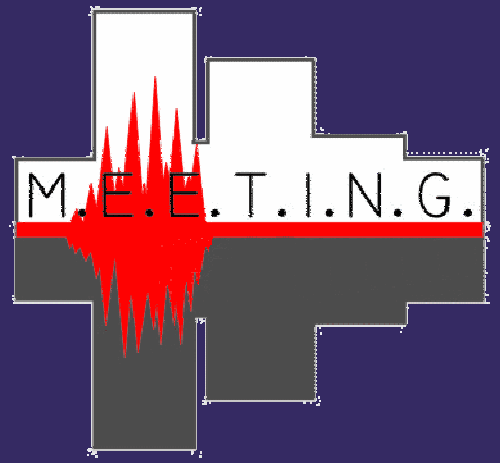

M.E.E.T.I.N.G.

Mitigating of the Earthquakes Effects in Towns
and in Industrial reGional districts

“Strategies for reduction of the seismic risk”

THE CONTRIBUTION TO INDUSTRIAL RISKS DUE TO ACCIDENTAL SCENARIOS INITIATED BY EARTHQUAKES

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Termoli, 14-15 Luglio 2007

INTRODUCTION

The severity of industrial accidents have raised a strong concern for the prevention of *major accidents*

Directives "Seveso" I, II, III

Directive on Land Use Planning

Natural events (earthquakes) are not considered as the trigger of major accidental scenarios but (rarely):

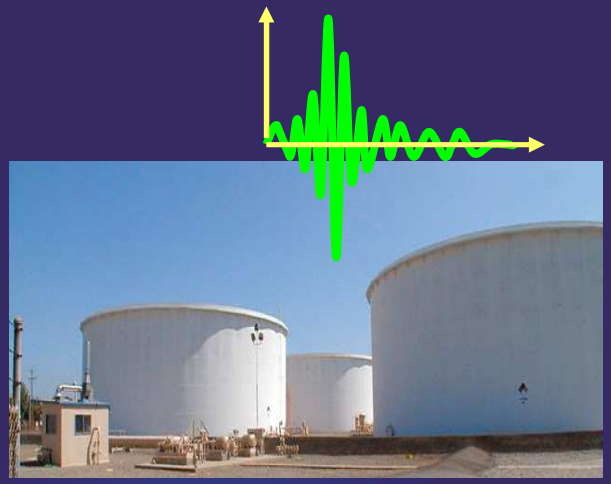
IN THE EARLY DESIGN PHASES of equipment

IN THE SAFETY RESPONSE after accident

INTRODUCTION

Quantitative Risk Assessment, Safety Management, Land Use Planning, Emergency Plans, Governance

Failure consequences



Structural response (Structural/Seismic Engineering)

Site Effects (Geotechnical Engineering)

Geological Characterisation

Propagation (Geophisycs)

THE NEEDS

1) Simplified (but sound) tools for Quantitative Risk Assessment (QRA) with specific reference to equipment - earthquake interaction and accidental scenarios (fire, explosion,dispersion)
2) Seismic Threshold criteria for industrial area based on QRA
3) Shutdown procedure of critical systems
4) Early warning methodologies and systems
5) Land use management, shelter location
6) Disaster management

RISK ASSESSMENT TOOLS

- Damage State classes for seismic behaviour:
  - DS1 No damage
  - DS2 Slight damage to structures (shell, auxiliary system..)
  - …
  - DS5 Total collapse of equipment

- **No reference to the amount of content loss and industrial accidental scenarios**
- **Main scope: evaluation of post-earthquake *economical losses* (reconstruction, repair, upgrading)**

RISK ASSESSMENT TOOLS

Damage State (DS)

DS1 - absence of structual damage
DS2 - slight damages to structures
DS3 - moderate structual damages
DS4 - total collapse of structure

