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IGU

Asset Integrity Management Software

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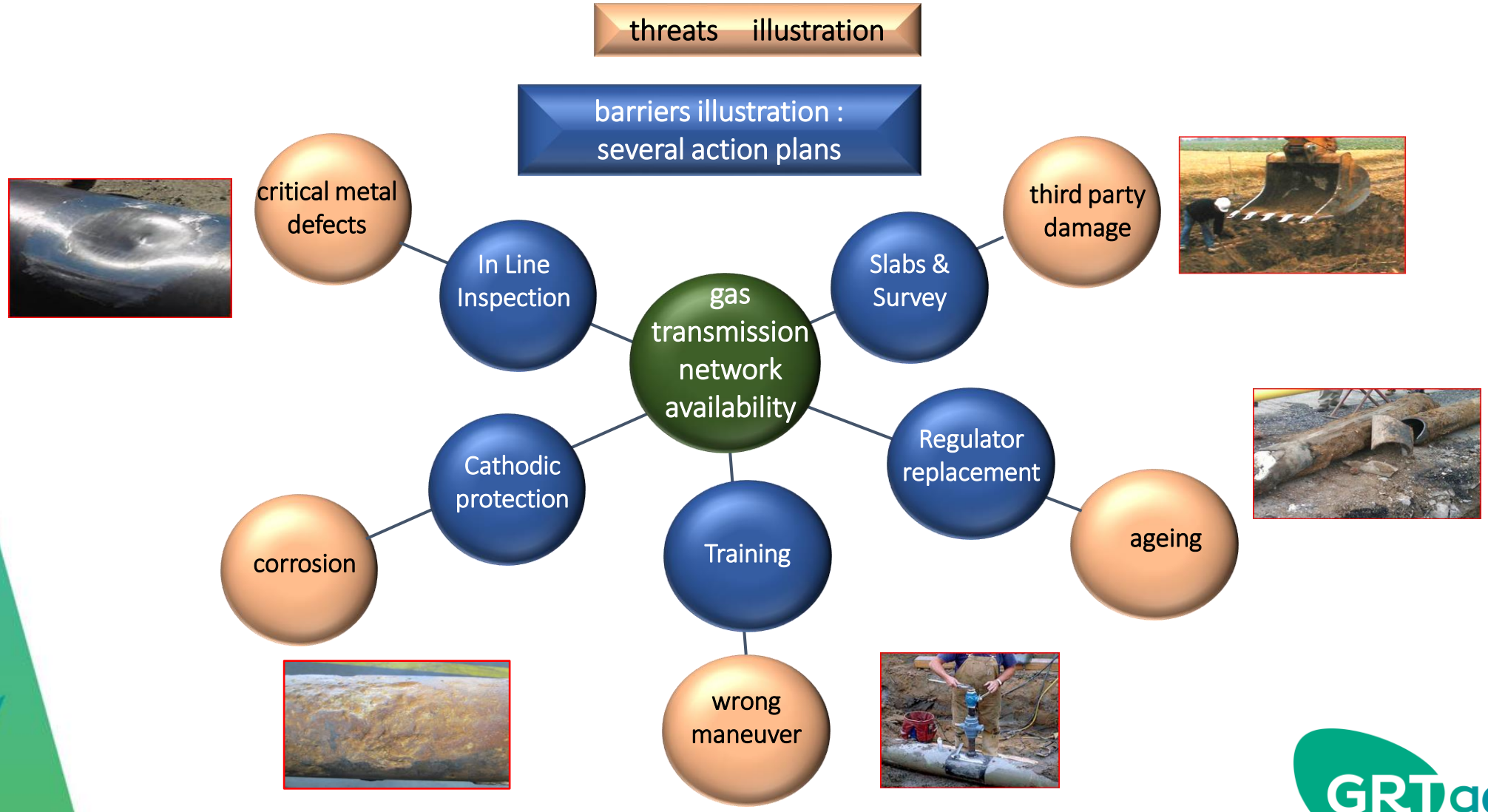
Gas transmission… a complex activity



Gas transmission financial / technical context

1. **Gas Transmission operator : high capitalistic activity**
2. **Gas Transmission safety / reliability : high operational activity**

need for an efficient Asset Management System

"make sure you spend the right €, on the right activity, at the right time"

