Economic Commission for Europe

Inland Transport Committee

Working Party on the Transport of Dangerous Goods **18 July 2014**

Joint Meeting of the RID Committee of Experts and the Working Party on the Transport of Dangerous Goods

Geneva, 15-19 September 2014
Item 6 of the provisional agenda
Reports of informal working groups

Report of the informal working group on the reduction of the risk of a BLEVE

Transmitted by the Government of the Netherlands on behalf of the working group

Risk Assessment & Accident Analysis

Presentation to the BLEVE Prevention Working Group

Gavin Astin

April 2014

How Risks are assessed

Selection of Preventive, Control & Mitigation Measures

- **1. European Initiatives for TDGs**:
  - Harmonised Risk Acceptance Criteria (RAC) for Transport of Dangerous Goods (TDG).
- **2. The Case in Rail :**
  - Developments in the rail transport environment:
    - CSM 402/2014 on Risk Evaluation and Assessment.
  - Case study on Freight Train Derailments
- **3. The Case in Road for LPG Transport :**
  - Parallels with TDG by other modes
- **4. Bleve LPG accidents analysis**
  - What do we know about road traffic accidents leading to BLEVE
  - What does this information tell us
  - Summary of the main conclusions/lessons learned
- **5. Summing Up**

1. European Initiatives for TDG's

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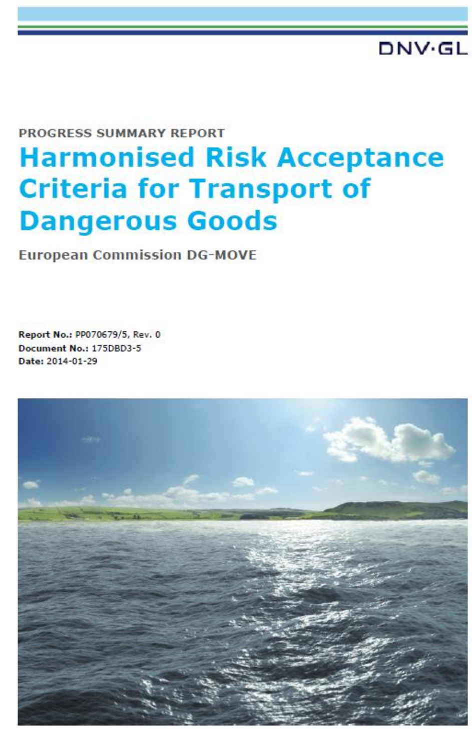
Harmonised Risk Acceptance Criteria (RAC) for Transport of Dangerous Goods (TDG) (DNV GL study for DG-MOVE)

- Survey of Member States (MS), finding that:
  - Different approaches lead to different restrictions on TDG for similar situations in different MS.
  - **RAC applied in isolation** can result in route changes, switching transport modes or supply patterns. These changes can alter the risk pattern. This **may increase the overall risk**.
- Study proposed **harmonised RAC**:
  - Based on continual improvement process with **threshold** and **maximum risk levels**.
  - Scrutiny level for exposed communities/ routes.
  - Improvement targets.
- Other proposals:
  - Network and local risk assessments.
  - **Analyse TDG activity and incident data to produce accident frequencies** suitable for network and local risk assessments.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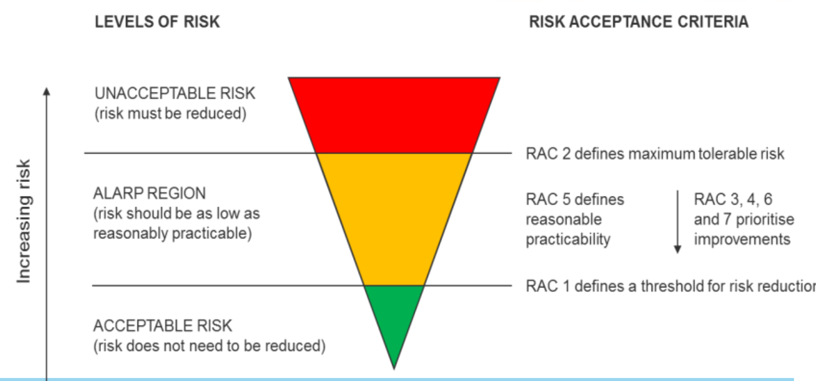
PROGRESS SUMMARY REPORT

