Application of the Inland TDG Risk Management Framework on an Italian Infrastructure Manager

Case study

/FER/

User case example

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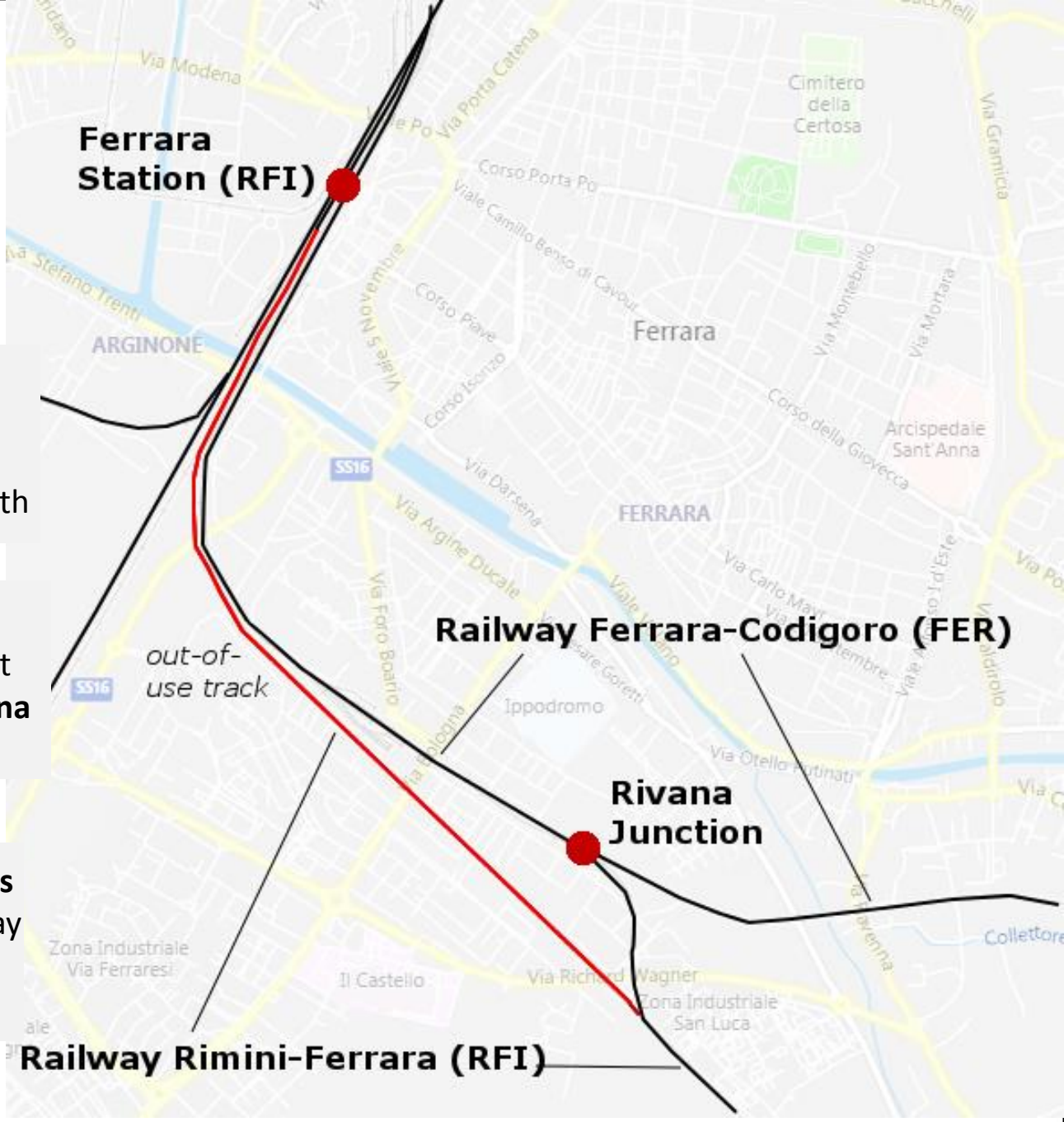
User case example

Introduction

1. Project for the construction of the **Ferrara railway tunnel**: the Rimini-Ferrara line (RFI) and the Ferrara-Codigoro line (FER) on the same path

2. The IM RFI diverts the Rimini-Ferrara railway line on the adjacent Ferrara-Codigoro railway: the **Rivana Junction** is established