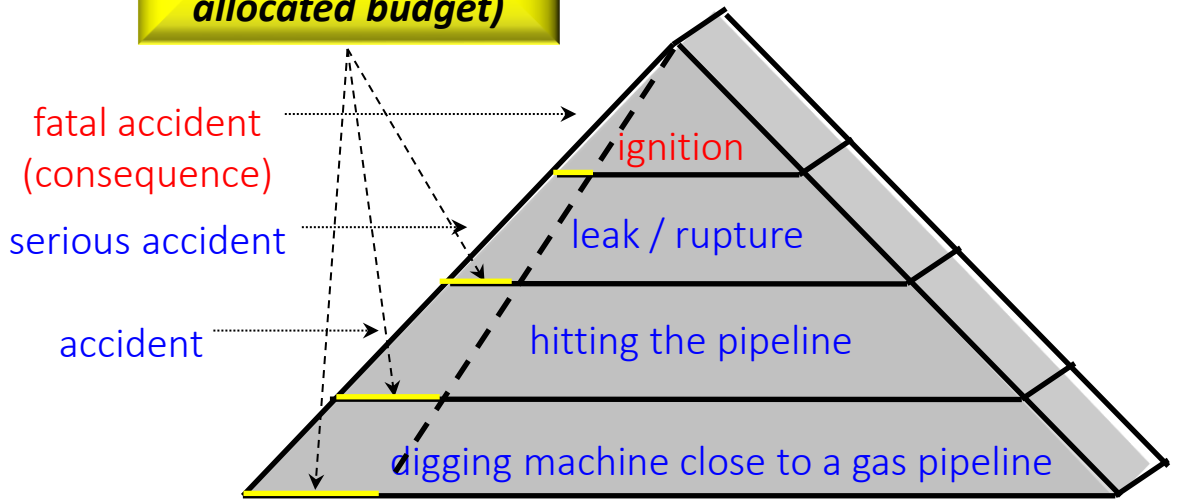
See ISO 55000 : Asset Management = "*set of coordinated activities that an organization uses to realize value from assets in the delivery of its outcomes or objectives*"

"*the best value should be a cost effective one minimizing the operator's overall risk*"

Method : Risk notion & assumption

Action plna j
Slabs and survey

risk mitigation ***(in accordance with the allocated budget)***



For one action plan j :

E_j total budget
e_j annual budget

$\alpha_j = e_j / E_j$

$Risk_j$ (one action plan) = $frequency_j$ x $consequence_j$

$$frequency_j = \prod_{i=1}^{n} frequency_{ij}$$

$impact\ C_j$

in-house software *AIMS* : Asset *Integrity* Management Software

(no global additional cost and minimize the global risk)

Mathematical model behind the software “AIMS”

- **Goal : for “p” action plans**

the global annual budget “**e**” to be split,

according to a new annual cost distribution e'_j per action plan *“j”*

➢ **financial requirement :** *no additional cost* ➔

$$\sum_{j=1}^{p} e'_j = \sum_{j=1}^{p} e_j = e$$

➢ **technical requirement :** *minimize residual risk* ➔

$$\textbf{Residual overall risk} = \sum_{j=1}^{p} \textbf{Residual Risk}_j = \sum_{j=1}^{p} Risk_j \ (1 - \frac{e'_j}{E_j})^n$$

How to assess in practice the risk for the company

Risk is an empirical concept, ***Risk = frequency*** x ***consequence***

- ***Frequency*** : given by history and past event.
- ***Consequence*** : more subjective and evaluated after analysis of all **dreaded events** for the company.
  - ***Probable causes*** : listed for all these dreaded events.