Harmonised Risk Acceptance Criteria for Transport of Dangerous Goods

European Commission DG-MOVE

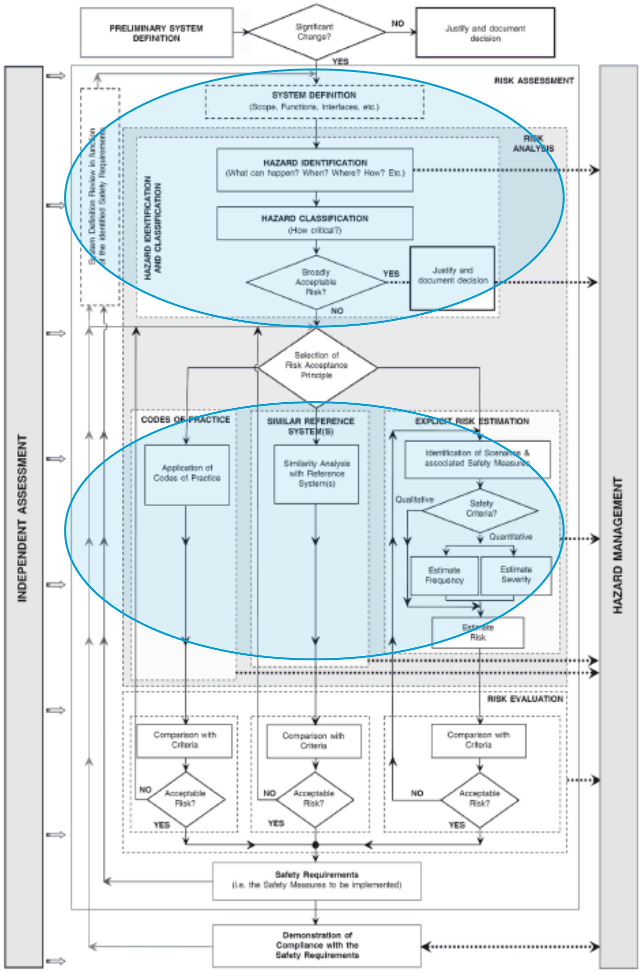
Report No.: PP070679/5, Rev. 0
Document No.: 175DBD3-5
Date: 2014-01-29



2. The Case in Rail

Use of Risk Based Methods in the Railway Transport Sector

- European Railway Agency (ERA) produce Common Safety Method on Risk Evaluation and Assessment.
- For a "significant change":
  1. Hazards are assessed to estimate their risks (usually based on engineering judgement).
  2. If risks are not "broadly acceptable" then further work is required to demonstrate risk acceptability:
     – Codes of practice (*usually when the hazard and controls are well known and proven*);
     – Comparison with similar systems (*usually when a reference system exists*);
     – Explicit risk estimation (usually for novel hazards or new risk controls).
- Guidance on use of Chapter 1.9 of RID/ADR suggests a similar approach.



Freight Train Derailment – Case Study

- RID Committee of Experts proposed a requirement for a derailment detection device (DDD) on certain wagons. (A DDD acts after a derailment and can be considered a consequence mitigation measure.)
- ERA study of the RID proposal reviewed derailment accidents over a 10 year period and concluded:
  - From a safety point of view, **the RID provision did not contribute significantly to safety improvement**;
    - It **did not prevent the accident in the first instance**.
    - It **could only be effective in a specific set of scenarios**.
    - The cost to equip freight trains was significant compared to the benefit.
- A new study was scoped; this was to **consider prevention** as well as mitigation measures.

