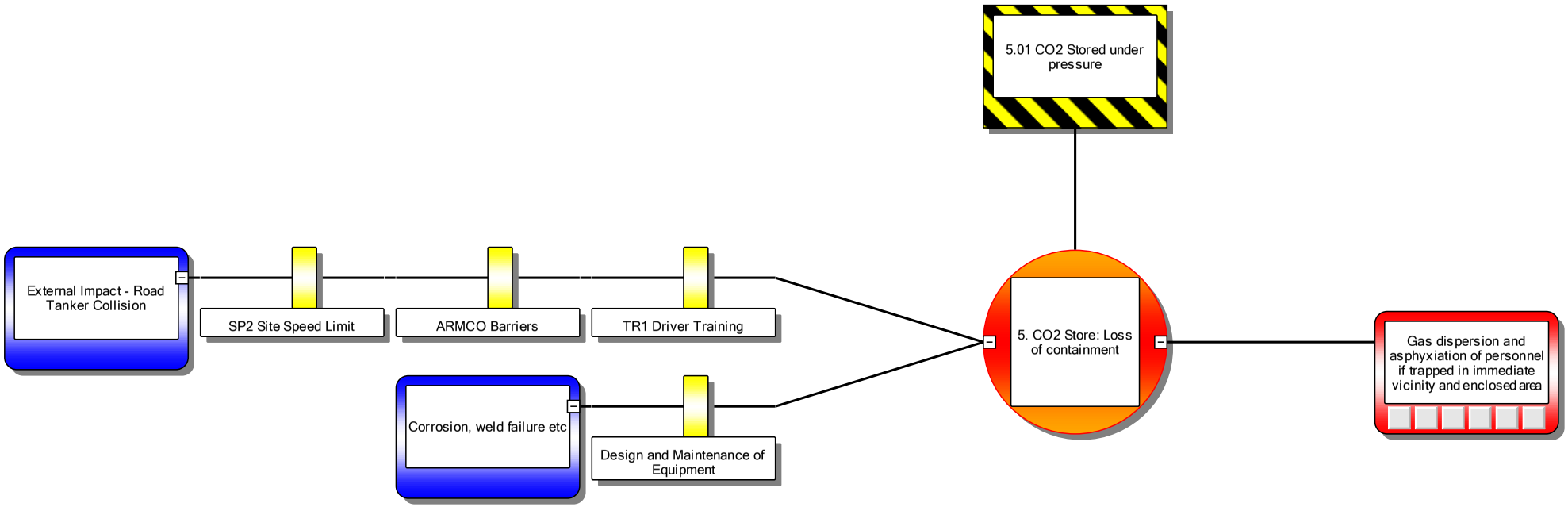

2.02 Toluene Through Pumps
Failure of Pumps Seal
Design and Maintenance of Equipment
External Impact - Tanker Collision
SP2 Site Speed Limit
TR1 Driver Training
Failure of Fitting / Flange
Design and Maintenance of Equipment
2. Warwick Farm - VRU: Loss of Containment - Toluene Liquid
LP1 Personnel Vigilance and Leak Procedure
IG1 Ignition Control
Fire detection, extinguisher, operator training
2m High Concrete Wall at Site Boundary would act as a Radiation Barrier
Toluene Fire - Possible off site impact
LP1 Personnel Vigilance and Leak Procedure
IG1 Ignition Control
Explosion
LP1 Personnel Vigilance and Leak Procedure
SC1 Bund and gradient should prevent spill going off site
Toluene Release - Possible Off site Impact