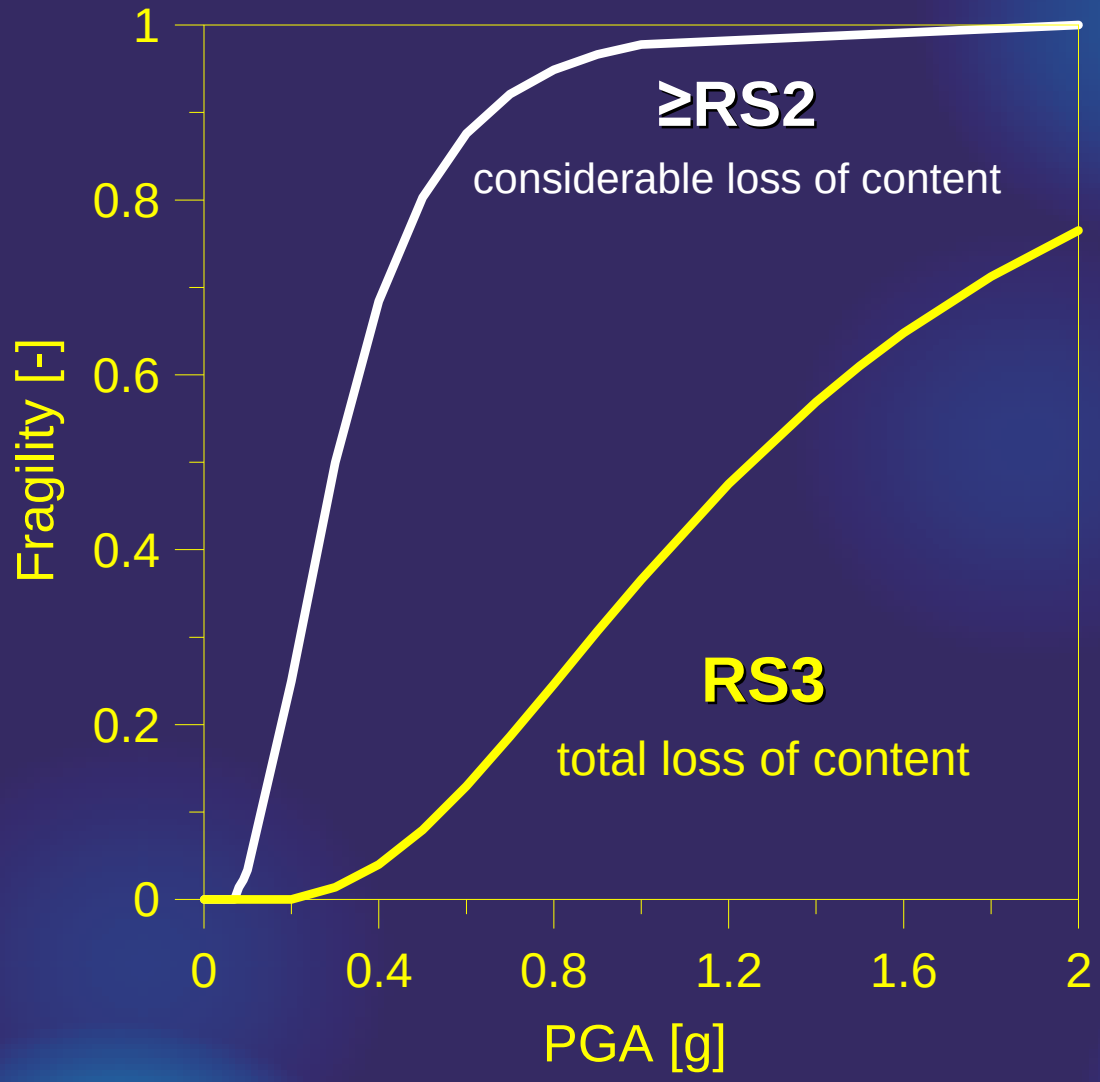
HAZUS

Risk State (RS)

RS1 - Shell damage with absence or negligible loss of containment
RS2 - Considerable loss of content
RS3 - Total (instantaneous) loss of content