European Railway Agency

European Railway Agency

Final Report

Impact Assessment on the use of Derailment Detection Devices in the EU Railway System

Reference:	ERA/REP/03-2009/SAF	**Document type:**	Public
Version :	1.0		
Date :	07 / 05 / 2009		

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Date & Signature	Signed	Signed	Signed

Freight Train Derailment – Scope and Objectives

- To collect from the sector preventative and consequence mitigation measures in use.
  - **Technical, operational, organisational**.
- To **collect accident and incident data**.
  - 556 accidents and incidents over a 10 year period were assessed.
- To **develop a risk model whereby measures could be considered based on their <u>effectiveness</u>**.
- To determine the outcome costs and losses arising from a freight train derailment.
- To **complete an efficiency assessment** of the identified measures.
- To identify those measures that offered the **best benefit to cost ratio**.

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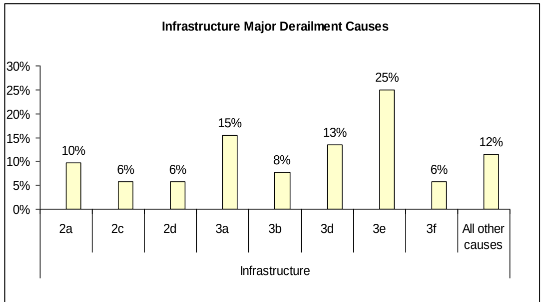
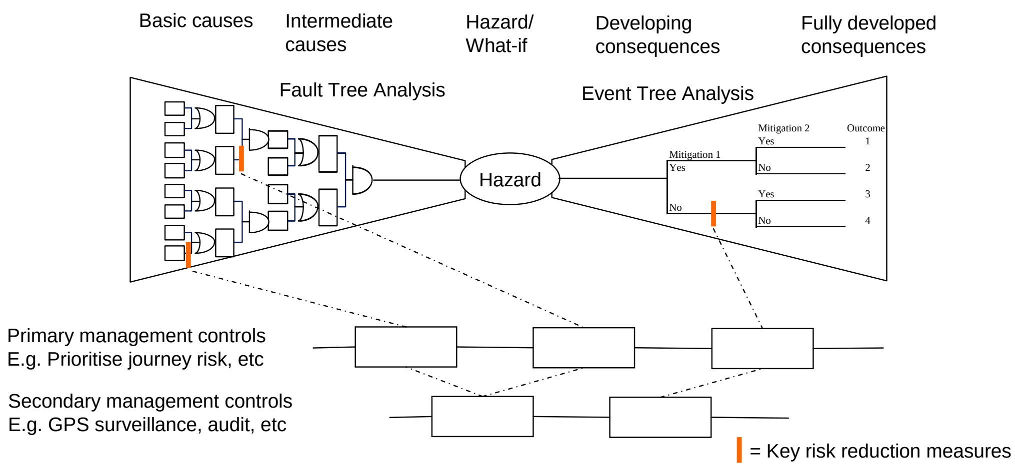
Freight Train Derailment - Modelling



#	Description (only those contributing >3% shown in diagram)
2	Structural failure of the track superstructure, comprising:
a.	Rail failures
c.	Switch component structural failure
d.	Failure of rail support and fastening
3	Track geometry failure, comprising:
a.	Excessive track twist
b.	Track height/cant failure
d.	Track buckles (heat-curves)
e.	Excessive track width
f.	Other track geometry failures
Oth	All other causes

DG Accident Scenario	Impact Area (m2)	Lethality (%)
Pool Fire	320	100
Vapor Cloud Explosion (VCE)	11300	100
Boiling Liquid Expanding in Vapor Explosion (BLEVE)	44000	100
VCE of Liquefied Propane Gas (LPG)	18000	100
Jet Fire og LPG	2400	100
Chlorine Release	540000	50
Amonia Release	20000	50
Class 4 Fires	1200	100
Less Significant	320	100