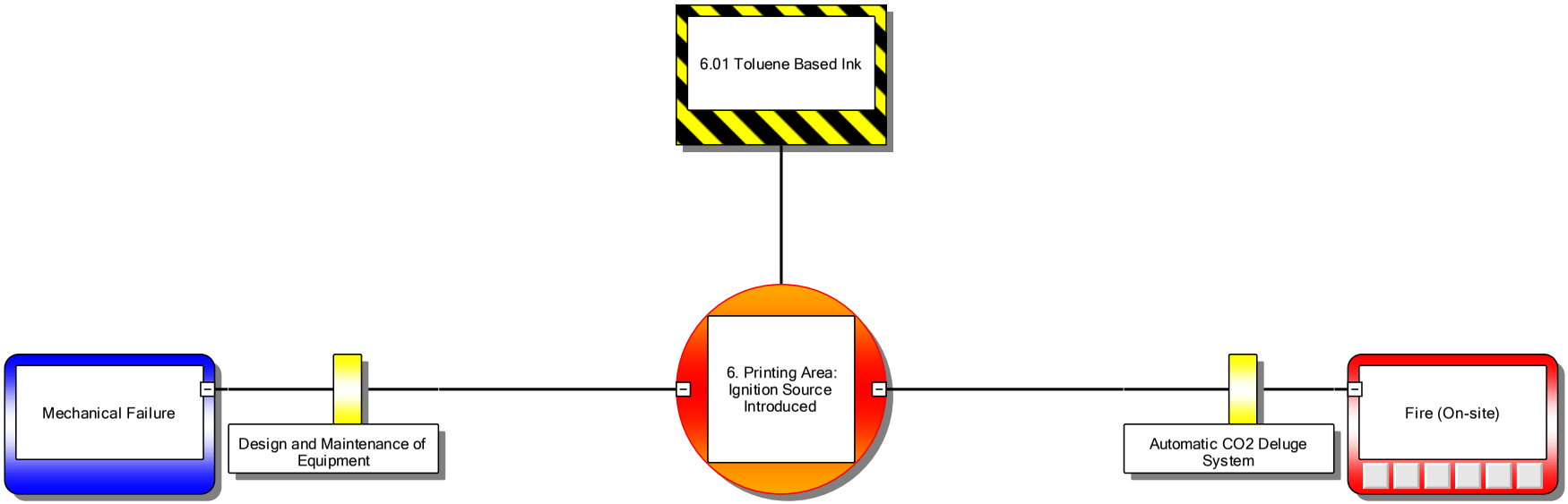

2.03 Toluene in Decanting Tank
External Impact - Road Tanker Collision
SP2 Site Speed Limit
SC1 Concrete Bund around Vessels
TR1 Driver Training
Storage Vessel overfill
ESD Automatic shut-down on high level
Level gauge (high level alarm) and operator procedures
Failure of fitting / flange
PM1 Design and Maintenance of Equipment
2. Warwick Farm - VRU: Loss of Containment from Tank
IG1 Ignition Control
2m High Concrete Wall at Site Boundary would act as a Radiation Barrier
Toluene Fire - Possible off site impact
IG1 Ignition Control
LA1 Well Ventilated Area - Open to atmosphere
Explosion
SC1 Bund prevent spill going off site
Toluene Release - Possible Off site Impact