- **Risk** level of

"cause a" =

∑ *"risk levels" of all couples*

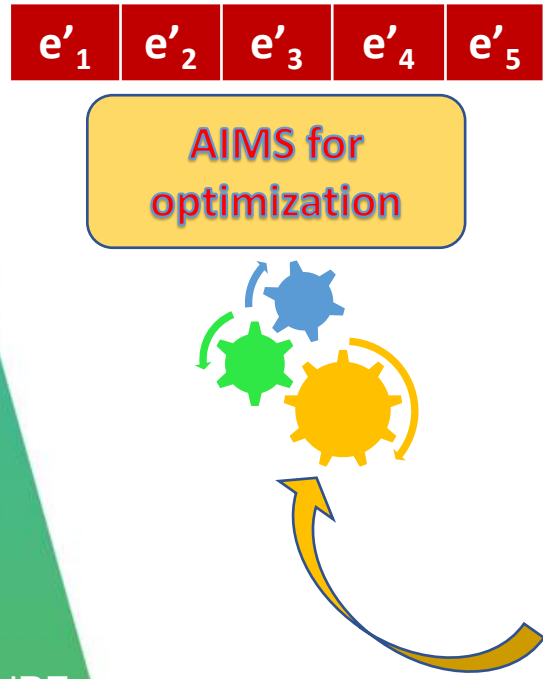
"cause a" / "event".

Dreaded events	Consequence level	Causes	Frequency of causes/events	Risk level of causes/events
Breach on a pipe	20	Landslide areas	2.10^{-2}	0.4
		Third party Interference	4.10^{-1}	8
		Metal corrosion	5.10^{-1}	10
Leaking pipe	10	Landslide areas	6.10^{-2}	0.6
		Third party interference	8.10^{-1}	8
		Metal corrosion	1	10
Gas supply interruption	5	Obsolete regulators	8.10^{-1}	4
		Wrong maneuver	2.10^{-1}	1

How to determine the budget used to mitigate the risk

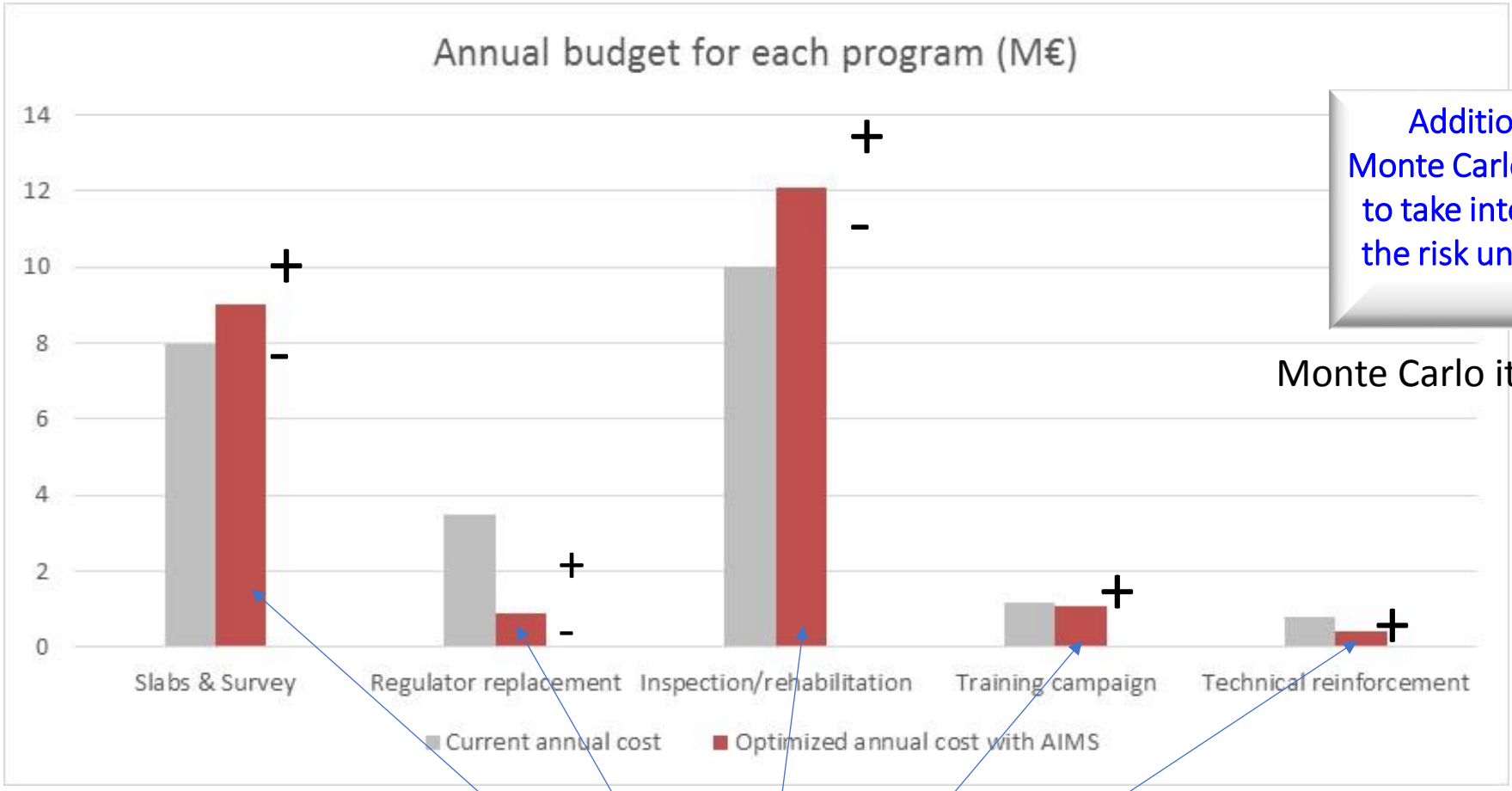
- A maintenance or an investment program fights against one or several causes
- A cause may be targeted by one or several programs.