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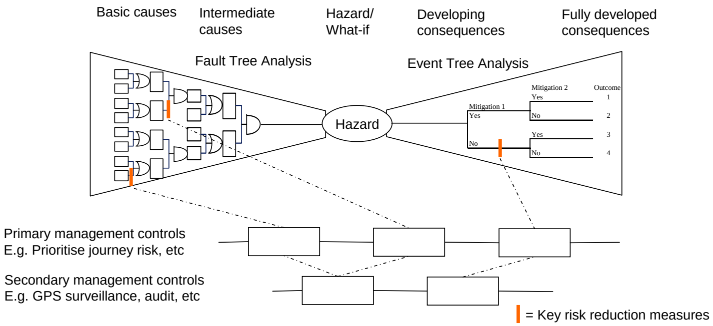
Freight Train Derailment - Results

- **Prevention measures have potentially the biggest impact.**



- **Preventative measures occupy the first 5 places.**
- Measures could be ranked on a sub-set of benefits (e.g. safety only).
- Once set up, can be re-used to easily assess new options.

		Costs	Prevention	Control/ Mitigation
			Eff: 50%	Eff: 50%; Red: 50%
Safety	3%	**EUR 27,737**	EUR 13,868	EUR 6,934.13
Track	22%	**EUR 218,530**	EUR 109,265	EUR 54,632.49
Wagon	9%	**EUR 85,081**	EUR 42,541	EUR 21,270.36
Operational	50%	**EUR 500,716**	EUR 250,358	EUR 125,178.89
Environment	17%	**EUR 167,937**	EUR 83,968	EUR 41,984.13
		EUR 1,000,000	**EUR 500,000**	**EUR 250,000**
			50%	**25%**

		Net Present Values			Benefit / Cost Ratio		
Rank	Measure	10 years	20 years	40 years	10 Years	20 Years	40 Years
1	P13-WLID/WIM	379	756	1,183	3.1	5.1	7.4
2	P28-Roller Cages	109	284	482	1.7	2.9	4.2
3	P15 Bogie Hunting Detector	80	283	514	1.4	2.2	3.2
4	P11-BAM	47	294	572	1.1	1.9	2.8
5	F7-Sliding Wheel Detector	-0	35	75	1.0	1.6	2.4
6	M1a-Derail Det RID	-2	17	39	0.9	1.5	2.2
7	P16-Wheel Profile	-27	65	170	0.8	1.4	1.9
8	M1a-Derail Det All DG	-44	56	170	0.8	1.3	1.8
9	M1a-Derail Det All Freight	-385	303	1,094	0.7	1.2	1.7
10	P10&12-HABD/HWD	-507	-257	27	0.5	0.7	1.0
11	P19-Clearance Flange Groove	-20	-34	-49	0.6	0.6	0.6
12	P18-Track Geometry	-373	-568	-788	0.5	0.6	0.6
13	P1-Check Rail	-701	-635	-559	0.2	0.3	0.4
14	P2-Track Lubrication	-276	-459	-667	0.3	0.3	0.3
15	F6-Anti Lock Device	-3,581	-3,581	-3,580	0.0	0.1	0.1

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3. The Case in Road for LPG Transport

Towards a similar approach as Rail; Risk Based (why different?)

Rail

1. To collect from the sector preventative and consequence mitigation measures in use:
   - Technical, operational, organisational.