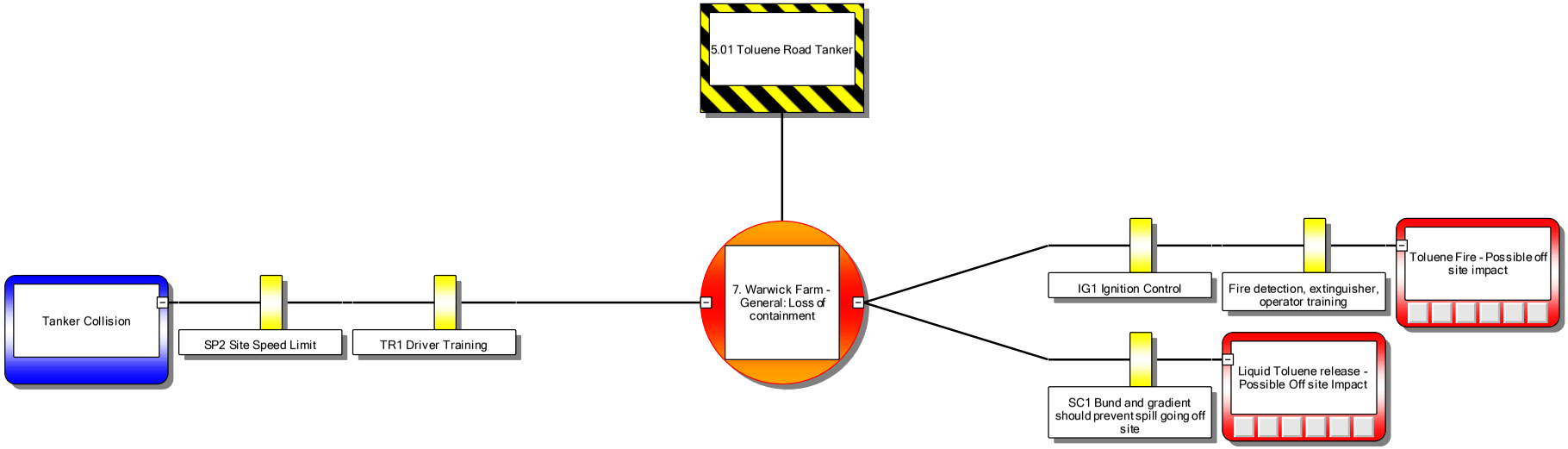

2.04 Toluene Vapour in Ductwork
Failure of Fan (Multiple Redundant Fans)
Automatic Start of Standby Fan on Fan Failure
Low Flow Alarm on Panel and Operator Procedure
Inlet Air Restricted
Low Flow Alarm on Panel and Operator Procedure
2. Warwick Farm - VRU: Toluene Enters Flammable Region
No ignition sources in ductwork
Explosion in Duct


3.01 Bulk Paper storage in warehouse
Forklift Fault
Design and Maintenance of Equipment
Smoking
Site Security Patrols and Procedures Covering No Smoking Enforcement
No smoking policy
External Source - Arson
Site Security Patrols and Procedures cover actions when Intruder Detected
CCTV Coverage and Procedures when Intruder Detected
Electrical Faults
Segregation - no electrical equipment in paper storage area
Design and Maintenance of Equipment
External Source - Lightning
Lightning Protection
3. Warwick Farm - Warehouse: Ignition
Sprinkler System
Warehouse Fire - Possible Off site Impact


4.01 Storage Acid
External Impact - Fork lift
SP2 Site Speed Limit
TR1 Driver Training
Failure of fitting / flange
PM1 Plant Maintenance
Flood
Store in elevated location
4. Warwick Farm - Acid Storage Room: Loss of containment
SC1 Bund prevent spill going off site (enclosed room)
Site drainage is controlled
Release of acid / chemicals
Contaminated flood water


5.01 CO2 Stored under pressure
External Impact - Road Tanker Collision
SP2 Site Speed Limit
ARMCO Barriers
TR1 Driver Training
Corrosion, weld failure etc
Design and Maintenance of Equipment
5. CO2 Store: Loss of containment
Gas dispersion and asphyxiation of personnel if trapped in immediate vicinity and enclosed area


6.01 Toluene Based Ink
Mechanical Failure
Design and Maintenance of Equipment
6. Printing Area: Ignition Source Introduced
Automatic CO2 Deluge System
Fire (On-site)


5.01 Toluene Road Tanker
Tanker Collision
SP2 Site Speed Limit
TR1 Driver Training
7. Warwick Farm - General: Loss of containment
IG1 Ignition Control
Fire detection, extinguisher, operator training
Toluene Fire - Possible off site impact
SC1 Bund and gradient should prevent spill going off site
Liquid Toluene release - Possible Off site Impact

APPENDIX 3. REVIEW OF HAZARDOUS SUBSTANCES PROPERTIES

A 3.1. Toluene

Toluene is a Class 3 hazardous material, which is highly flammable. Detailed properties are given below.