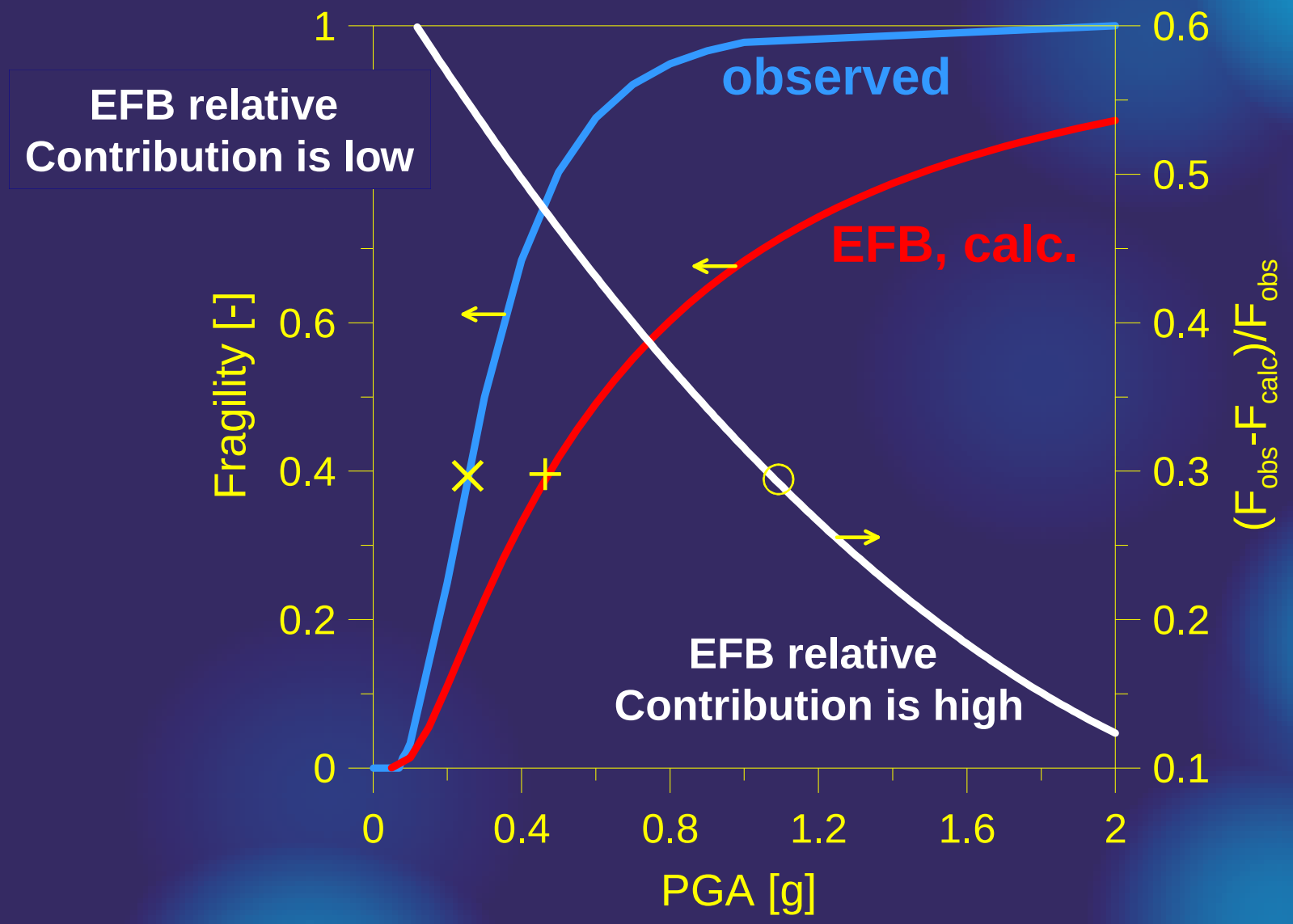
For each substance, for each equipment, for each design

RISK ASSESSMENT TOOLS



Observational fragilities – Full, anchored tanks

RISK ASSESSMENT TOOLS



Full, atmospheric anchored tanks, V = 30000 m³

QRA

INDIVIDUAL RISK

Probability that an average unprotected person permanently present at any point/location would get killed due to an accident

Threshold value: 10^{-5} less vulnerable object (office, hotels, shops..)
10^{-6} vulnerable object (house, hospital, school…)