3. Vehicles carrying **Dangerous Goods** are introduced on a regional railway with passenger traffic only



- RFI S.p.A. is the Italian National Infrastructure Manager
- FER S.r.l. is a regional Infrastructure Manager

Significance criteria for changes

Ref. Reg. (EU) 402/2013 (CSM RA)

Art. 4 comma 2 CSM RA	FER's SMS assessment	
a) Failure consequence	New accident scenarios	
b) Novelty in implementing the change	New safety activity	
c) Complexity	New legal framework and procedures	
d) Monitoring	Easy monitoring	
e) Reversibility	Reversible	
f) Additionality	None	

Significant change

Interfaces between FER and the Railway Undertakings

Ref. Annex III Reg. (EU) 1158/2010

Before Safety Authorisation	After Safety Authorisation
-	**Safety Authorisation**, including the transport of DG
Interface agreements among IM and RUs	Part B Certificate extension Both IM and RUs have an SMS and must comply with the **same national and European legal framework**
Temporary use of RFI's operation rules	Use of **FER's operation rules**

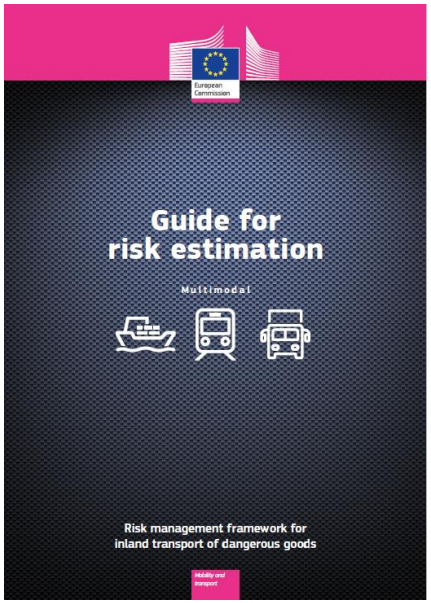
Cooperation meetings between IM and RUs

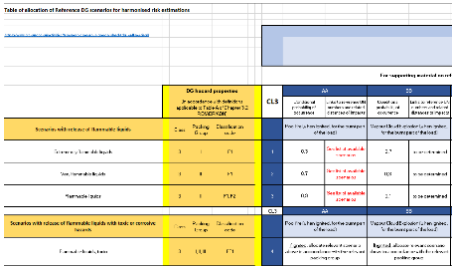
Ref. Art. 4 Reg. (EU) 1078/2012

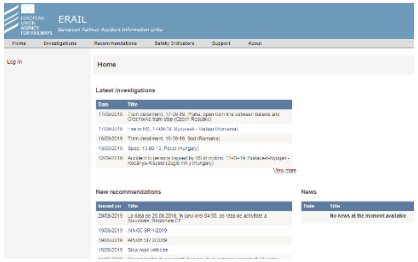
1. Identification and analysis of shared and transferred risks related to operational safety
2. Operating accidents or incidents that have caused or could have caused operational safety
3. Monitoring of safety indicators
4. Issues related to reports of failures or inefficiencies
5. Problems related to modules, identification documents, procedures of a Party assumed by the other Party
6. Audit results, experience returns
7. Criticalities found during activities, proposals for modification / integration of the Interface Agreement

Supports for the risk assessment

1. **Guide for risk estimation** (2018) by the European Union Agency for Railways (ERA)
2. **Reference tables** for computations: F1 reference table (F1_RL_OLN_ALL), table_of_allocation_of_tdg_scenarios
3. **ERAIL** and **Eurostat databases**
4. **Transport data** from the Railway Undertakings (ton×km and DG UN numbers)