Table A3.1: Toluene Properties

Property	unit	Value
Formula		$C_6H_5CH_3$
Boiling point	^oC	110.6
Vapour density (cf air = 1)		3.1
Liquid density (cf water = 1)		0.87
Heat of combustion	MJ/kg	40.6
Flashpoint	^oC	4.44
Lower Flammable Limit (LFL)	vol%	1.1
Upper Flammable Limit (UFL)	vol%	7.1

Table A3.2: Toluene Hazardous Properties & Emergency Advice

Incident	Hazardous Properties
Release as Mist	Irritating to eyes, nose, throat and respiratory system. If inhaled, will cause headache, eye irritation and euphoria. Move to fresh air. IF IN EYES, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention.
Release as Liquid	Irritant to skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, ensure adequate ventilation, consider gastric aspiration within 1 hour of serious ingestion. DO NOT INDUCE VOMITING. Seek medical attention.
Fire	Highly flammable. Products of combustion are carbon oxides (CO and CO_2). Not flammable. For small fire, extinguish with dry chemical powder. For large fire, use water spray or fog.

A 3.2. Sulphuric Acid (94%)

Concentrated sulphuric acid is a Class 8 hazardous material, which is highly corrosive. Detailed properties are given below.

Table A3.3: Sulphuric Acid Properties

Property	**unit**	**Value**
Formula		H_2SO_4
Boiling point	^oC	340
Vapour density (cf air = 1)		N/A
Liquid density (cf water = 1)		1.84
Heat of combustion	**MJ/kg**	**N/A**
Flashpoint	^oC	N/A
Lower Flammable Limit (LFL)	vol%	N/A
Upper Flammable Limit (UFL)	vol%	N/A

Table A3.4: Sulphuric Acid Hazardous Properties & Emergency Advice

Incident	**Hazardous Properties**
Release as Mist	Irritating to eyes, nose and throat. If inhaled, will cause coughing, difficult breathing, or loss of consciousness. Move to fresh air. IF IN EYES, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention.
Release as Liquid	Will burn skin and eyes. Harmful if swallowed. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING. Seek medical attention.
Fire	Not flammable. Poisonous gas may be produced in fire. Extinguish with dry chemical or carbon dioxide.

A 3.3. Carbon Dioxide

Carbon dioxide is a non-hazardous substance and normally used as fire extinguishing agent. Detailed properties are given below.

Table A3.5: Carbon Dioxide properties

Property	unit	Value
Formula		CO_2
Boiling point	^oC	-78.5
Vapour density (cf air = 1)		1.87
Heat of combustion	MJ/kg	N/A
Flashpoint	^oC	N/A
Lower Flammable Limit (LFL)	vol%	N/A
Upper Flammable Limit (UFL)	vol%	N/A

Table A3.6: Carbon Dioxide Hazardous Properties & Emergency Advice

Incident	Hazardous Properties
Release as Mist	Vapours may cause dizziness or asphyxiation without warning. Effects of oxygen deficiency (below 6 %) are as follows: convulsive movements, possible respiratory collapse and death. Contact with gas or liquefied gas may cause burns, severe injury and/or frostbite. Contact with eyes Immediately flush eyes with plenty of water whilst holding lids open. If redness, itching or burning occurs seek medical attention. Contact with skin Wash material off skin with copious amounts of water and soap for at least 15 minutes. If redness, itching or burning seek get medical attention. Inhalation If victim is conscious, move to uncontaminated area to breath fresh air. Keep warm and quiet. If breathing is difficult, administer oxygen. If victim is unconscious, move to uncontaminated area and give assisted respiration.
Fire	Non-flammable gas. Ruptured cylinders may rocket

A 3.4. Chromic Acid Solution

Chromic acid solution is a strong oxidizer and it reacts rapidly with many materials including common combustibles, often causing ignition and hence fire. Mixing with reducing agents can cause explosions. Detailed properties are given below.