SOCIETAL RISK

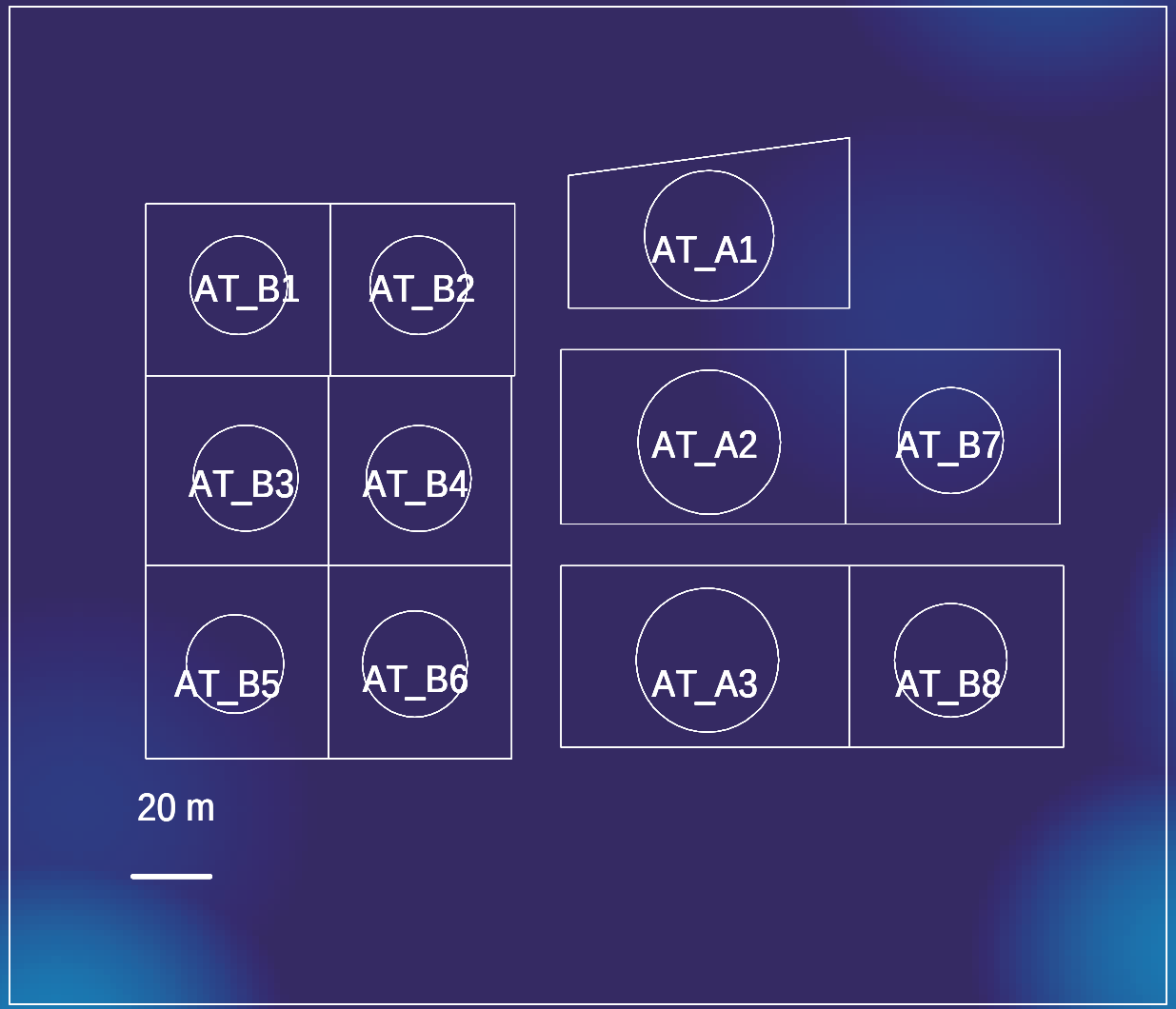
It is expressed by curves which show the cumulative frequency on the target area (F) of accidents causing at least N fatalities, considering the actual probability of presence of population

