# THE STORYBUILDER DATABASE

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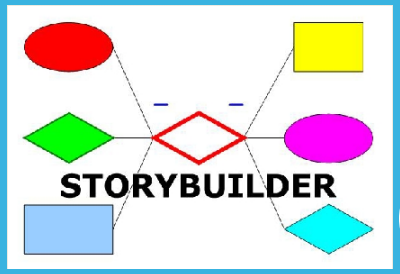
# APPROACH

- Extensive program of work initiated by Ministry of Social Affairs & Employment in the Netherlands 2003-current
- Accident model developed within a group of experts with expertise in safety management and risk assessment:
- Tailor-made software for recording analysis of cause and effect data from accident reports: Storybuilder™
- Detailed accident reports of the Labour Inspectorate



# STORYBUILDER, NL

- Databases of Dutch accidents

  - 2005-2012 Major hazards: 210 ongoing

  - 1998-2009 Most serious occupational accidents (~1%) of all : 23.000

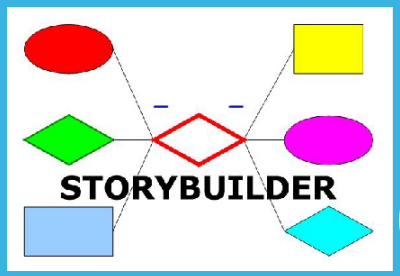
- Accident causation model

  - What to analyse

- Software

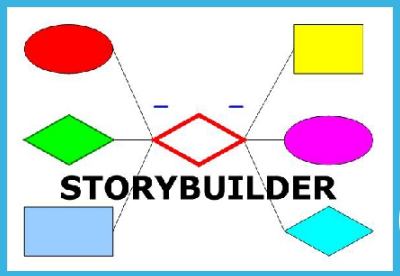
  - Storybuilder I: Single –user PC-based since 2004, built by White Queen

  - Storybuilder II: Multi-user prototype 2013 (Phase 1), built by ICT group, Dutch National Institute for Public Heath and the Environment (RIVM)



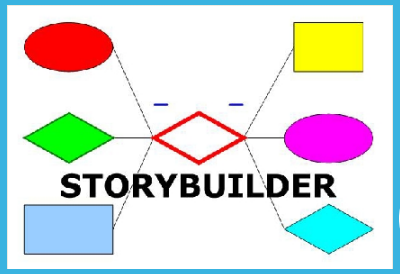
# MAJOR HAZARDS

- 200+ Chemical Loss of Containment (LOC) accidents 2005-2012 ..... (approx 30/yr investigated)
- 175 Dutch upper tier Seveso plant accidents
- 64 refineries - all Major Accident Reporting System (64 MARS accidents).
- 87 overfillings (77 UK accidents, 5 Dutch accidents,1 US)
- .....of which 9 were MARS reportable
- 21 tanks storage & warehouses (14 MARS accidents)
- UK Health & Safety Laboratory also have a model with ~1000 chemical accidents



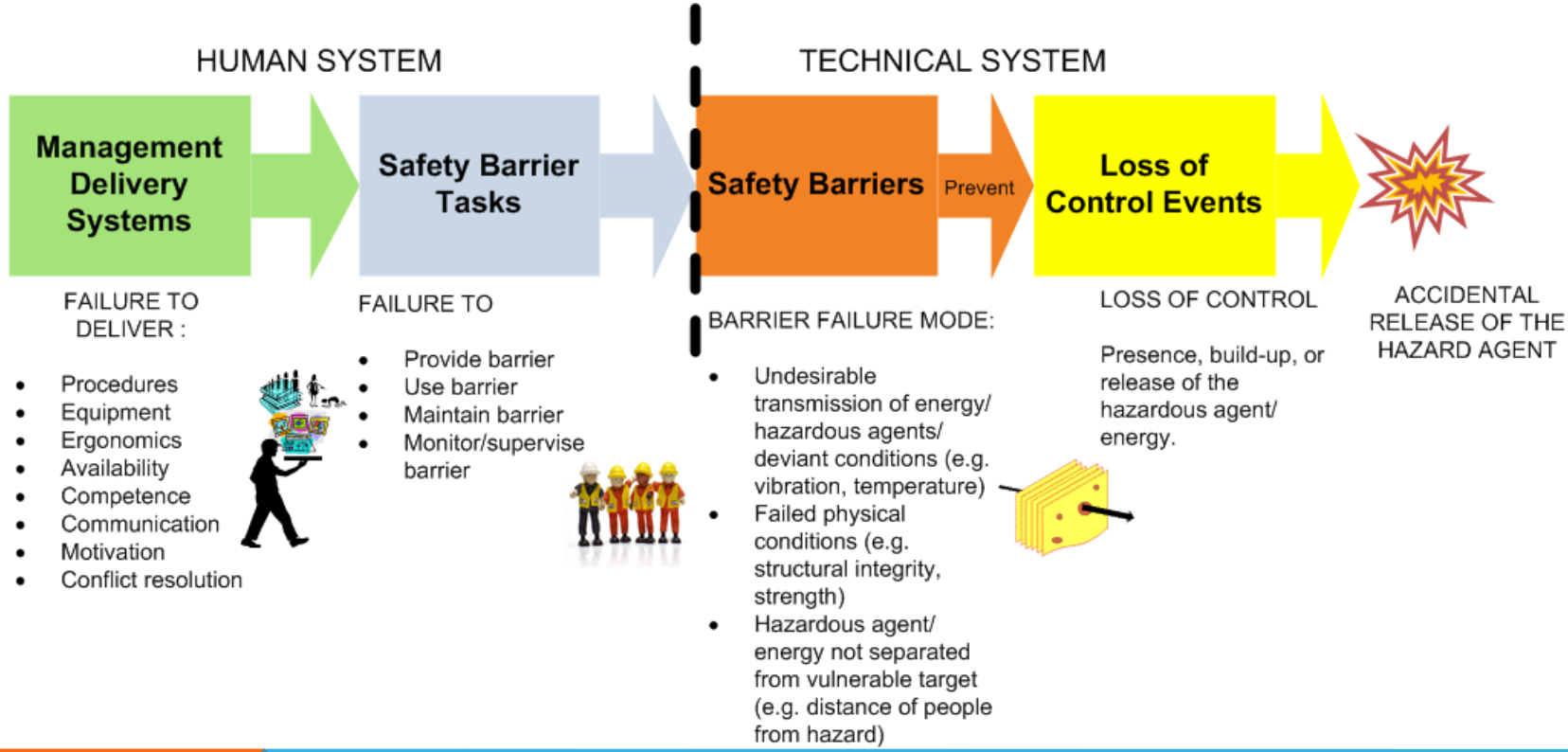
# THE MODEL DETERMINES KIND OF DATA COLLECTED

- Bow-tie
- Safety barriers
- People doing tasks
- Management resource delivery systems

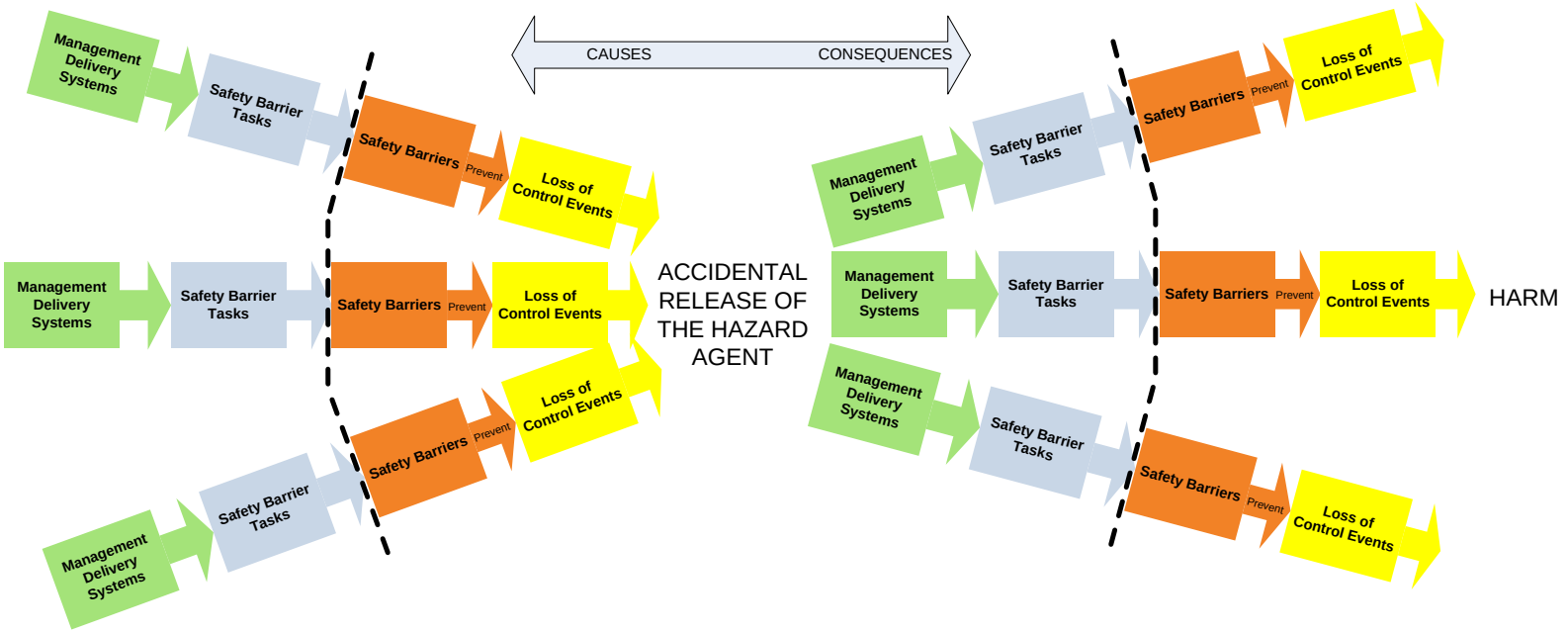


# MODEL

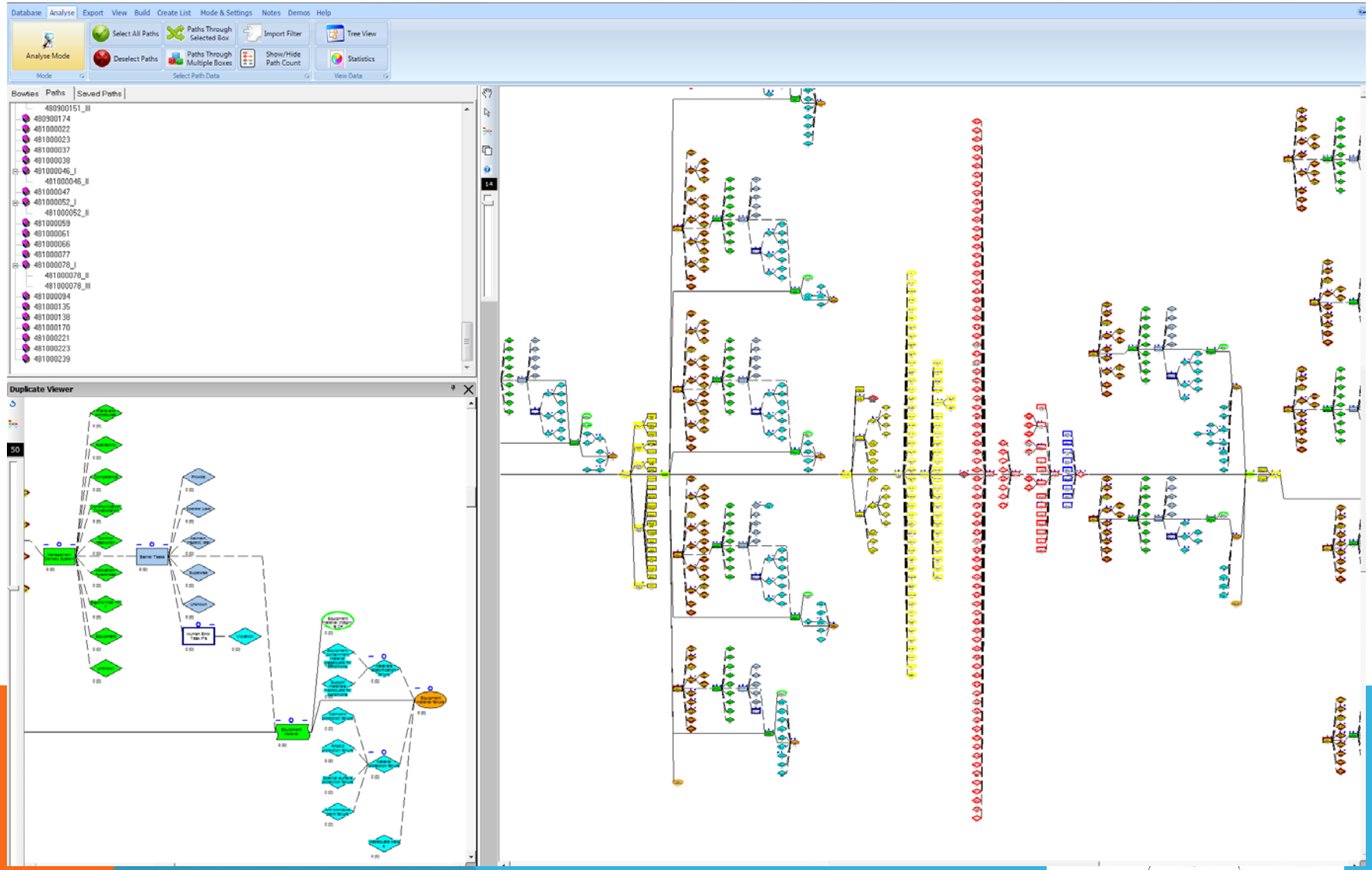
- Same model used for occupational and major accident analysis