Table A3.7: Chromic acid solution properties

Property	unit	Value
Formula		CrO_3
Melting point	^oC	197
Boiling point	^oC	250, decomposes
Specific gravity		2.7
Heat of combustion	MJ/kg	N/A
Flashpoint	^oC	N/A
Lower Flammable Limit (LFL)	vol%	N/A
Upper Flammable Limit (UFL)	vol%	N/A

Table A3.8: Chromic Acid Solution Hazardous Properties & Emergency Advice

Incident	Hazardous Properties
Release as Liquid	Chromic acid solution is toxic. Inhalation, ingestion or contact with skin may cause severe injury or death. Contact with molten substance may cause severe burns to skin and eyes. Avoid any contact, effects of contact and inhalation may be delayed. Fire may produce irritating, corrosive and/or toxic gases. Run-off from fire control or dilution may be corrosive and/or toxic and cause pollution. <u>First Aid</u> Move victim to fresh air. Seek emergency medical service. Give artificial respiration is victim is not breathing. Do not use mouth-to-mouth method if victim ingested or inhales the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Administer oxygen if breathing is difficult. Remove and isolate contaminated clothing and shoes. In case of contact, immediately flush skin or eyes with plenty of water. Keep victim warm and quiet. Ensure that medical personnel are aware of the substance(s) involved and take precautions to protect themselves.
Fire	Non-combustible, substance itself does not burn but may decompose upon heating to produce corrosive and/or toxic fumes. For small fire, extinguish with dry chemical, CO_2 or water spray. For large fire, extinguish with dry chemical, CO_2, alcohol-resistant foam or water spray.

A 3.5. Chromium Trioxide Solid

Chromium trioxide is an acid anhydride of chromic acid, classified as Class 5.1, 6.1 and 8 hazardous material. Chromium trioxide is toxic, corrosive, carcinogenic and a strong oxidizer, hence contact with other material may cause fire. Detailed properties are given below.

Table A3.9: Chromium Trioxide properties

Property	unit	Value
Formula		CrO_3
Melting point	^oC	197
Boiling point	^oC	250, decomposes
Specific gravity		2.7
Heat of combustion	MJ/kg	N/A
Flashpoint	^oC	N/A
Lower Flammable Limit (LFL)	vol%	N/A
Upper Flammable Limit (UFL)	vol%	N/A

Table A3.10: Chromium Trioxide Hazardous Properties & Emergency Advice

Incident	Hazardous Properties
Release as Solid	Extremely destructive to respiratory tract, may cause ulceration and perforation of nasal septum. If inhaled, symptoms include sore throat and coughing. Corrosive, any contact with skin and eyes will cause several burns. Contact with eyes could cause pain, redness and severe tissue burns. May cause corneal injury or blindness. Ingestion could cause severe burns to mouth, throat and stomach, leading to death. Symptoms include vomiting, diarrhoea and gastroentertis. Move to fresh air. If swallowed, DO NOT INDUCE VOMITTING, give large quantities of water. Contact can cause blurred vision, redness, pain and severe tissue burns. May cause corneal injury or blindness. IF IN EYES, hold eyelids open and flush with plenty of water. If breathing has stopped, give artificial respiration. If breathing is difficult, administer oxygen. Seek medical attention.
Fire	Not combustible, but substance is a strong oxidizer and its heat of reaction with reducing agents or combustibles may cause ignition. Releases oxygen upon decomposition, increasing the fire hazard.

A 3.6. Steam

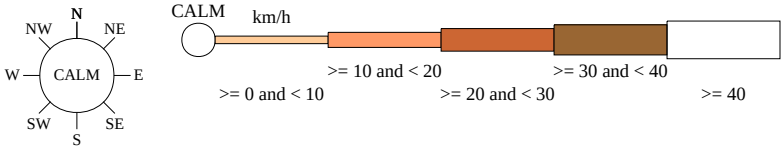
Steam is used to regenerate the carbon filters in the VRU. It is generated in boilers with a maximum temperature and pressure to be determined.