Threshold value: $10^{-3}/N$

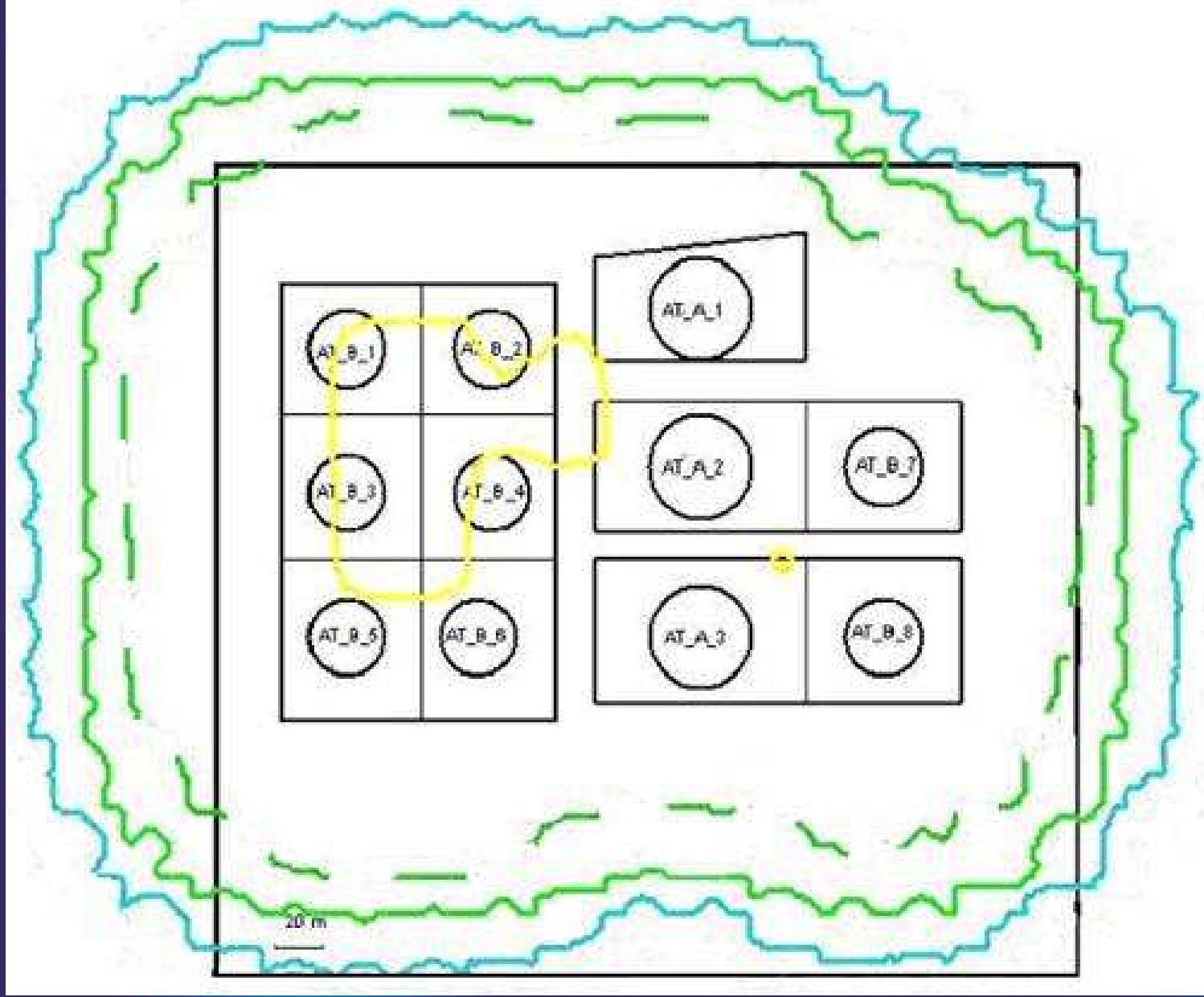
Bottelberghs, JHM 71 (2000) 59

QRA

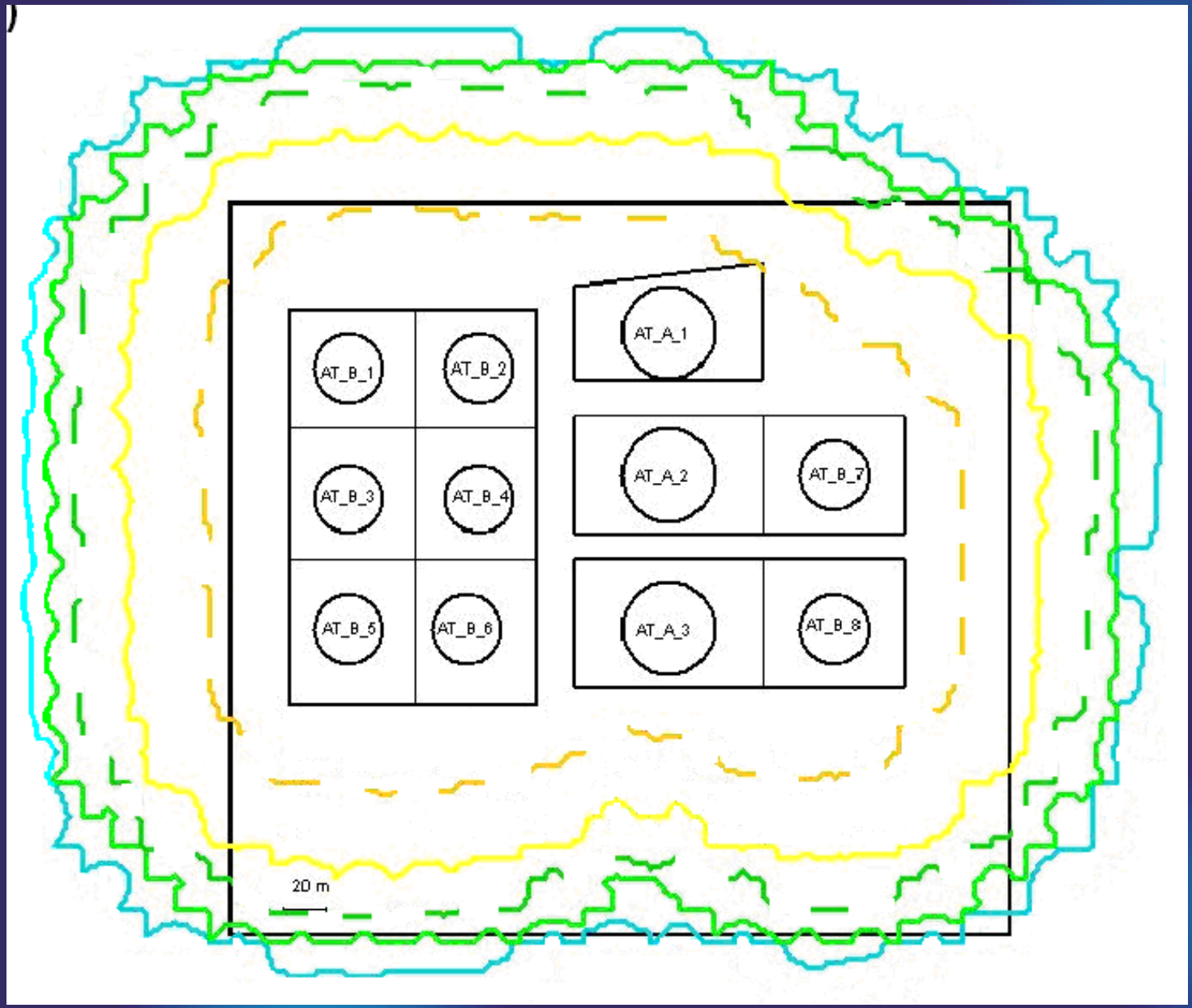
Section of Milazzo refinery



QRA: WITHOUT EARTHQUAKE



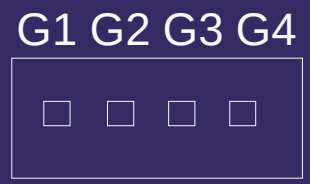
QRA: WITH EARTHQUAKE



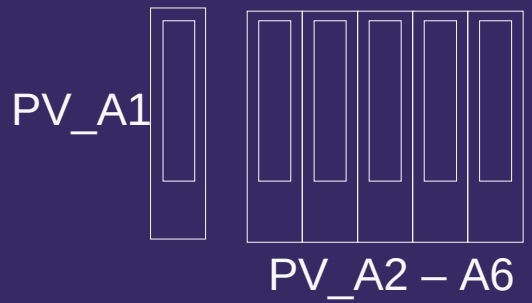
Individual Risk
(events/year)