# THE BOW-TIE


CAUSES
CONSEQUENCES
Management Delivery Systems
Safety Barrier Tasks
Safety Barriers
Prevent
Loss of Control Events
ACCIDENTAL RELEASE OF THE HAZARD AGENT
HARM

# GRAPHIC STORYBUILDER STRUCTURE



# CODED EVENTS

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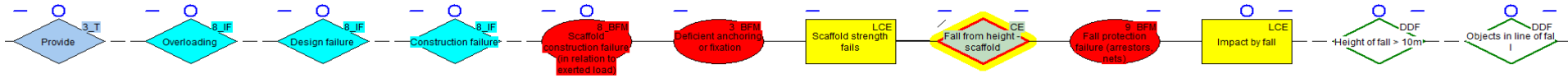
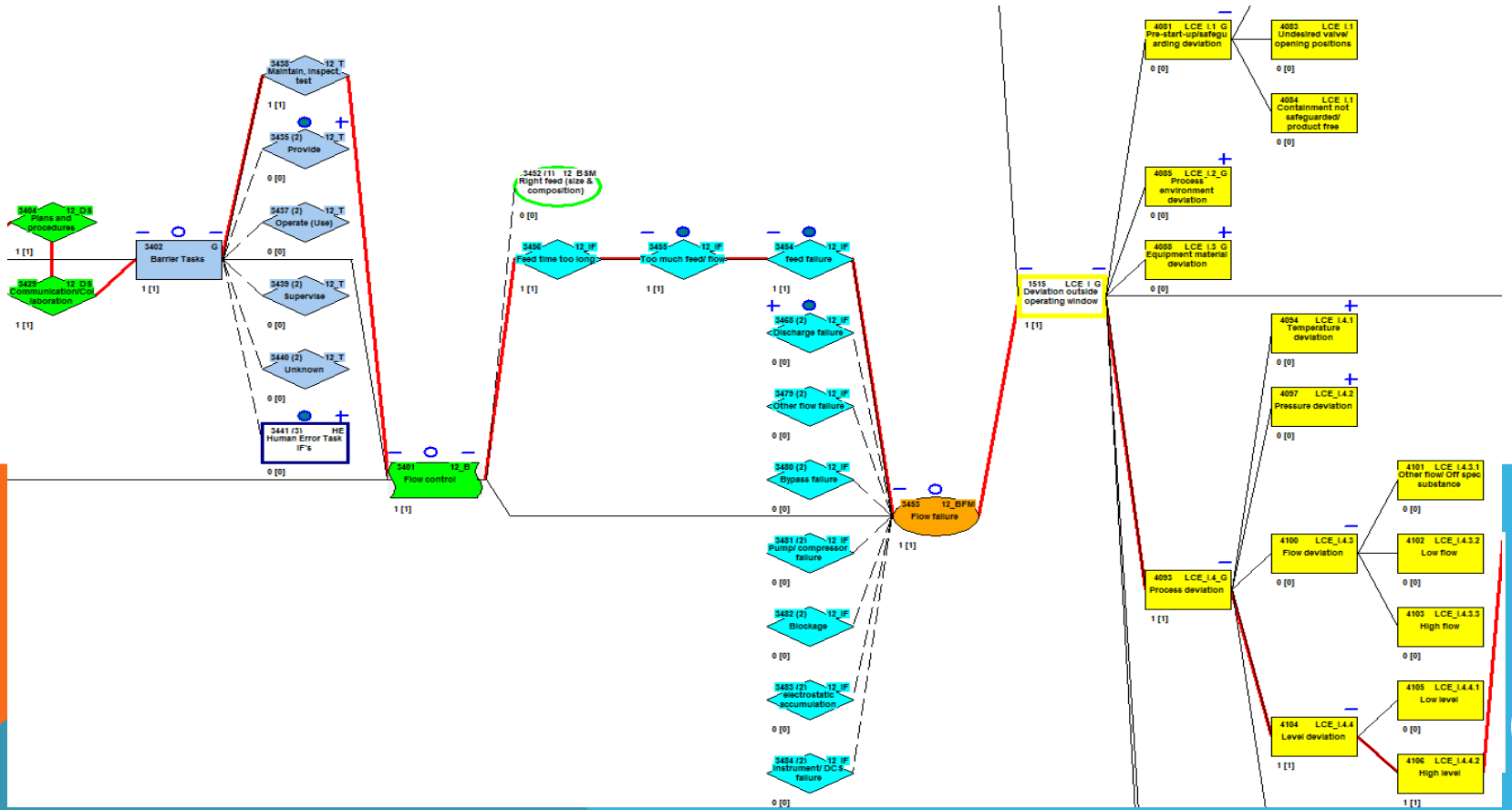
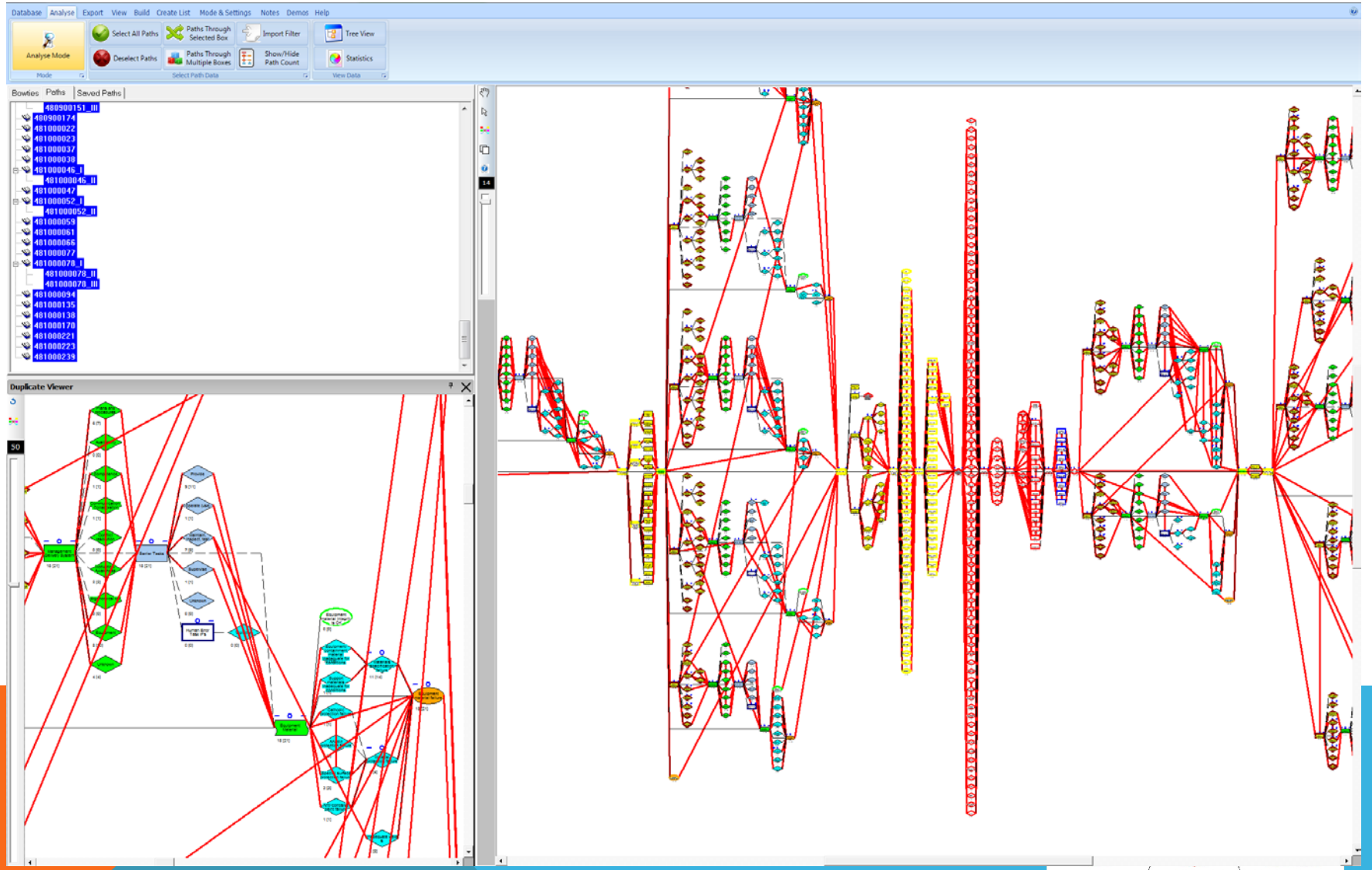


# PLOT ACCIDENT PATHS THROUGH STRUCTURE

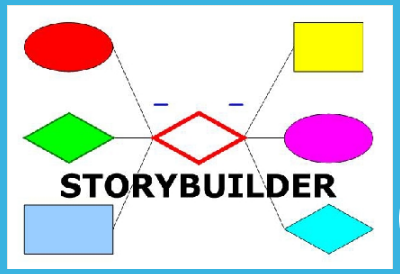


# THE IDEA

- Recreate the story of an accident  in the bow-tie
- Build up the bow-tie model from the stories
- Count the common points of failure

For example..