APPENDIX 4. WIND ROSE DATA

Rose of Wind direction versus Wind speed in km/h (01 Jul 1968 to 31 Dec 2006)
BANKSTOWN AIRPORT AWS

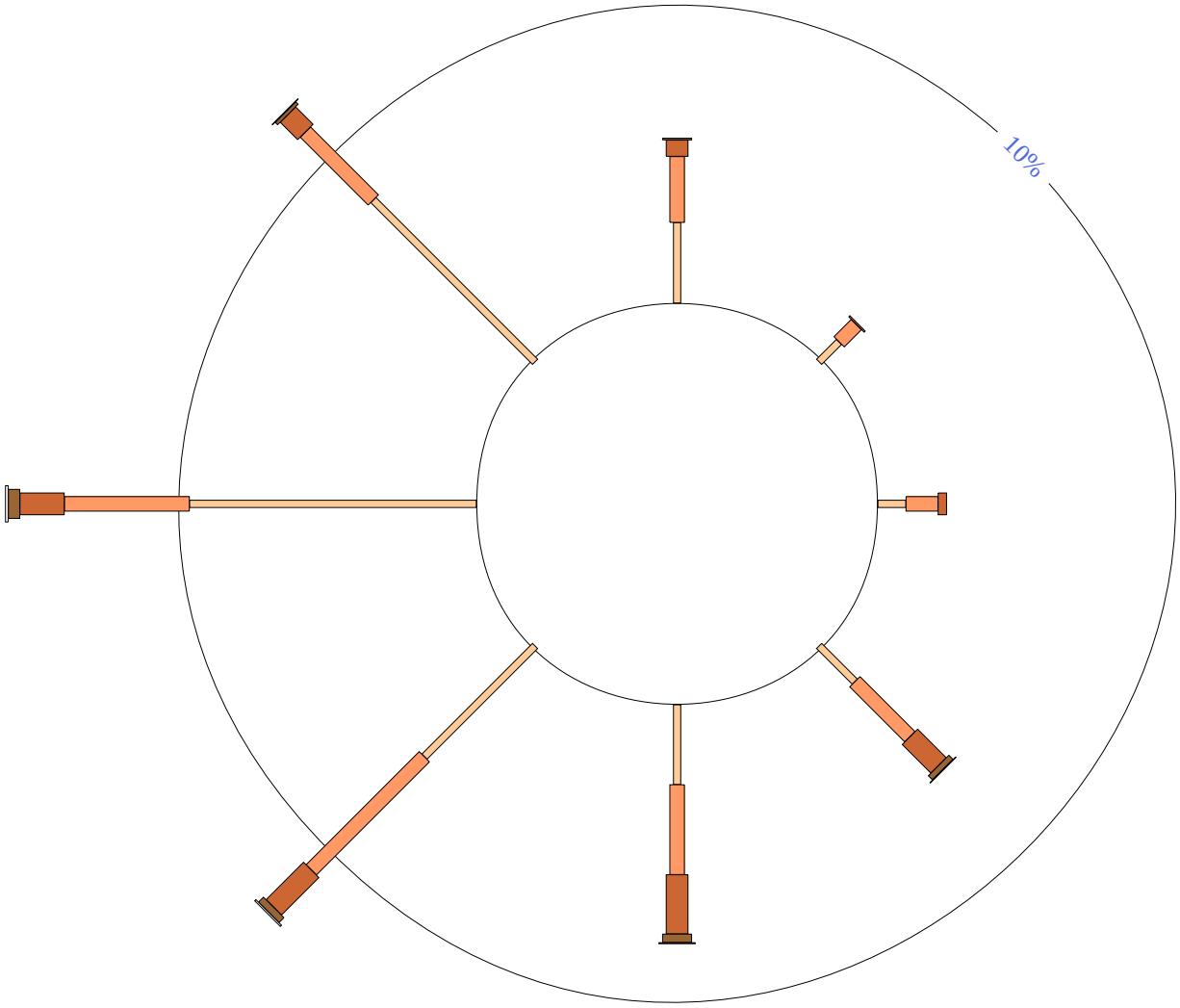
Site No: 066137 • Opened Jan 1968 • Still Open • Latitude: -33.9181° • Longitude: 150.9864° • Elevation 6.m

An asterisk (*) indicates that calm is less than 0.5%.
Other important info about this analysis is available in the accompanying notes.