10^{-9}
10^{-8}
10^{-7}
10^{-6}
10^{-5}

QRA

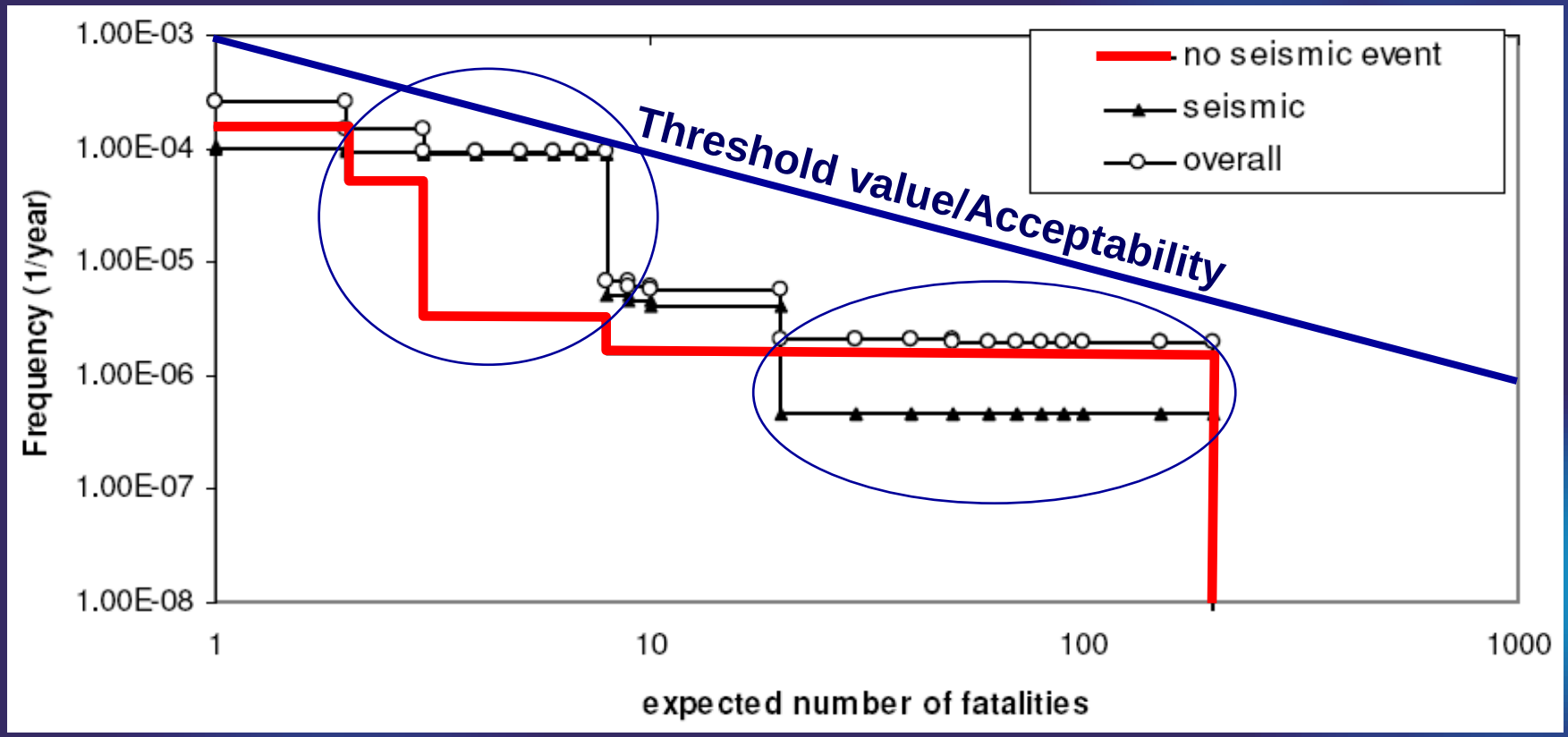


Unit code	Type	Geom	Diam	Lenght	Substance
AT_F1-5	Atm.	V	35 m	10 m	gasoline
PV_A1-A6	Press.	H	4 m	40 m	LPG
G1-2	Pump	-	-	-	LPG
G3-4	Pump	-	-	-	butane



QRA RESULTS

SOCIETAL RISK



SHUTDOWN, EARLY WARNING PROCEDURE

… a few seconds before an earthquake

Earthquake Early Warning Systems

Pre-warning times of zero to over 1 minute allow:

- ✓ ***Stop trains (Shinkanzen, Japan)***
- ✓ ***….***
- ✓ ***Shut-down of critical systems: nuclear***
- ✓ ***Shut-down of critical systems: chemical process***

CONCLUSIONS

- *Fragility for each equipment, for each condition*
- *Introduction of natural event risks for the evaluation of Seveso II - land use planning*
- *Development of threshold criteria for Early Warning System*
- *QRA is valuable tool for the analysis of NATECH risks*

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