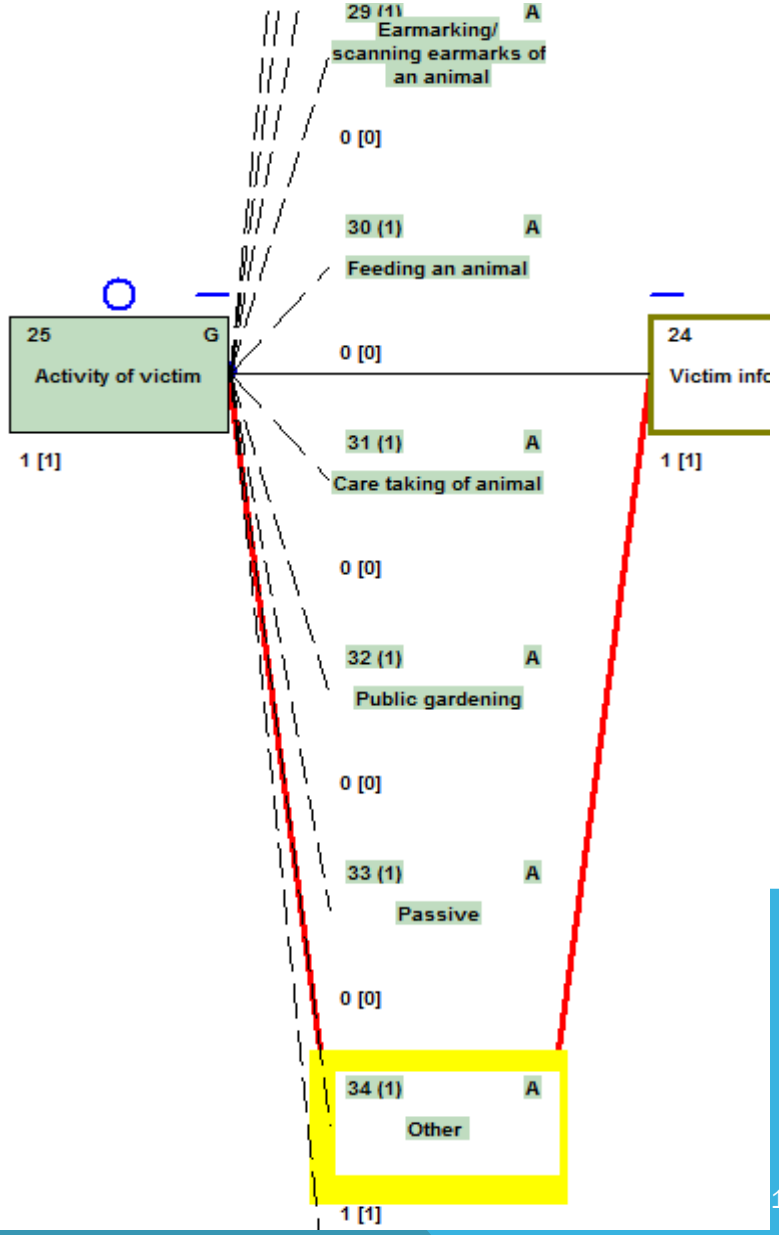
Walking through woods .....Stray from the path .....Eaten by wolf

# SELECT ONE OF 36 BOW-TIES

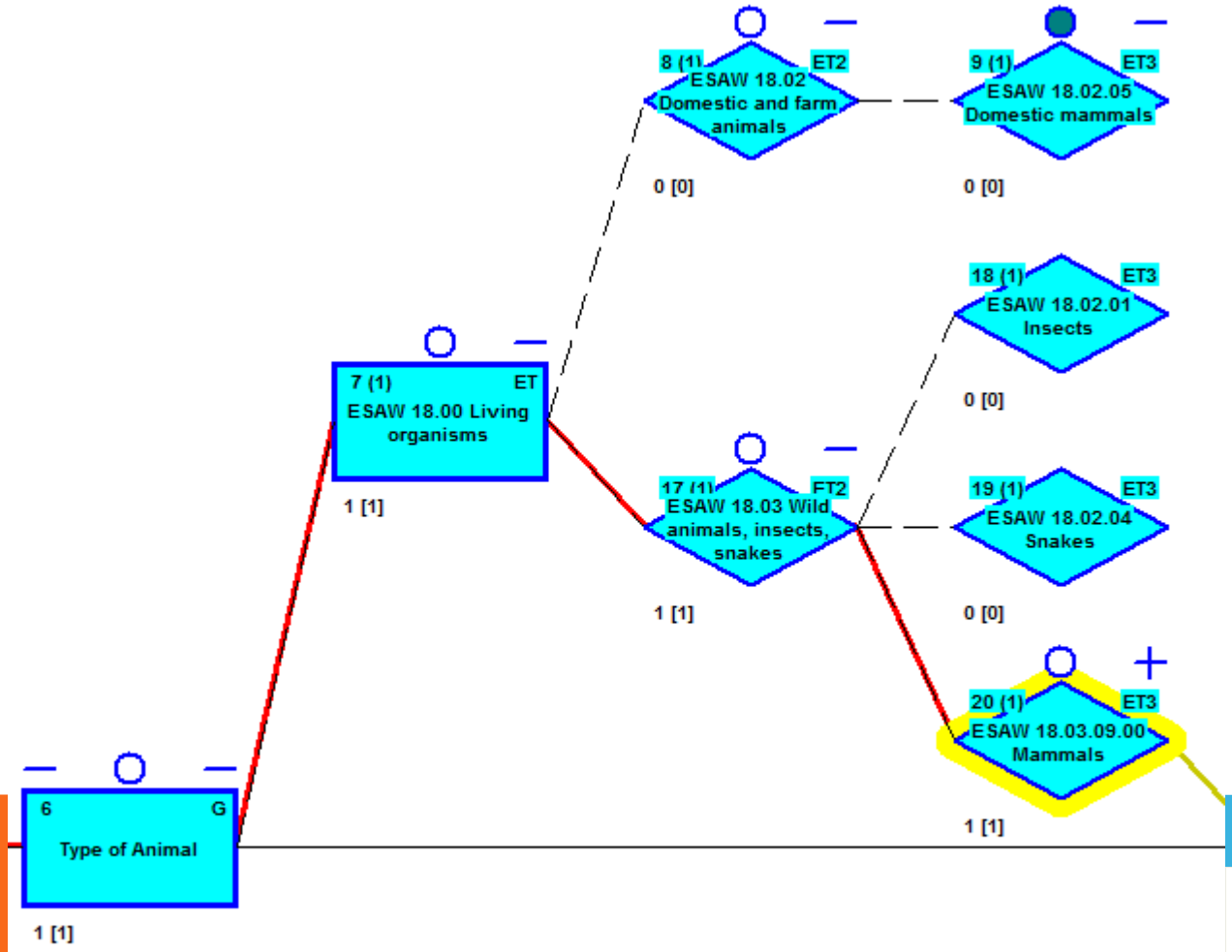
14.1 LoC Open containment
14.2 Contact with hazardous substance without LOC
15 Loss of Containment from normally closed containments
17 Fire
20.1 Victim of Human Aggression
20.2 Victim of animal behaviour
22.1 Contact with hazardous atmosphere in confined space
22.2 Contact with hazardous atmosphere through breathing apparatus
23 Impact by immersion in liquid
24 Too rapid (de)compression
25 Extreme muscular exertion
27 Explosion

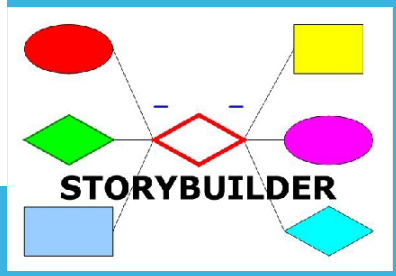
# WHAT WAS THE ACTIVITY AT THE TIME?