9 am
13797 Total Observations

Calm 35%



Rose of Wind direction versus Wind speed in km/h (01 Jul 1968 to 31 Dec 2006)
BANKSTOWN AIRPORT AWS

Site No: 066137 • Opened Jan 1968 • Still Open • Latitude: -33.9181° • Longitude: 150.9864° • Elevation 6.m

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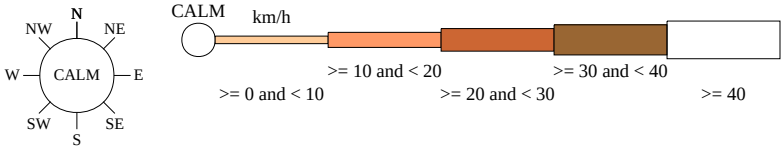
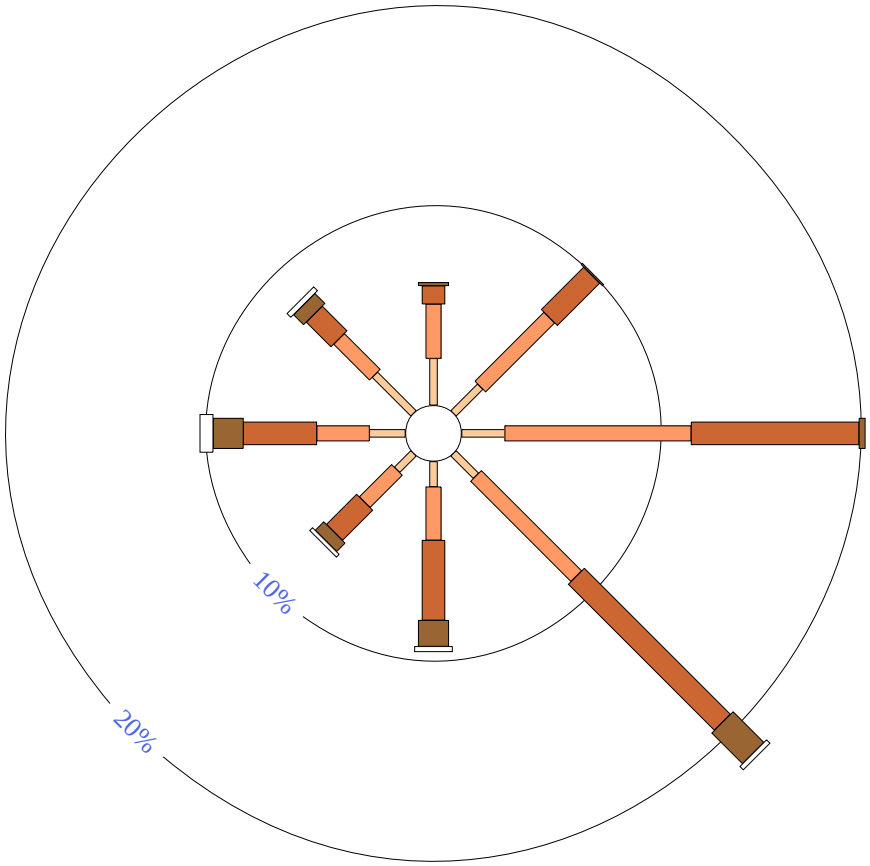
Other important info about this analysis is available in the accompanying notes.



3 pm
12039 Total Observations

Calm 7%



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