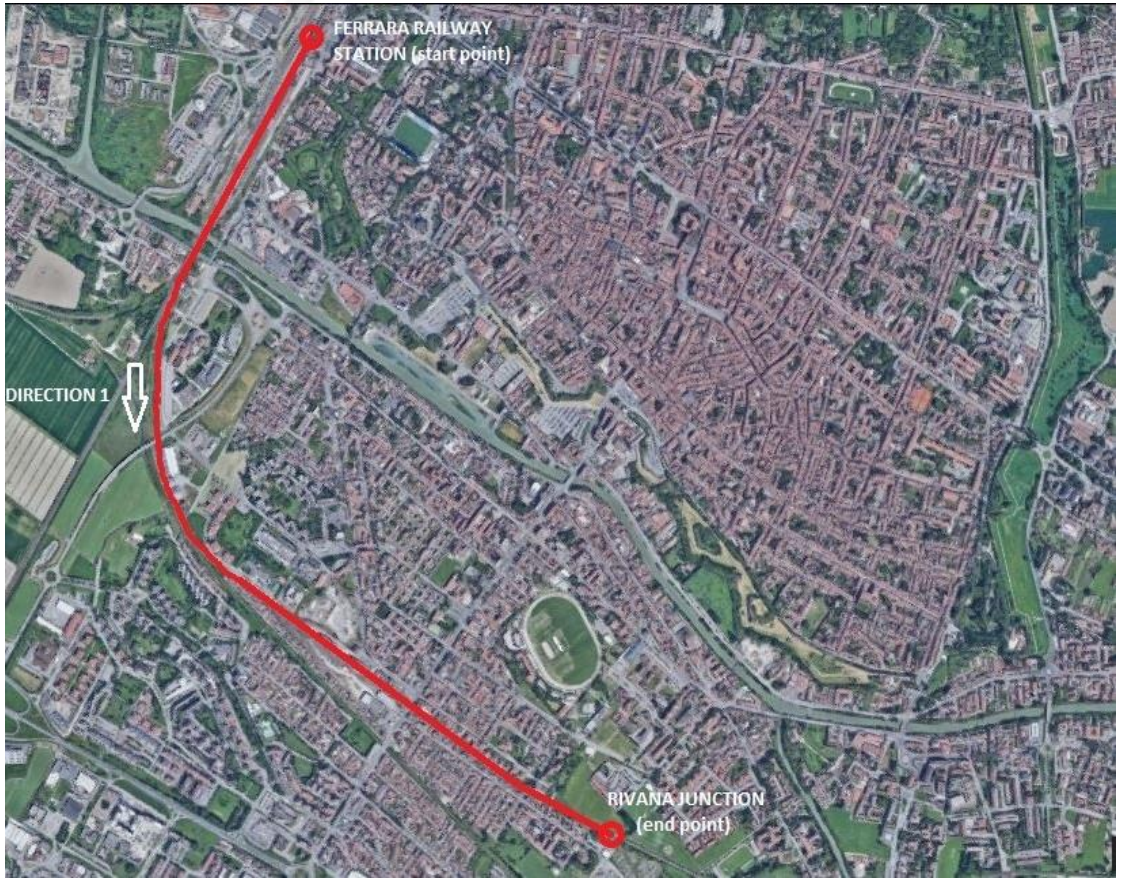
Harmonised description of a risk situation

Ref. §4 «Guide for risk estimation»

1. Harmonised description of the infrastructure
2. Transport operation parameters
3. Harmonised description of DG traffic
4. Harmonised description of reference DG scenarios and hazards
5. Harmonised description of vulnerabilities

Harmonised description of the infrastructure

Ref. §4.1 «Guide for risk estimation»



Defining the 'Use case' infrastructure according to the template '**Use case – Infrastructure and operation description**'.

Mapping and segmenting the railway: homogeneous infrastructure, operations type and volume of traffic → homogeneous traffic and vulnerability segment

1. **Length**: 2,444 km
2. **Infrastructure category**: open line (OLN)
3. **Transport operation category**: URBAN
4. **Total number of tracks**: 1
5. **Speed limit**: 60 km/h

Transport operation parameters

Ref. §4.1 «Guide for risk estimation»

1. Dangerous goods freight traffic mixed with passenger and non-dangerous goods freight traffic
2. (Ton × km) of freight from the Railway Undertakings
3. RFI and FER remote signalers

Harmonised description of DG traffic

Ref. §4.2 «Guide for risk estimation»