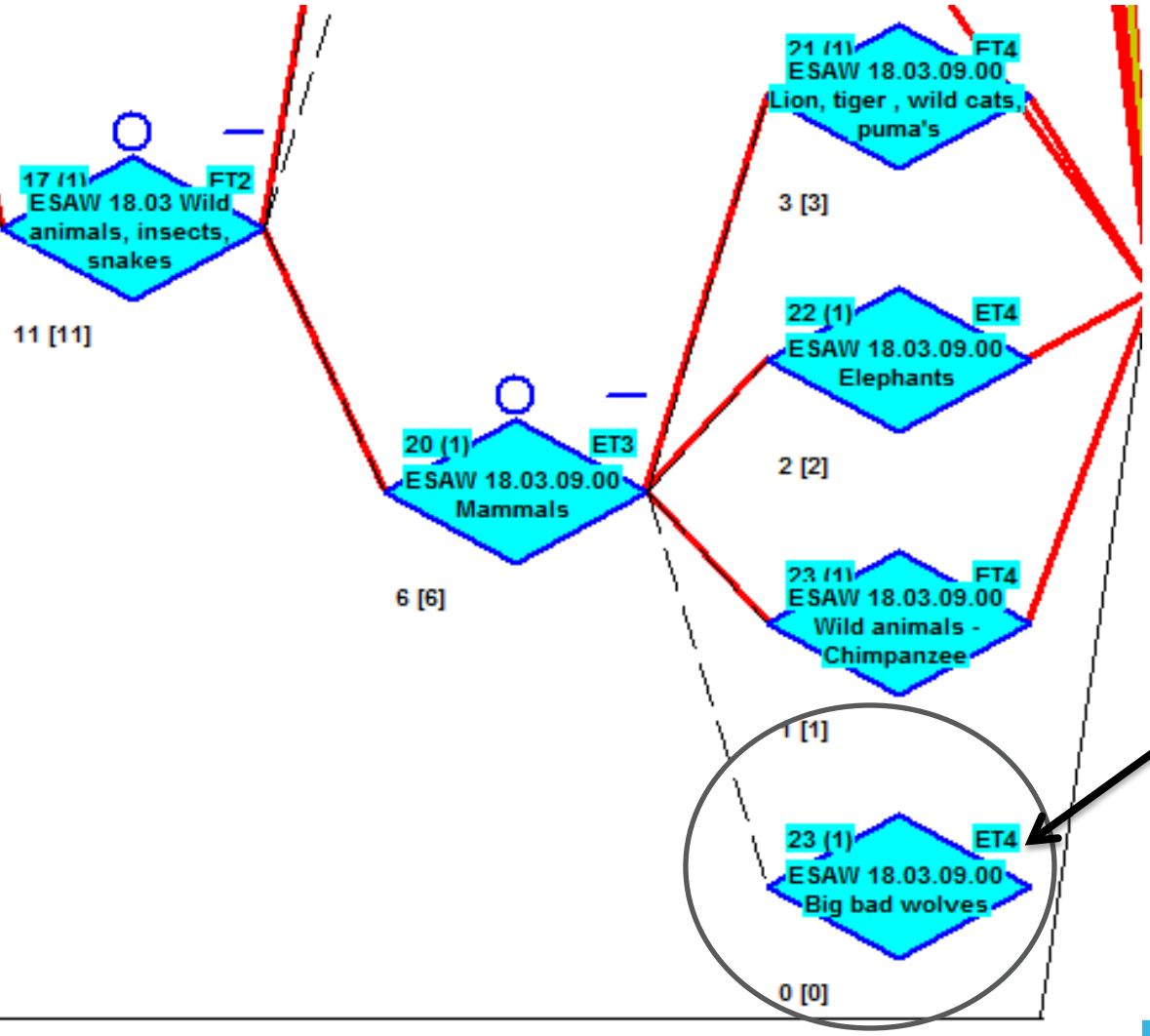



AND
13

# AGENT OF HARM: EQUIPMENT OR LIVING ORGANISM

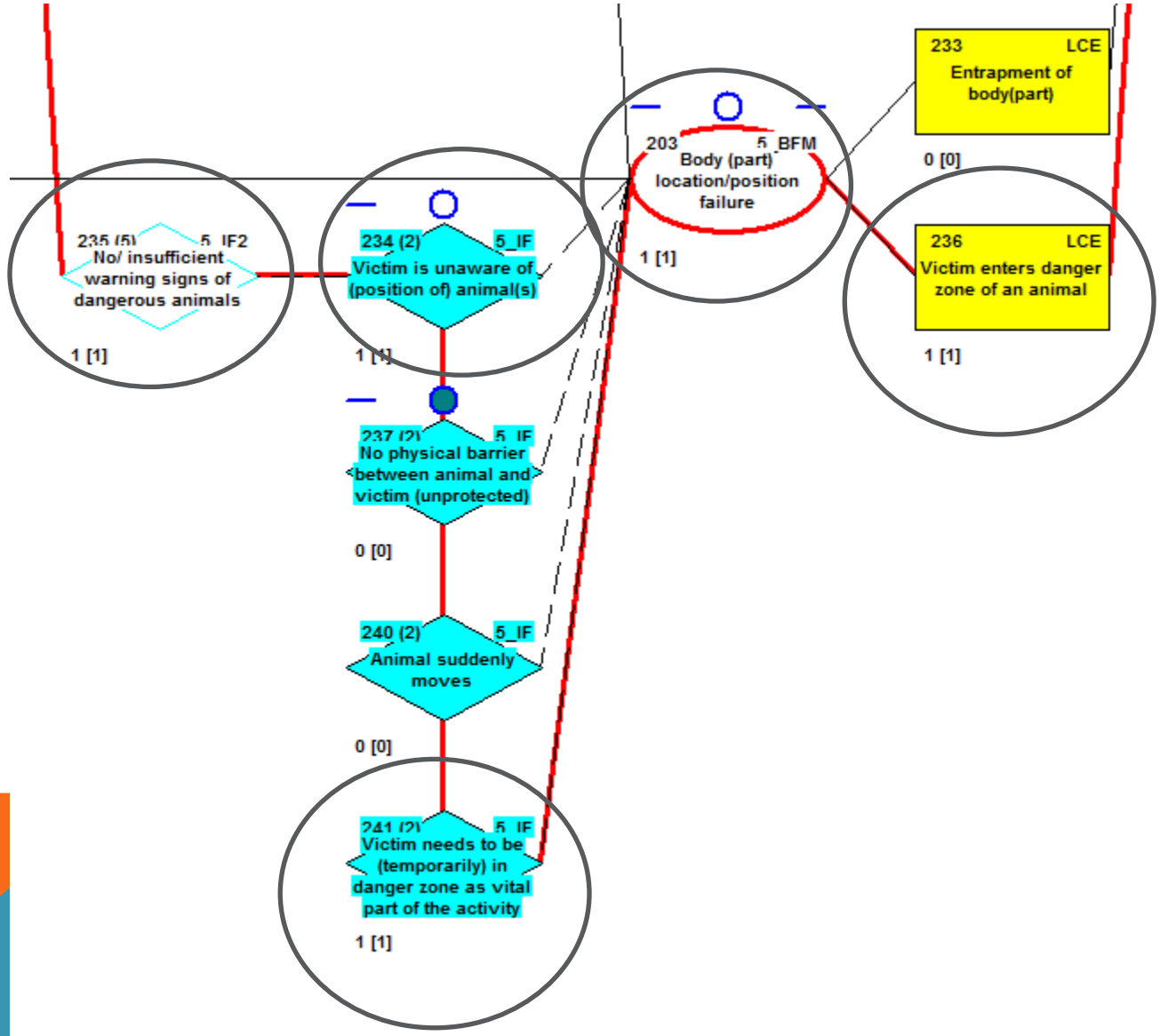




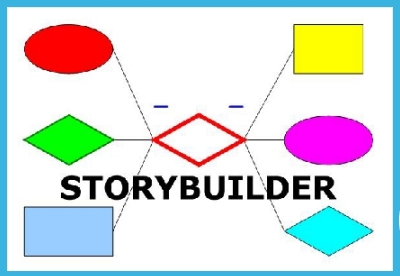

Can always add a missing category if analyst considers that desirable

# WHAT WENT WRONG?

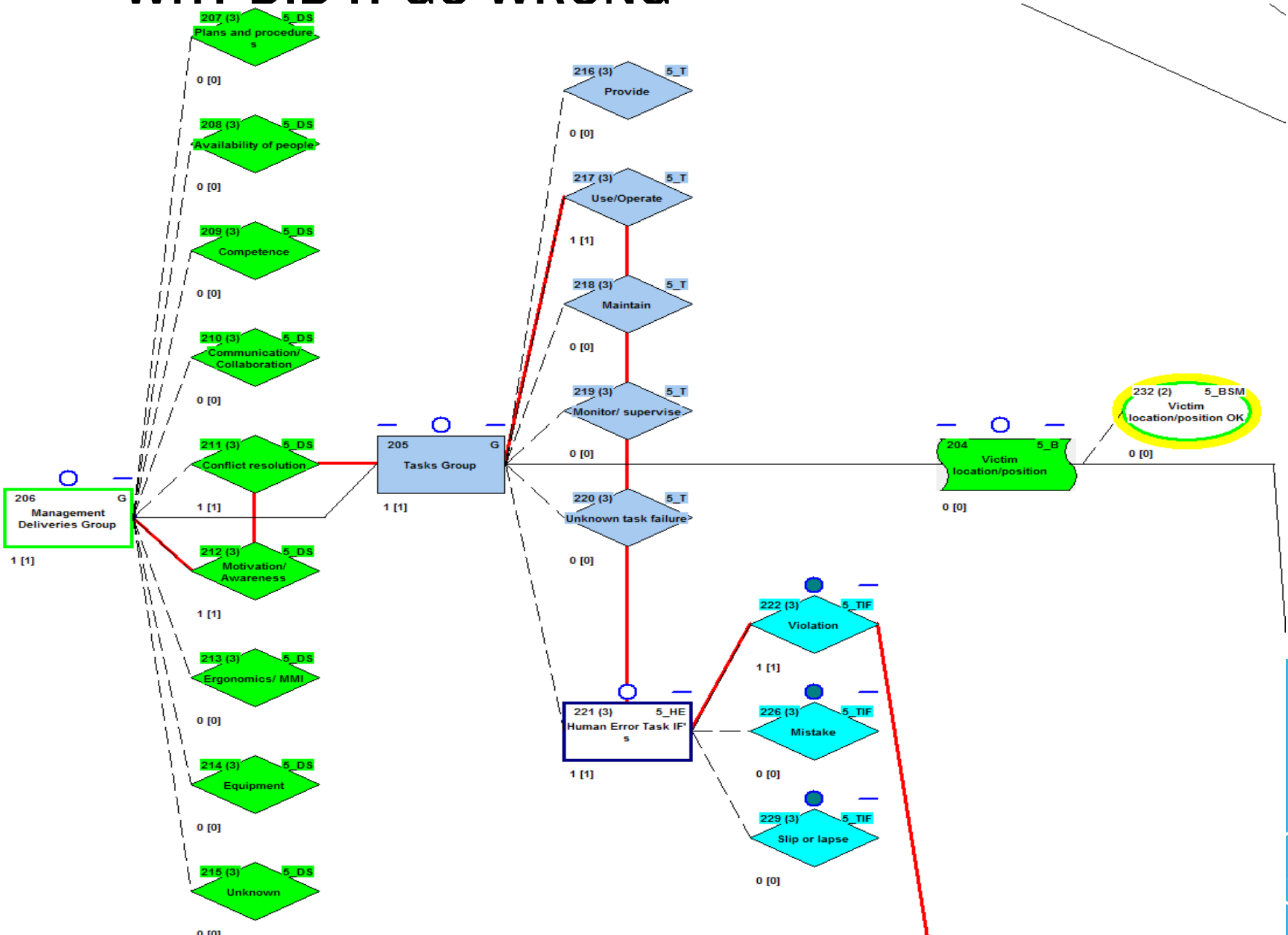



BEWARE
of WOLF

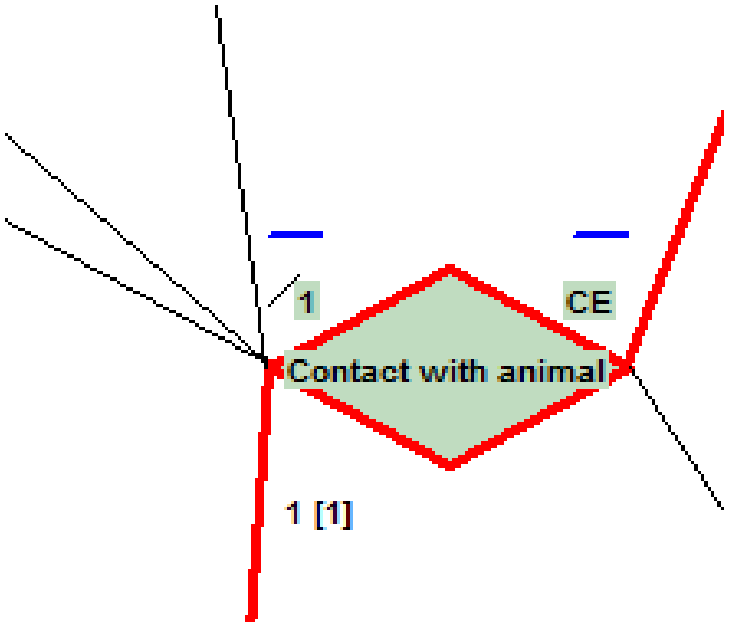



STORYBUILDER

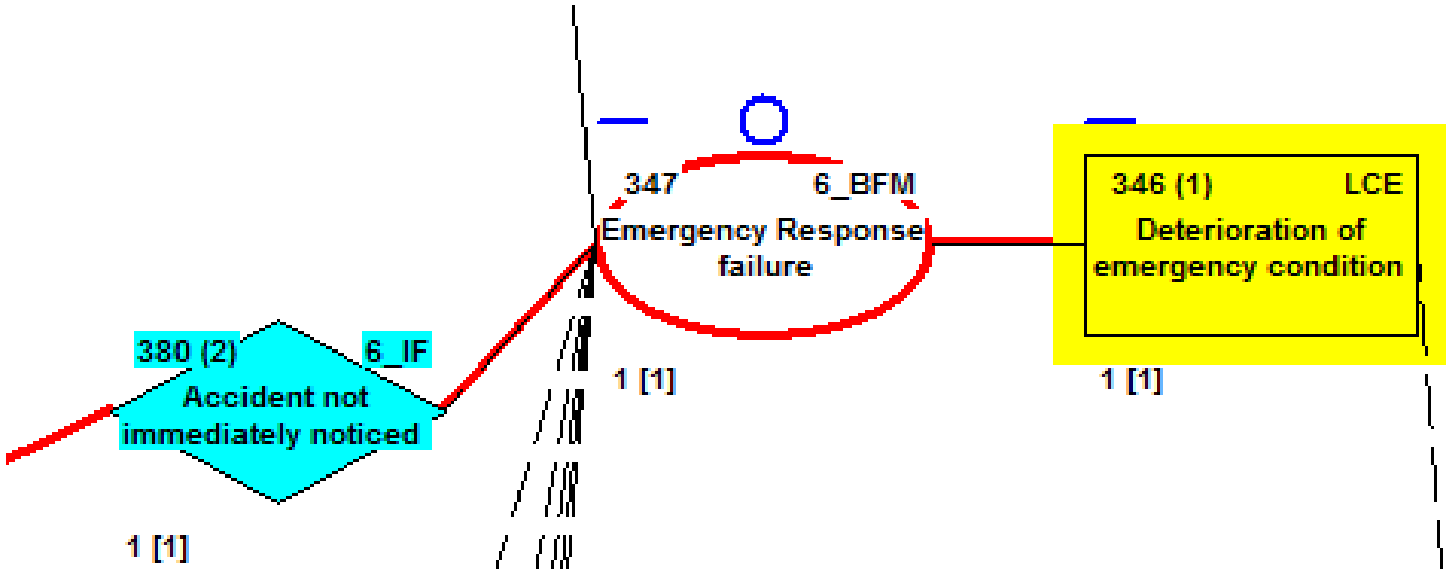
# WHY DID IT GO WRONG



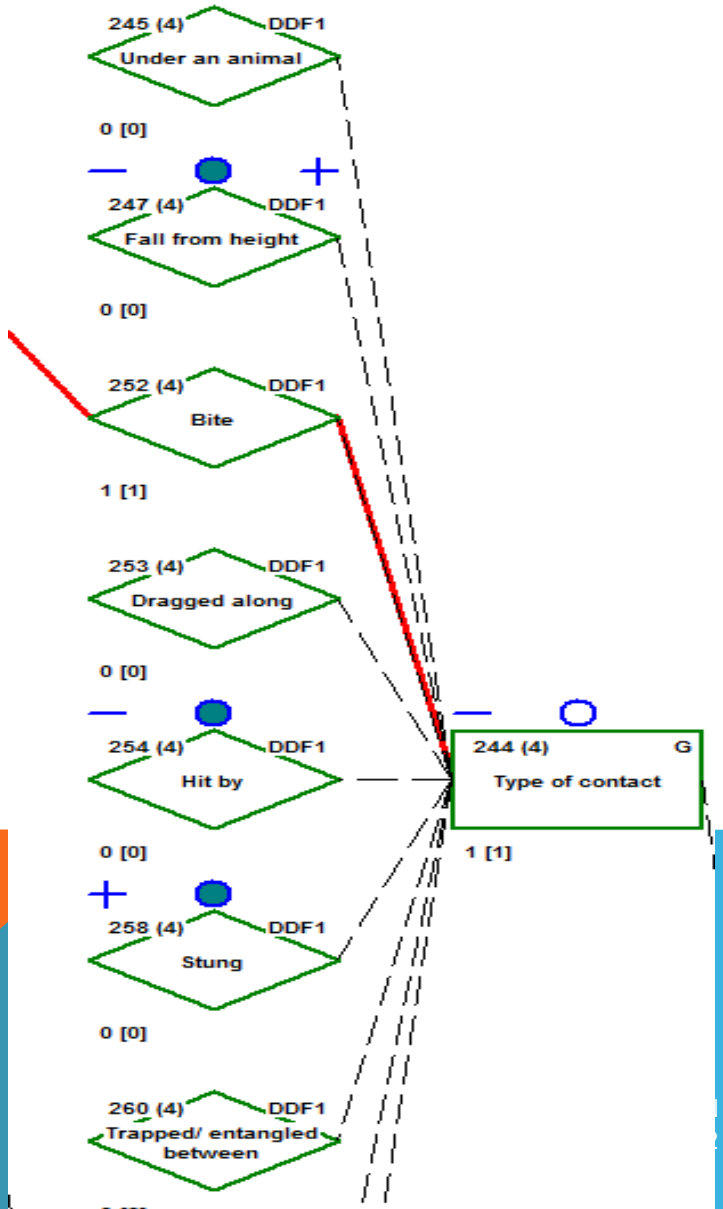
# CENTRE EVENT



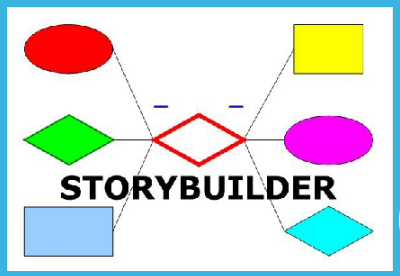
# RIGHT HAND SIDE OF BOW-TIE: EFFECT AND CONSEQUENCE REDUCING BARRIERS



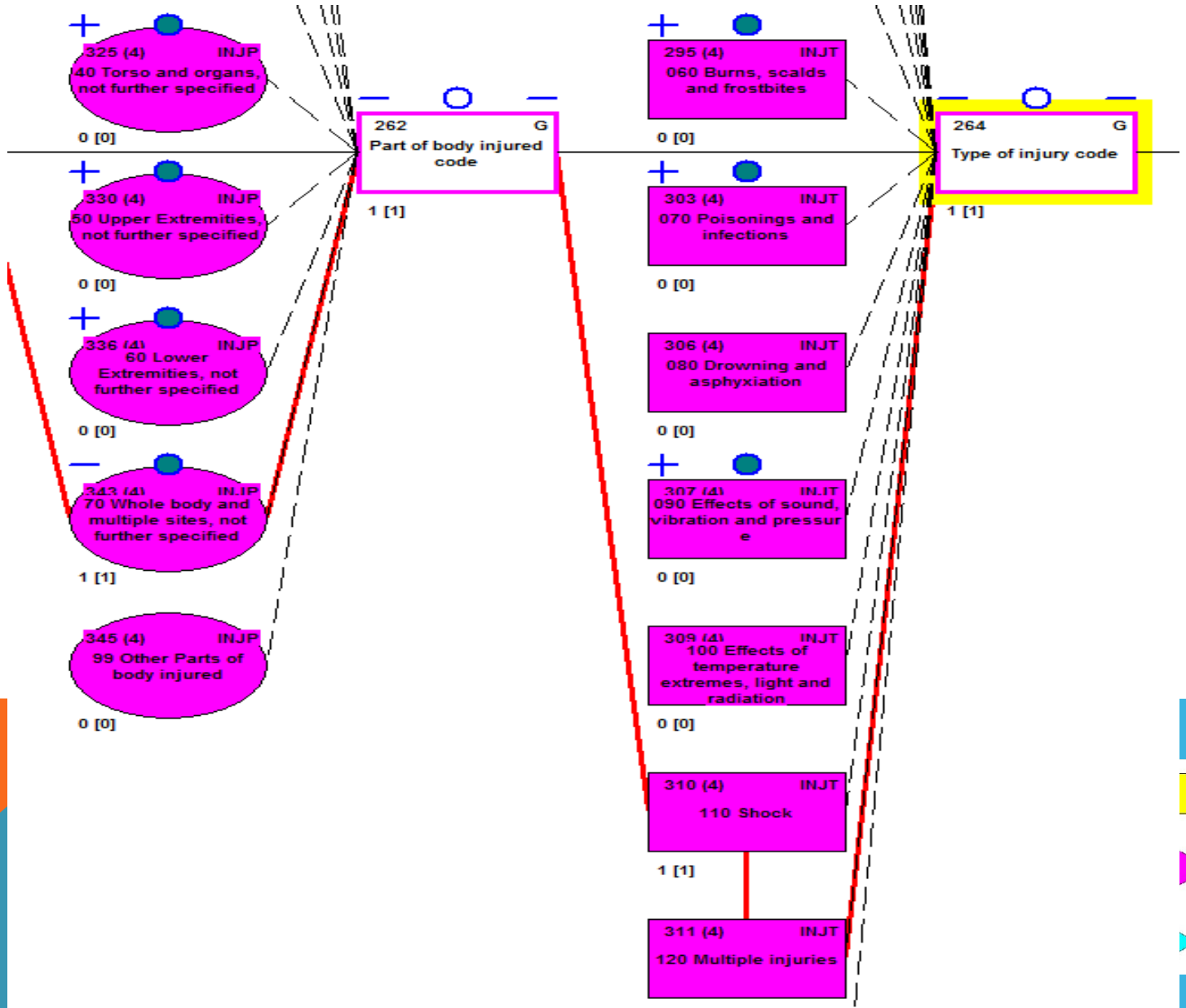
# DOSE DETERMINING FACTORS



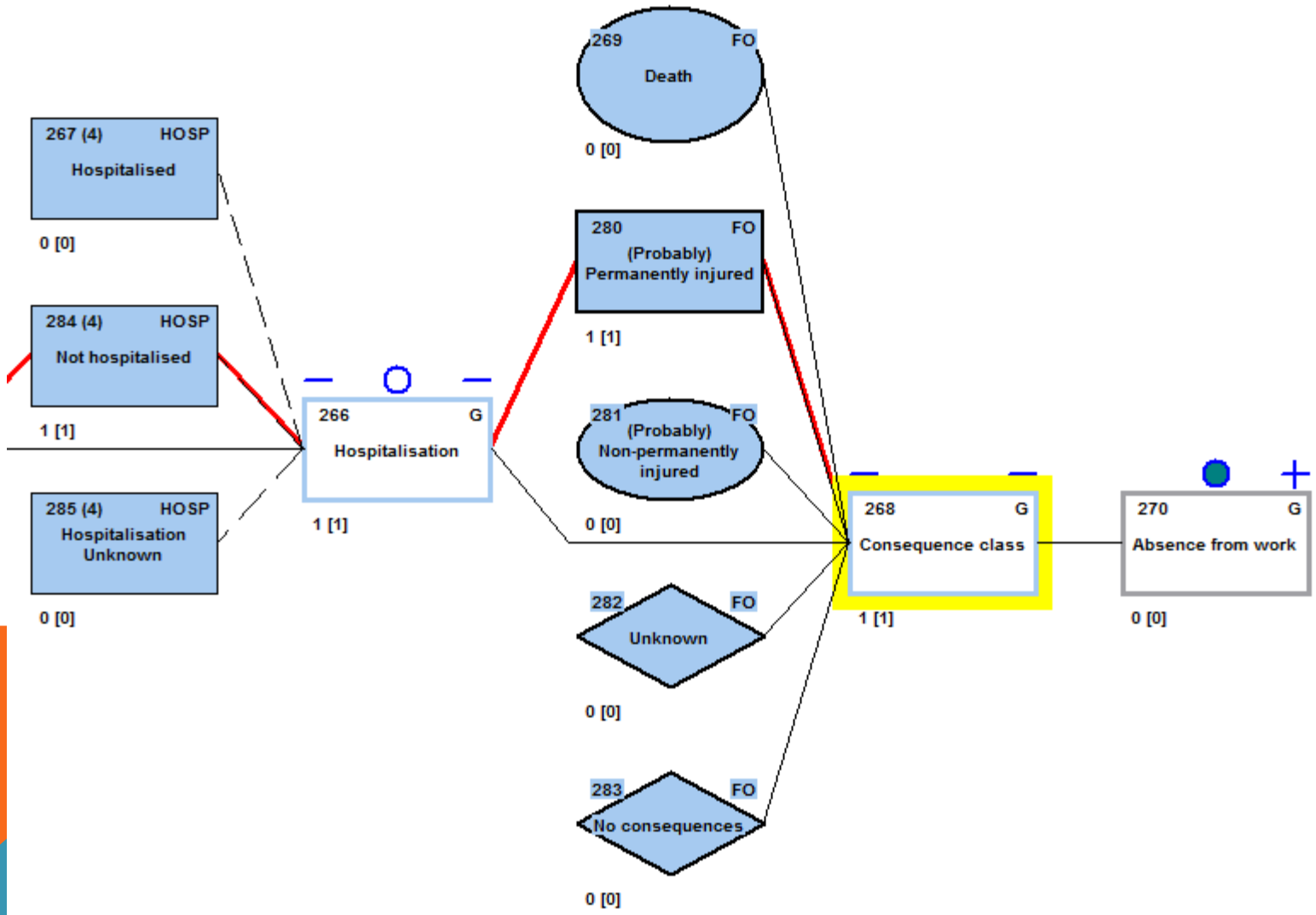


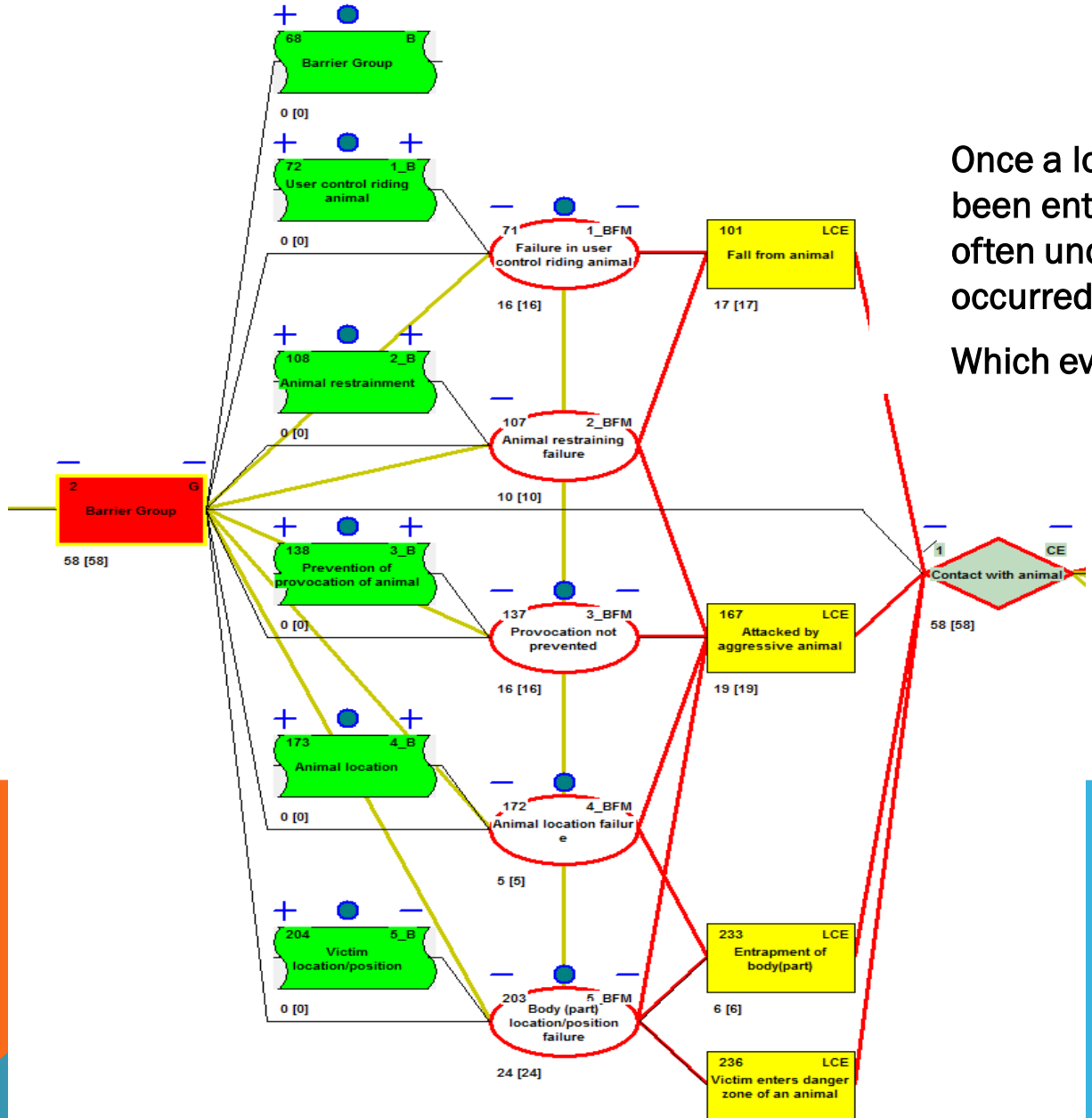
# INJURY


325 (4) INJP
40 Torso and organs, not further specified
0 [0]
330 (4) INJP
50 Upper Extremities, not further specified
0 [0]
336 (4) INJP
60 Lower Extremities, not further specified
0 [0]
343 (4) INJP
70 Whole body and multiple sites, not further specified
1 [1]
345 (4) INJP
99 Other Parts of body injured
0 [0]
262 G
Part of body injured code
1 [1]
295 (4) INJT
060 Burns, scalds and frostbites
0 [0]
303 (4) INJT
070 Poisonings and infections
0 [0]
306 (4) INJT
080 Drowning and asphyxiation
0 [0]
307 (4) INJT
090 Effects of sound, vibration and pressure
0 [0]
309 (4) INJT
100 Effects of temperature extremes, light and radiation
0 [0]
310 (4) INJT
110 Shock
1 [1]
311 (4) INJT
120 Multiple injuries
264 G
Type of injury code
1 [1]

# CONSEQUENCES



# MULTIPLE EVENTS




Once a lot of accidents have been entered can count how often underlying events occurred.

Which events occur most?

# FACTS AND FIGURES SHEETS GIVE OVERVIEW

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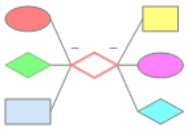
Safety Strategies




## 02 STRUCK BY MOVING VEHICLE

**1042 REPORTABLE OCCUPATIONAL ACCIDENTS WITH 1049 VICTIMS IN THE NETHERLANDS FROM 1998-2009 INCLUSIVE (12 YEAR PERIOD)**

***Table 1 Accident consequences***

| HAZARD | AVERAGE NUMBER OF VICTIMS PER YEAR | | | | RATIOS[1] | | |
|---|---|---|---|---|---|---|---|
| | Deaths | Permanent injuries | Recoverable injuries | Unknown injury type | Deaths | Permanent injuries | Recoverable injuries |
| 02 Struck by moving vehicle | 7 | 18 | 33.5 | 29 | 1 | 4 | 8 |

***Table 2 Type of vehicle[2]***

| Type of vehicle engaged in accident | Accidents 1998-2009 | Accidents per year | Victims per year | % Accidents |
|---|---|---|---|---|
| Forklift trucks | 539 | 45 | 45 | 52% |
| Powered stacking trucks, elevators, stackers with driver | 68 | 6 | 6 | 7% |
| Hydraulic excavators / Bulldozers, loaders | 41 | 3 | 4 | 4% |
| Earthmoving equipment, bob-cat, mini-loader, etc. | 24 | 2 | 2 | 2% |
| Powered stacking trucks, elevators, stackers with walking operator | 23 | 2 | 2 | 2% |
| Mobile handling device -manually moved | 17 | 1 | 1 | 2% |
| Road construction and maintenance | 14 | 1 | 1 | 1% |
| Agricultural tractor | 13 | 1 | 1 | 1% |
| Powered stacking trucks, pallet truck, stackers unmanned/ automatic | 12 | 1 | 1 | 1% |

[1] Calculated with unknowns reallocated proportionally to permanent and recoverable injuries