2. To collect accident and incident data.

3. To develop a risk model whereby measures could be considered based on their effectiveness.

4. To complete an efficiency assessment of the identified measures.

5. To identify those measures that offer the best benefit to cost ratio.

Road

1. Done: see list on Bow-tie slide discussed in 2008

2. In progress : Bleve part is done + see UNECE project for all incidents

3. Started with DNV but stopped, by the WG in 2009

4. In progress

5. Still to be done

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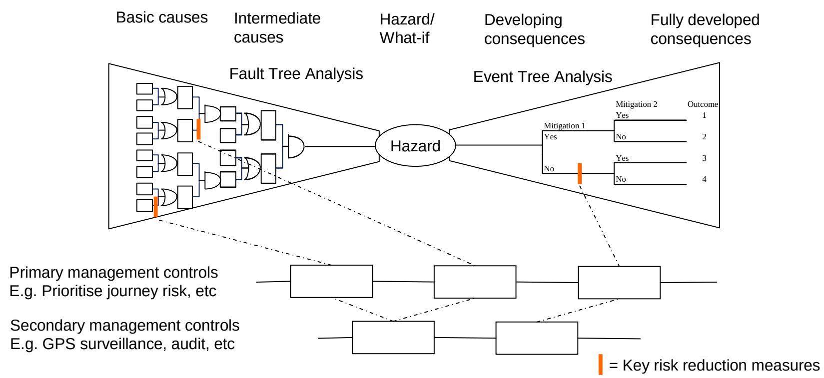
Towards a similar approach as Rail; Risk Based (why different?)



- Causes:
  - We know accident causes leading to major events involving TDG by road.
  - We surely know (as an industry) causes of incidents with the potential to have lead to a major event.
  - We know a lot about road traffic accidents in general.
  - We can identify prevention measures and discuss their costs and effectiveness.
- Consequences:
  - We know the steps needed for an accident involving TDG to escalate to a major event.
  - We can model the outcomes (models or empirical data).
  - We can establish the safety and other implications of different accident types.
  - We can identify mitigation measures and discuss their costs and effectiveness.

4. Bleve LPG accidents analysis AEGPL

(over the last 50 years)

LPG Road Transport BLEVE Accidents (main conclusions)

- 13 accidents leading to BLEVE events in 50 years. (Includes **3 cases** where **sabotage** is the likely cause.)

- Most important accidents happened in the period (1963–1987):

  - Martelange – (1967): 22 fatalities & 47 injuries.
    - Neither **Thermal Coating**, nor **PRV's** could have had any impact on the number of victims.

  - Los Alfaques – (1978) : 215 fatalities in one incident (80% over the 50 years):
    Cause = **Cold BLEVE** due to overloading (23,5t of Propylene, instead of 19t) and high external temperature. The vehicle was travelling on a route where DG not permitted.
    PRVs would have prevented the accident
    Thermal coating would not have made any difference

  - 50 % of the 13 accidents had as origin :
    - collision with of fixed object and other vehicle

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BLEVE Accidents concerning LPG Road Transport (main conclusions)

- The main causes identified are:
  1. Human error – **2.** Procedures - **3.** Other vehicle - **4.** Technical default

- In 4 cases of these accidents:
  - neither **Thermal Coating**, nor **PRV's** could have avoided the accident or have had an impact on the number of victims

- Significant improvement, in second half:
  - With the exclusion of the "Los Alfaques" & "Martelange" accidents the comparison between the first 25 years (1963-1987) and the last 25 years (1988-2013), shows a **reduction of 50 %.** of the Nbr of fatalities and injuries. This is mainly due to:
    - Improvements of Standards
    - Better Safety Management
    - Better Legislation

- Risk based approaches can help to provide ***guidance*** on the size of the risk and lead to a ***prioritisation*** of options to control it.

5. Summing up

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- **1. Developments in the transport sector:**
  - Risk based approaches are now frequently applied to identify and assess risk and provide input to answering these questions.
- **2. Measures:**
  - What are the existing measures (prevent/ control/ mitigate);
  - What are the potential future options?
- **3. What about the data?**
  - There is likely to be a shortage of data for a quantitative risk analysis.
  - But we do have some data and knowledge about causes and outcomes of accidents involving TDG.
  - A simple risk model would structure the problem – bow-tie, cause-hazard-consequence model or mind map.
  - Use the knowledge we do have to allow some ranking to be performed.
  - Identify data gaps and a possible data collection strategy for a more detailed model at a later date.

Accident Analysis and Risk Assessment

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