UN Number	Class	Classific. code	Packaging group	Proper shipping name	Hazards	DG scenarios
UN 1010	2	2F	-	Butadienes, stabilised or Butadienes and Hydrocarbon mixture, stabilised containing more than 40% butadienes	239	• Vapour Cloud Explosion (when ignited) • Gascloud fire (when ignited) • Jet fire/Torch fire (when ignited) • BLEVE
UN 1170	3	F1	II	Ethanol (ethyl alcohol) or Ethanol solution (ethyl alcohol solution)	33	• Pool fire (when ignited, for the burnt part of the load) • Vapour Cloud Explosion (when ignited, for the burnt part of the load) • Pollution of soil and water, possibility toxic or/and corrosive (non-burnt part only) • BLEVE
UN 2789	8	CF1	II	Acetic acid, glacial or acetic acid solution, more than 80% acid, by mass	83	• Scenarios to be determined yet
…	…	…	…	…	…	…

DOCUMENTS

1. 5 **UN numbers** of DG from the Railway Undertakings
2. 3 **classes** of DG according to RID, §3.2 'Dangerous goods list'
3. 'Use case – traffic description'
4. 'Table of allocation of DG scenarios'

Harmonised description of reference DG scenarios and hazards

Ref. §4.3 and Table 6 «Guide for risk estimation»

HAZARDS

1. Mechanical (collision, projectile impact, friction…)
2. Overpressure / Deflagration / Detonation
3. Heat flux
4. Toxicity through inhalation, contact or ingestion

Harmonised description of vulnerabilities

Ref. §4.4 «Guide for risk estimation»

1. **Human:** workers and people in the urban area
2. **Assets:** railway building, bridges, power supply system
3. **Operations:** railway and road traffic disruption
4. **Environment:** water supplies and channels

Risk estimation steps

Ref. §7 and Table 15a «Guide for risk estimation»

1. **Frequency of transport events (F1)**
2. **Frequency of occurrence of Dangerous Goods events (F0)**
   - 2.1. Probability to involve a DG unit – P(DG unit)
   - 2.2. Probability to involve a DG unit with a given capacity – P(DG capacity)
   - 2.3 Probability to involve a given class of DG – P(DG class)
3. **Frequency of occurrence of DG releases (F_DGR)**
   - 3.1. Probability of occurrence of DG releases with a given size – P(Release size)
4. **Selection of reference DG scenarios (DGSC)**
   - 4.1. Probability of occurrence of specific conditions – P(Specific conditions)
   - 4.2. Probability of occurrence of a reference DG scenario type – P(Reference DG scenario type)

F_DGSC(Scenario type) = F1(transport event) × P(DG unit) × P(Unit capacity) × P(DG class) × P(Release size) × P(Specific conditions) × P(Reference DG scenario type)

1. Frequency of transport events (F1)

Ref. §7.1 «Guide for risk estimation»

- **Common Safety Indicators** (collisions, derailments, etc.) corrected with the rilevance factors INFRA and OPE
- **Yearly probability of DG accidents** on the infrastructure corrected by the user :

$$F1\ (\text{transport event}) = \frac{F1\_Y\_RL\_NET\_ALL}{N\_TK\_REF} \times CF\_DC\_USR$$

- **F1 (transport event)** = $2{,}62 \times 10^{-10}$ events/ton×km/year

* CF_DCi_USR = 0,41 correction factor representing the share of CSI triggering DG scenarios

2. Frequency of occurrence of Dangerous Goods events (F0)

Ref. §7.2 «Guide for risk estimation»

UN Number	Hazards	Class	Classification code	Packaging group	Probability P(DG class)
UN 1010	239	2	2F	-	0,63
UN 1011	23				
UN 1012	23				
UN 1170	33	3	F1	II	0,32
UN 2789	83	8	CF1	II	0,05

- P (DG unit): percentage of DG cargo units on a train → 1
- P (Unit capacity): percentage of **large**/medium **size tank** or bundle of cylinders/single small receptacle/articles and packages → 1
- P (DG class): grouping UN numbers being in the same class

3. Frequency of occurrence of DG releases (F_DGR)

Ref. §7.3 and Table 14 «Guide for risk estimation»

Proposed harmonised release breakdown – P(RELEASE_SIZE) for open line railways (Table 14)

Release category	Conditional probability	Notes
No release	0,17	No DG scenarios expected OHS and emergency procedures are enough
Small release	0,70	
Limited release	0,09	No DG scenarios expected
Continuous release	0,039	No DG scenarios expected
Full release	0,001	No DG scenarios expected

0,13

4. Selection of reference DG scenarios (F_DGSC)

Ref. §7.4 «Guide for risk estimation»