[2] Due to space restrictions vehicle types with smaller values not reported here

# FACTS & FIGURES: BARRIER FAILURES

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***Table 3 Barrier failure modes for being struck by moving vehicle. Where did it go wrong?[3]***

| BARRIER FAILURE MODE | Description | Accidents 1998-2009 | Accidents per year | Victims per year | % Accidents |
|---|---|---|---|---|---|
| **Before being struck by moving vehicle** | | | | | |
| Visual contact failure (driver with respect to pedestrian) | (driver does not see pedestrian in time). Could also be automatic detection failure in case of unmanned vehicle. | 585 | 49 | 49 | 56% |
| Location/ position failure | Pedestrian/ victim in hazardous location (in line of fire")." | 497 | 41 | 42 | 48% |
| Infrastructure failure | This barrier related to the infrastructure itself, state and/or geometry. Typical related incident factors are: - lack of suitable marking, signalling, road blocks. Including the absence of adequate crossing points on vehicle routes. - insufficient lighting. This refers to the lighting (conditions) of the location, not the vehicle - Insufficient space/ separation (between vehicle routes and/or pedestrian/ working areas): - Obstruction: e.g. obstacles in the pathway/ road blocking view or otherwise causing uncontrolled vehicles - Substandard surface condition: (pot) holes, spilled liquids, not firm and flat, or slippery, etc. | 418 | 35 | 35 | 40% |
| Visual and/or audible contact failure (pedestrian with respect to driver) | i.e. victim does not see/ hear vehicle coming (in time) | 287 | 24 | 24 | 28% |
| Failure to control vehicle | Failure to stop in time, avoid collision, keep correct lane, etc. Failure could be skill related, physical (e.g. fatigue or substandard eye-sight (medical)), behaviour related (horseplay, dangerous short-cuttings etc.) or a temporary lack of attention (lapse slip). | 197 | 16 | 17 | 19% |
| Failure to prevent contact with vehicle by pedestrian | To avoid contact with vehicle coming towards the victim. Factors include the ability to participate in traffic in general, to keep on the pedestrian area/ track- away from the vehicle, to judge the speed and distance of the approaching vehicle and to be aware of/ concentrated on possible hazards). | 151 | 13 | 13 | 14% |
| Lock-out failure | This barrier failure indicates movement of a vehicle that is supposed to stand still. This could be the case, e.g., when leaving a vehicle prematurely, vehicle not on brake (or other means to prevent unintended movement), ignition key not removed or sudden start-up due to other errors. Further detail is provided though the incident factors (The blue rhombuses labelled IF). e.g. leaving vehicle prematurely, vehicle not on break, ignition key not removed or start-up due to other errors. | 148 | 12 | 12 | 14% |
| Vehicle state/ condition failure | Mechanical, electrical, logics related. E.g. with respect to maintenance of brakes, steering function, tires, etc. | 31 | 3 | 3 | 3% |
| Speeding | with respect to the specific situation (not necessarily with respect to a specific speed limit set). | 22 | 2 | 2 | 2% |
| **After being struck by moving vehicle** | | | | | |