➔ A matrix, gives the final risk level borne by each program



		Maintenance / investment programs				
Causes	**Risk level**	**Slabs & Survey**	**Regulator replacement**	**Inspection/ rehabilitation**	**Training campaign**	**Technical reinforcement**
Landslide areas	1					100%
Third party interference	16	95%			5%	
Metal corrosion	20			100%		
Obsolete regulators	4		90%		10%	
Wrong maneuver	1		20%		80%	
Risk level		**15**	**4**	**20**	**2**	**1**
Initial annual cost		**e_1**	**e_2**	**e_3**	**e_4**	**e_5**

Study case :



Addition of a Monte Carlo approach to take into account the risk uncertainties

Monte Carlo iterations = 50

e'_1 e'_2 e'_3 e'_4 e'_5

Final conclusion

- **Based on risk assessment, the present approach contributes to asset management. (Only technical risks were considered).**

- **The approach may offer a smooth transition in order to optimize resources.**

- **Others options :**
    1. **do better with no additional cost (prevailing option)**
    2. **do your best with less cost (shortage situation)**

"make sure you spend the right €, on the right activity, at the right time"

APPENDIX

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Mathematical model behind the software “AIMS”

- **Goal : for “p” action plans** the global annual budget “**e**” to be split according to a new annual cost distribution e'_j per action plan ***“j”***,

with respect to :

➢ **financial requirement :** *no additional cost* ➔

$$\sum_{j=1}^{p} e'_j = \sum_{j=1}^{p} e_j = e$$

➢ **technical requirement :** *minimize residual risk* ➔

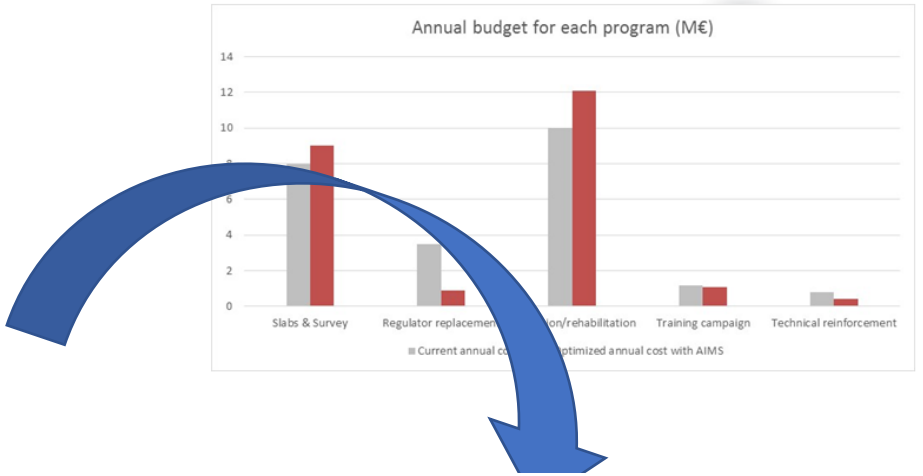
$$\textbf{Residual overall risk} = \sum_{j=1}^{p} \textbf{Residual Risk}_j = \sum_{j=1}^{p} Risk_j \left(1 - \frac{e'_j}{E_j}\right)^n$$