- **P (Specific conditions)**: Table of conditional probabilities for fires, explosions and BLEVEs (Table 16 Guide)
- **P (Reference DG scenario type)**: Table of allocation of TDG scenarios
- Below: application for class 2, limited release (highest probability). At the end, one multiplies by the ton×km of freight on the infrastructure ($7{,}342 \times 10^{6}$) , to have the "frequency" in events/y

Frequency of transport events (F1)	Frequency of DG releases (F_DGR)	Specific conditions	Result	Reference DG scenario type	P (Reference DG scenario type)	F_DGSC (Nb/ton×km/y)	F_DGSC (Nb/y)
$2{,}62 \times 10^{-10}$	0,09	P(fire) = 1	$1{,}49 \times 10^{-11}$	P (Gascloud fire)	0,25	$3{,}71 \times 10^{-12}$	$2{,}73 \times 10^{-5}$
				P (Jet fire/Torch fire)	0,50	$7{,}43 \times 10^{-12}$	$5{,}45 \times 10^{-5}$
$2{,}62 \times 10^{-10}$	0,09	P(explos.) = 0,9	$1{,}34 \times 10^{-11}$	P (VCE)	0,25	$3{,}35 \times 10^{-12}$	$2{,}46 \times 10^{-5}$
				P (BLEVE)*	0	0	
				P (soil pollution)	0	0	
				P (water pollution)	0	0	

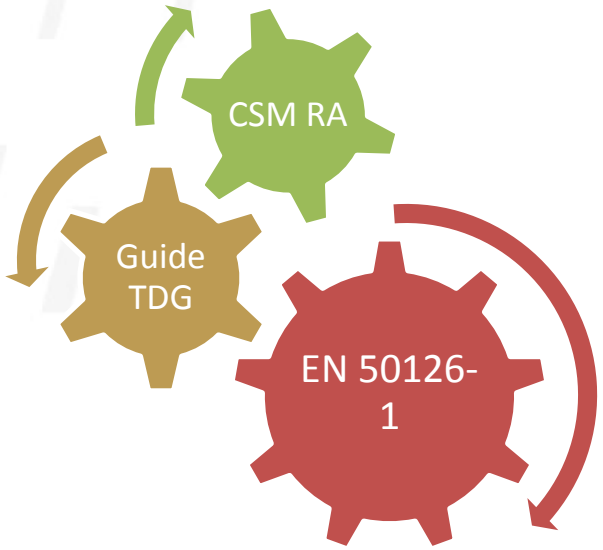
* BLEVE are not studied because the frequency of occurrence of the triggering events is already low enough

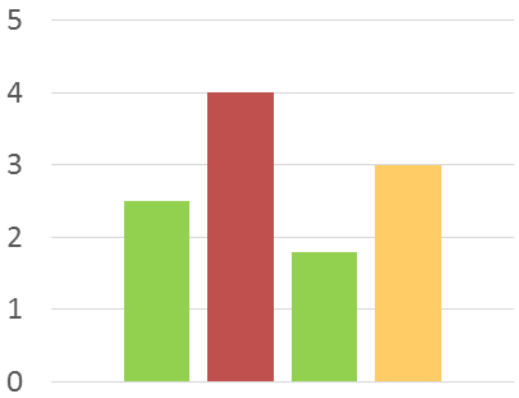
Safety measures to control risks

Ref. Annex I, §2.1.6 of CSM RA

- Being the probability of occurrence small, even a «catastrophic» severity brings to a **tolerable level of risk** at most → assessing the severity is unneeded in this case
- The IM FER must adopt and apply the **legal framework concerning the transport of Dangerous Goods** (RID 2019, §1.4.3.6. letter b))
    1. Composition of the train by indicating the number of each wagon and the wagon type,
    2. UN numbers of the dangerous goods being carried in or on each wagon,
    3. position of each wagon in the train.
- The IM FER must adopt **emergency plans** to operate promptly when a DG accident happens and share them with the Railway Undertakings (requir. 5.5 of Annexes I-II of the Reg. (EU) 2018/762)

Conclusions





1. Effective **interface and cooperation** between the IM and the RUs for the analysis of the shared risk

2. Integration among the CSM RA, the ERA Guide for risk estimation for DG and the standard EN 50126-1 (**best practices**)

3. **Quantitative risk analysis** thanks to the «Tables of reference», databases and transport data from the RUs → **awareness of the level of risk**

Thanks for your attention

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