| Emergency Response failure | Not in time, wrong diagnosis and/or unqualified as first aider | 14 | 1 | 1 | 1% |

[3] Note: there can be more than one barrier failure per accident

# FACTS & FIGURES: UNDERLYING CAUSES

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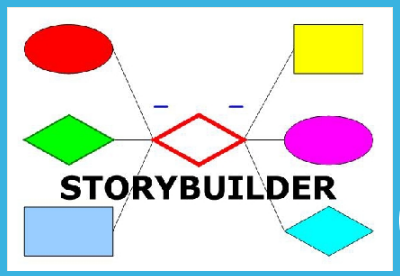
Safety Strategies

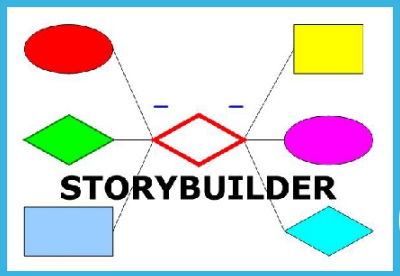
*Table 4 The most common underlying causes for being struck by a moving vehicle: barrier tasks and management delivery system failures. How and why did it go wrong?*[4]

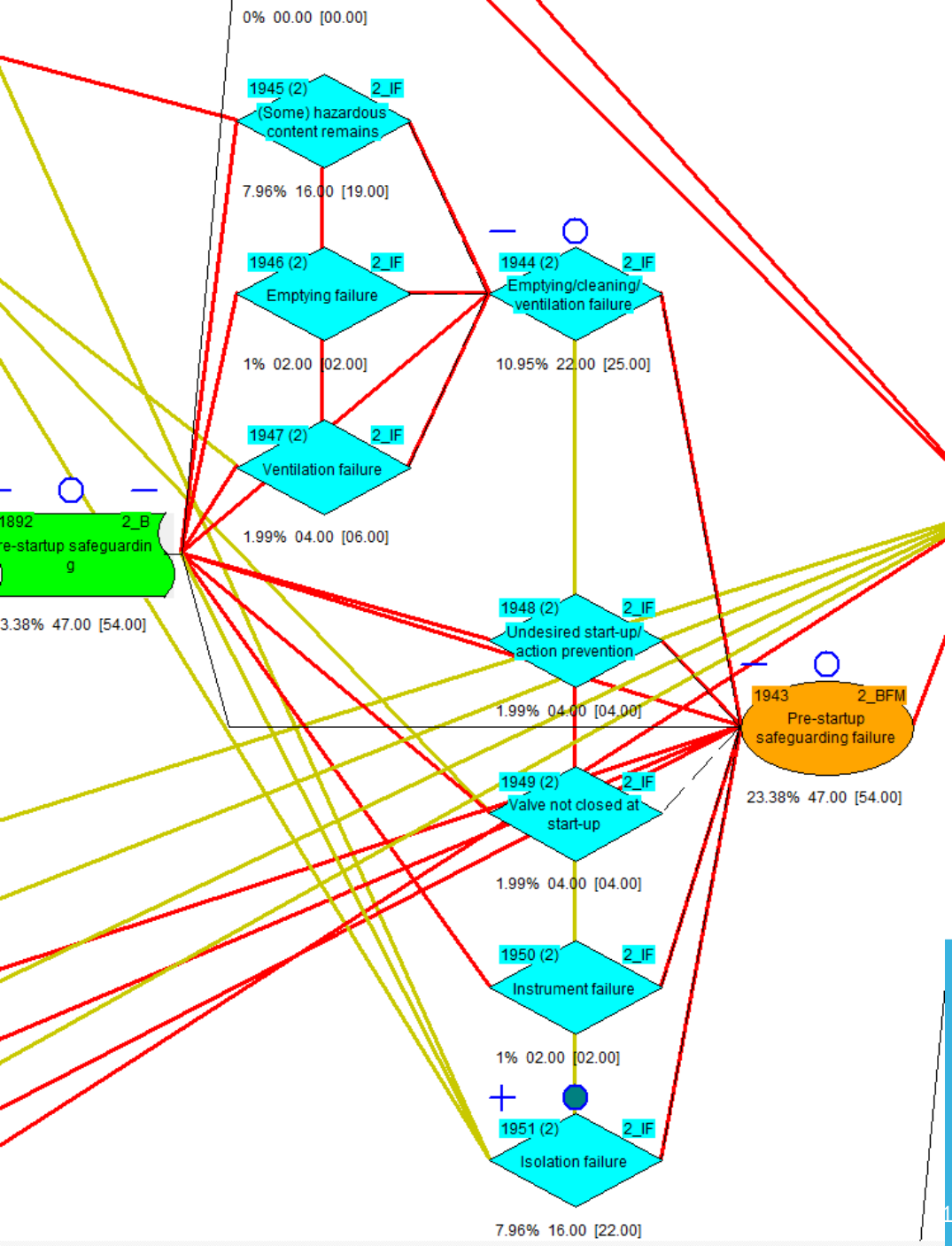
| UNDERLYING FAILURES[5] | Description | Accidents 1998-2009 | Accidents per year | Victims per year | % Accidents |
|---|---|---|---|---|---|
| **Task failures** | **The failure of the tasks which are required for the adequate functioning of the safety barriers.** | | | | |
| Use of: Good visual contact by driver with respect to pedestrian | Good visual contact by driver with respect to pedestrian: is provided, but the way in which the provided barrier is used or operated is incorrect, is only partially used, or is not used at all. | 428 | 36 | 36 | 41% |
| Use of: Proper location/ position of pedestrian | Proper location/ position of pedestrian: is provided, but the way in which the provided barrier is used or operated is incorrect, is only partially used, or is not used at all. | 388 | 32 | 32 | 37% |
| Provide: Adequate infrastructure | Adequate infrastructure: does not exist, has not been well designed, or it is not provided and / or sufficiently/easily available when required. | 364 | 30 | 31 | 35% |
| Use of: Good visual contact by pedestrian with respect to vehicle | Good visual contact by pedestrian with respect to vehicle: is provided, but the way in which the provided barrier is used or operated is incorrect, is only partially used, or is not used at all. | 178 | 15 | 15 | 17% |
| **Management delivery system failures** | **The failure of the necessary resources which should have been delivered by the management system for the execution of the tasks.** | | | | |
| Motivation/Awareness for: Good visual contact by driver with respect to pedestrian | The management system must provide for the motivation, alertness and risk awareness of workers for carrying out their tasks for achieving: Good visual contact by driver with respect to pedestrian | 382 | 32 | 32 | 37% |
| Motivation/Awareness for: Proper location/ position of pedestrian | The management system must provide for the motivation, alertness and risk awareness of workers for carrying out their tasks for achieving: Proper location/ position of pedestrian | 294 | 25 | 25 | 28% |
| Plans and procedures for: Adequate infrastructure | The management system must provide for specific performance criteria which specify in detail, usually in written form, a formalised 'normative' behaviour or method with which workers have to carry out their tasks for achieving: Adequate infrastructure | 166 | 14 | 14 | 16% |
| Motivation/Awareness for: Good visual contact by pedestrian with respect to vehicle | The management system must provide for the motivation, alertness and risk awareness of workers for carrying out their tasks for achieving: Good visual contact by pedestrian with respect to vehicle | 162 | 14 | 14 | 16% |