With

$$\textbf{Residual Risk}_j = \left[\prod_{i=1}^{n} (\textbf{frequency}_{ij} . (1 - \alpha_j))\right] . C_j = \textbf{Riskj} (1 - \alpha_j)^n$$

Full fictitious case study

- threat 1 : third party interference
- threat 2 : obsolete regulators
- threat 3 : metal corrosion
- threat 4 : wrong maneuver
- threat 5 : landslide areas



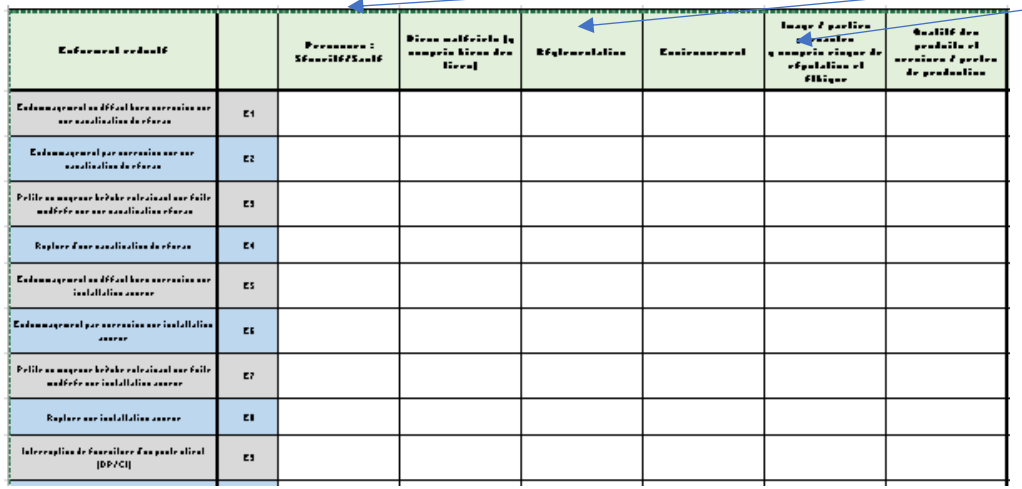
Action plan	Risk level	Initial annual cost	Optimized annual cost with AIMS
Slabs & Survey	15	8 M€	9 M€
Regulator replacement	4	3.5 M€	0.9 M€
Inspection/rehabilitation	20	10 M€	12.1 M€
Training campaign	2	1.2 M€	1.1 M€
Technical reinforcement	1	0.8 M€	0.4 M€
	total	23.5 M€	23.5 M€

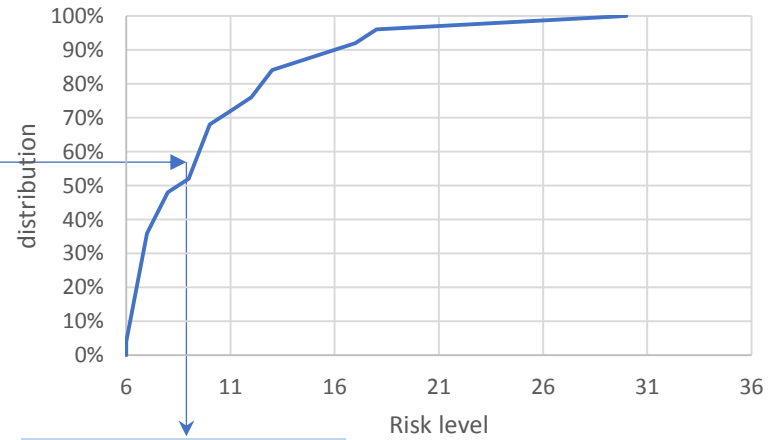
Monte Carlo approach and expert survey for risk assessment

- A risk matrix (17x6) to fill in was sent to GRTgaz experts (50)

Risk for each consequence

Dreaded events





Random [0 ; 1]

Dreaded event "leaking pipe"

Risk level = 10