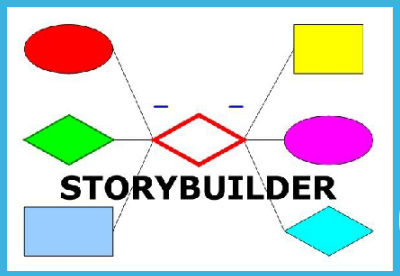
# MAJOR HAZARDS







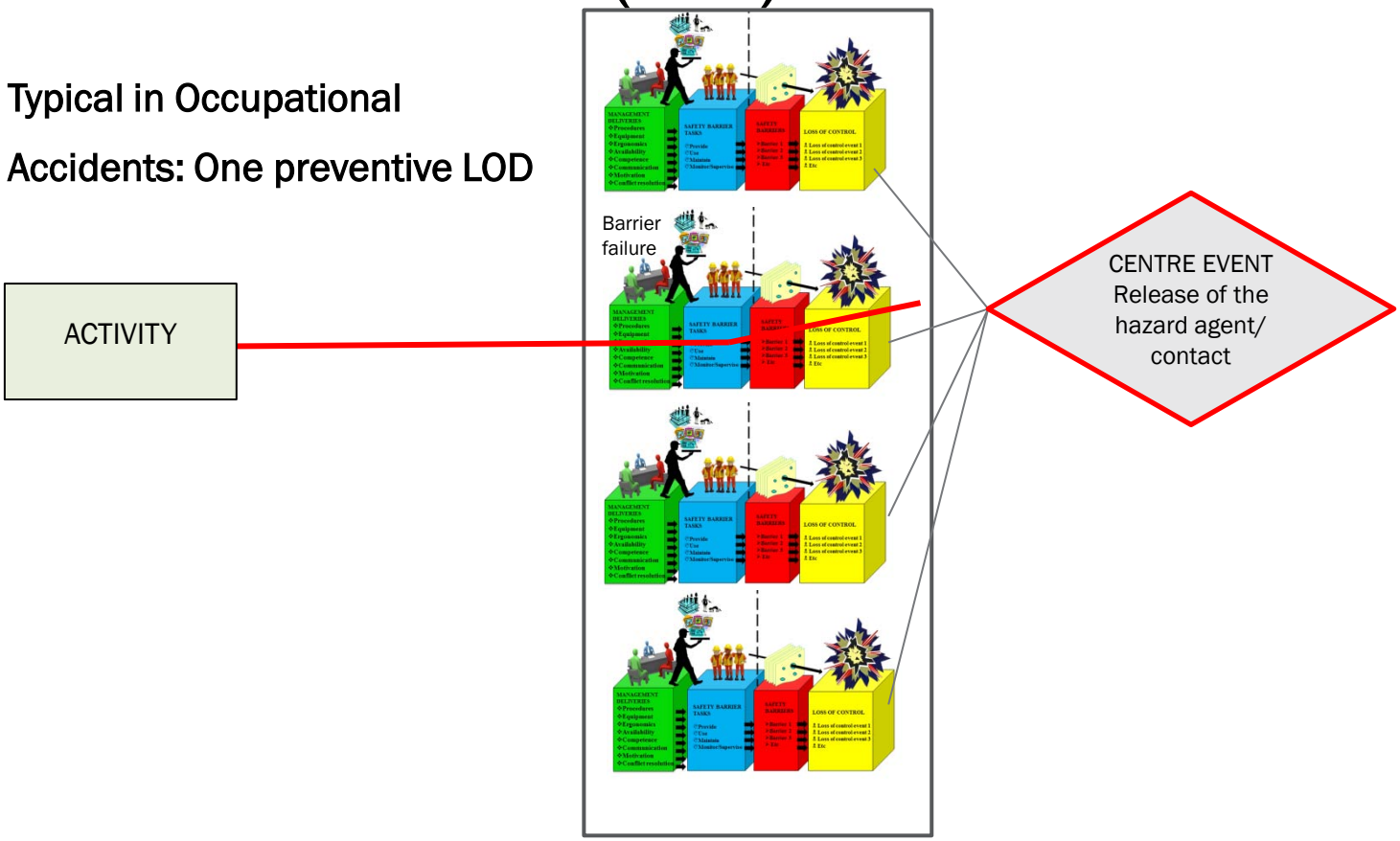

# SAME PRINCIPLES ARE APPLIED TO MAJOR HAZARD LOSS OF CONTAINMENT ACCIDENTS



# LINES OF DEFENCE (LOD)

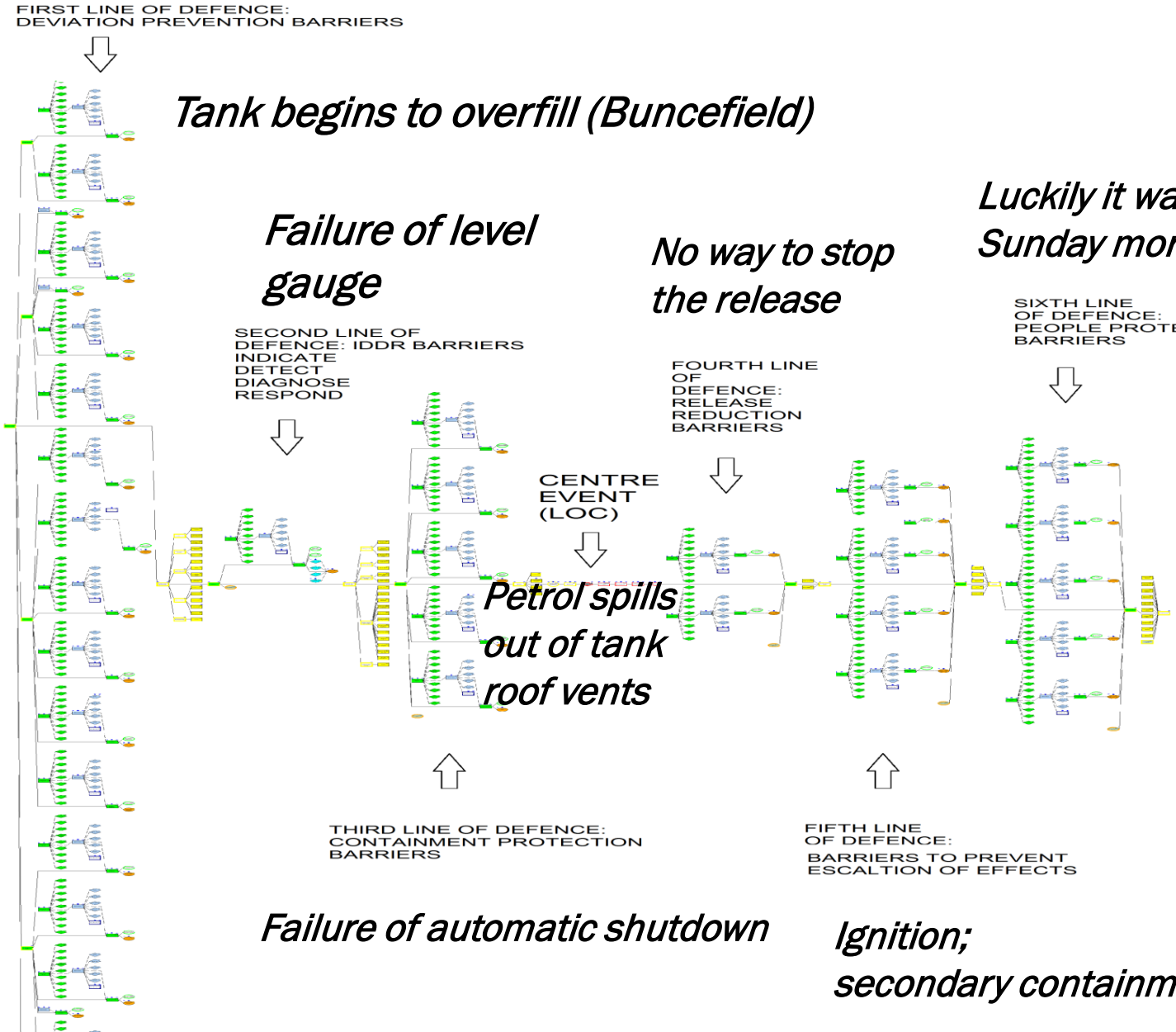
Typical in Occupational

Accidents: One preventive LOD



# LINES OF DEFENCE MAJOR HAZARDS

# MAJOR HAZARD MODEL




*Tank begins to overfill (Buncefield)*

*Failure of level gauge*

*No way to stop the release*

*Luckily it was early Sunday morning*

*Petrol spills out of tank roof vents*

*Failure of automatic shutdown*

*Ignition; secondary containment failures*

# OVERFILLING–87 ACCIDENTS (DURING BUNCEFIELD 2005 INVESTIAGTION)

White Queen
Safety Strategies

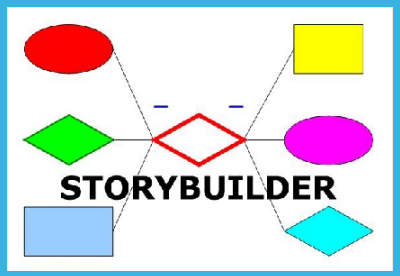
Types of BARRIER FAILURE MODE for overfilling:

1 Batch size preparation failure (e.g. not done, miscalculated)

2. Connection failure: wrong containments were connected or at wrong time

3. Flow feed control failure:
   - flow too high
   - flow duration too long

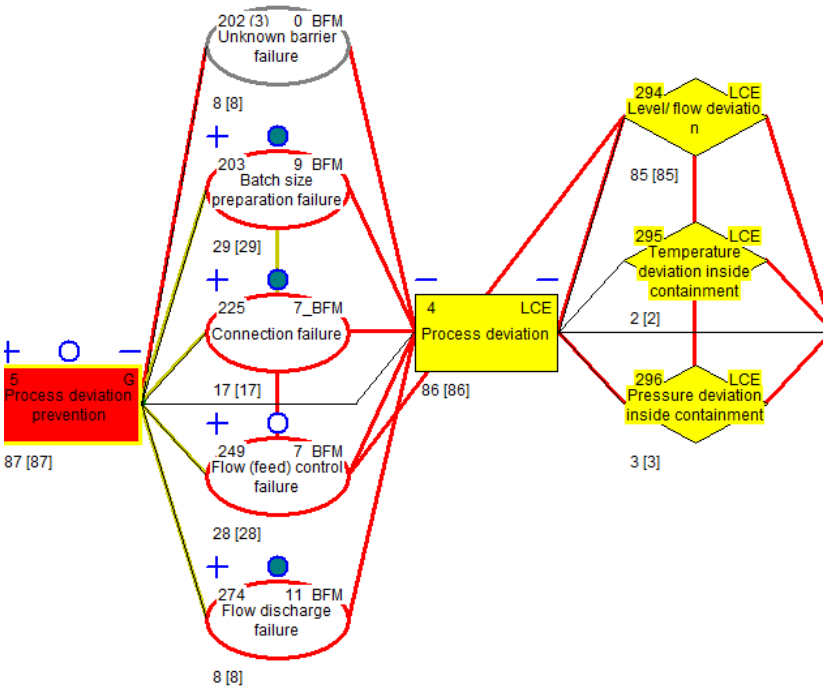
4. Flow discharge control failure:
   - flow too low
   - flow duration too short
   - reverse flow: feeding instead of discharging

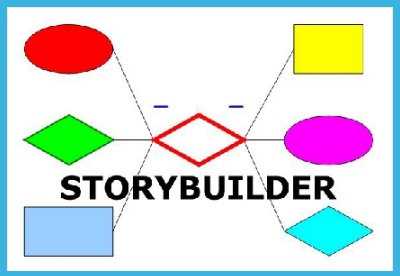


# BARRIER FAILURES (% OF ALL OVERFILLING ACCIDENTS)

White Queen
Safety Strategies

| | |
|---|---|
| LEVEL DEVIATION | |
| Batch size preparation failure | 34% |
| Flow feed control failure | |
| (Too high flow or too long) | 33% |
| Connection failure | 20% |
| Unknown | 9% |
| Flow discharge control failure | 8% |
| | |
| OVERFILLING | |
| Indication failure | 56% |
| Response failure | 21% |
| Detection failure | 16% |
| Unknown | 17% |
| Diagnosis failure | 1% |



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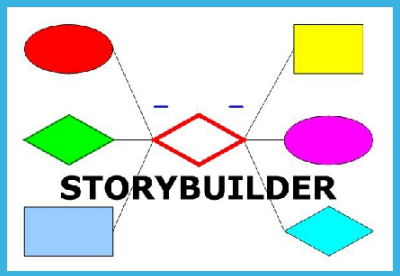
2. Connection failure: wrong containments were connected or at wrong time

3. Flow feed control failure:
   - flow too high
   - flow duration too long

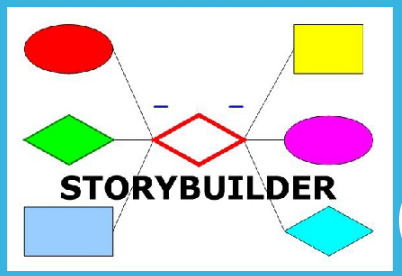
4. Flow discharge control failure:
   - flow too low
   - flow duration too short
   - reverse flow: feeding instead of discharging



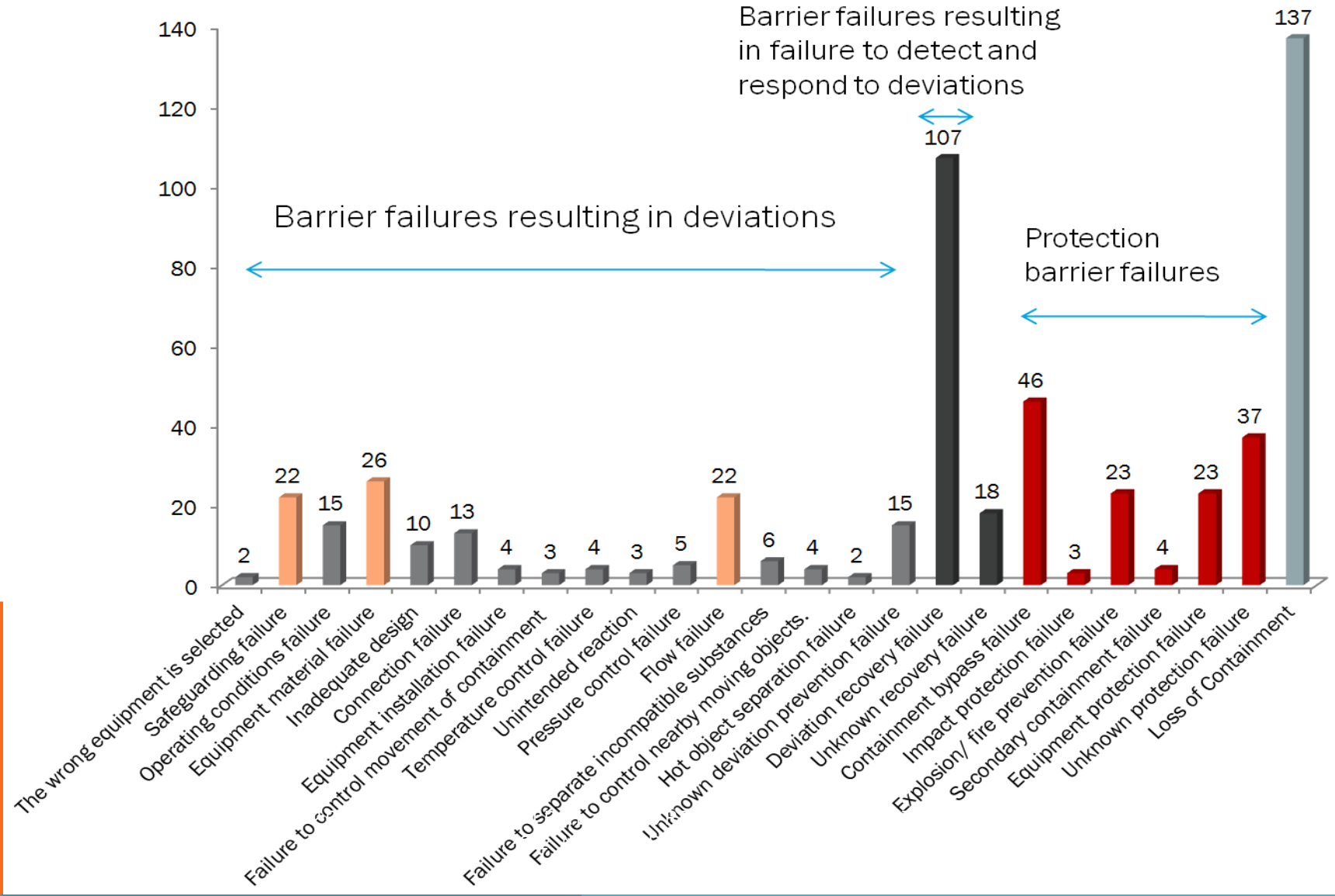
# MANAGEMENT DELIVERY SYSTEM FAILURES (% OF OVERFILLINGS)

- Lack of equipment to indicate the process deviation 38%
- Lack of competence to do batch size preparation 18%
- Lack of equipment for control of flow 13%
- Lack of competence to make the right connections (e.g. line up, timing valve ops) 11%

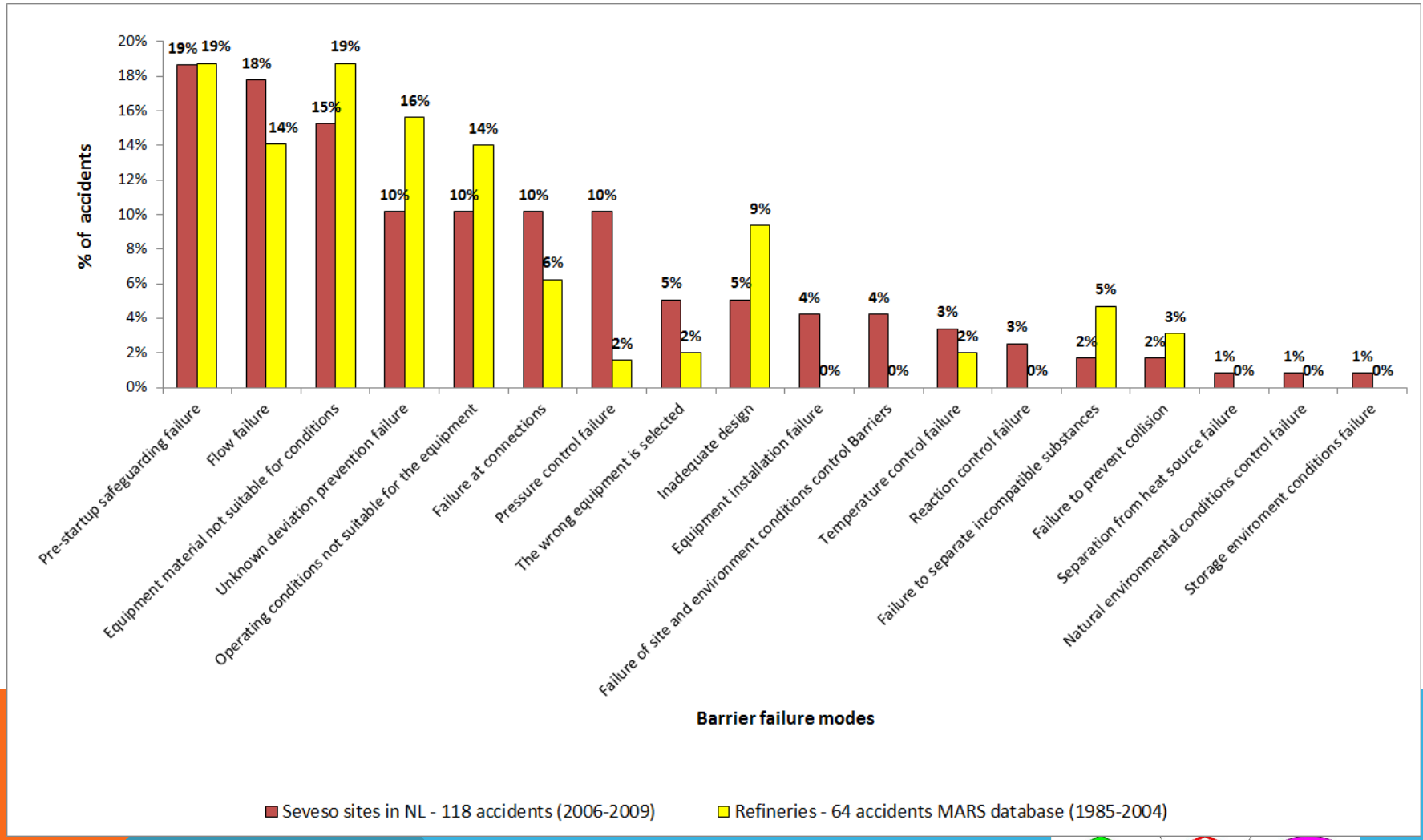




# CAUSES OF 137 LOCS (NL + EU MARS)



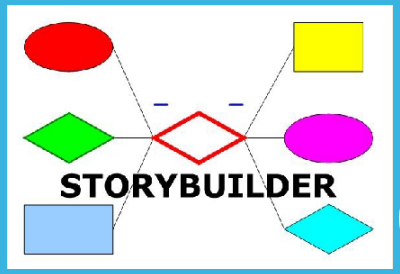
# DUTCH SEVESO ACCIDENTS & REFINERIES



# SUMMARY

- Good tool and model for generating products for helping the inspector
- Resilient in being able to answer questions.
- Inspectors use the occupational accident database for planning inspections
- Inspectors use the major hazards database for reporting to parliament
- Storybuilder and the occupational accident database are free for anyone to use.

(The major hazard database is NOT freely available).



# LINKS

The database itself is bilingual (EN and NL). The software has an English interface and help:

http://www.rivm.nl/en/Topics/S/Storybuilder_ENG (English web page)

http://www.rivm.nl/Onderwerpen/S/Storybuilder (Dutch web page).

Video help on You Tube:

http://www.youtube.com/user/StorybuilderHelp