
Screening of External Hazards in Belgium

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Introduction



Introduction

- Western European Nuclear Regulators' Association (WENRA) RLs 2014 Issue O
 - TEPCO Fukushima Daiichi nuclear accident
 - EU stress tests, IAEA safety requirements
- Natural and man-made hazards:
 - WENRA Guidance Document Issue T
 - Technical report of Advanced Safety Assessment Methodologies: Extended PSA (ASAMPSA_E)
- Preliminary results are presented. The study is ongoing.

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Methodology

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Methodology

- EPRI and SKI 02:27
- Qualitative Screening Criteria
 - Distance
 - Inclusion
 - Severity
 - Advanced Warning
 - Initiating Event
 - Frequency



Methodology

- Quantitative Screening Criteria
 - Initiating frequency (QN-1)
 - Plant damage (QN-2): CDF and Large early releases
- QN-2 $\approx 10^{-7}$ is less than 1% global CDF

	'Regular' hazards		Cliff-edge	Containment damage
Frequency	<10⁻⁶	>10 ⁻⁶	<10⁻⁷	<10 ⁻⁷
CDF	$\approx 10^{-7}$	$\approx 10^{-7}$	<10⁻⁷	N/A
LERF	$\approx 10^{-8}$		$\approx 10^{-8}$	$\approx 10^{-8}$

Methodology

- The criteria are applied by order of relevance:
 - QL-1, QL-5, QL-4, QL-3, QN-1/2, and QL-2
 - The most obvious hazards are screened out first, by narrowing the list down to those ones, which require quantification or included/treated within the existing studies



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Screening



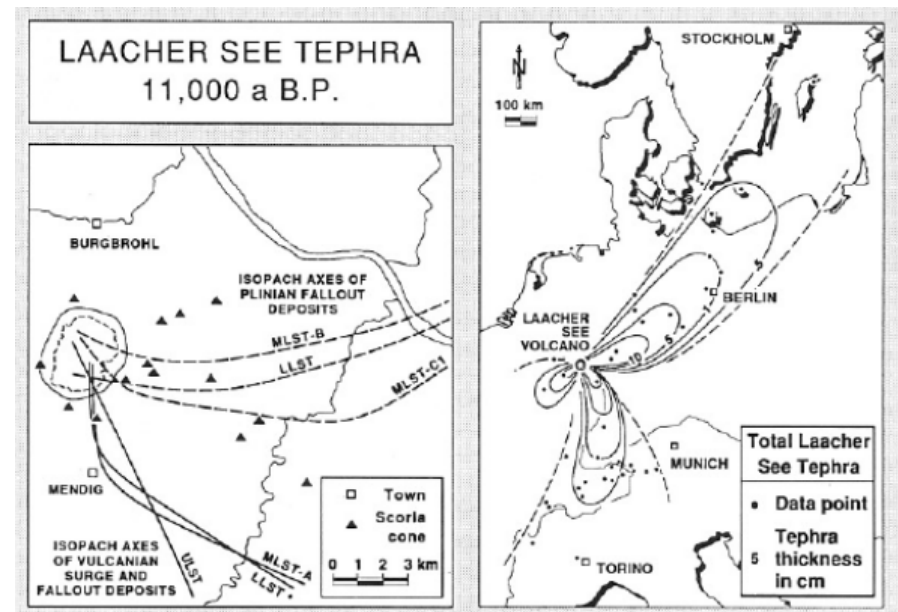
Hazards not physically possible at the site

QL-1: Distance: events cannot occur close enough to the site and its relevant surroundings during future decades

- N3 Surface faulting,
N6 Permanent ground displacement,
N13 Changes in river path,
N37 Permafrost,
N44 Sandstorm,
- N47 Snow avalanche,
N60 Slope instability,
N61 Underwater landslide,
N62 Debris/mud flow,
N64 Ground heave, N65 Karst, leaching of soluble rocks,
- N66 Sinkholes,
N67 Unstable soils N68 Volcanic hazards N70 Methane seep, M4 Military: explosion, projectiles
M6 Military activities.

Hazards not physically possible at the site: Volcanic hazards

- Eifel Mountains in Germany
- The creation of Laacher See, which took place 13000 years ago
- 6 km³ of magma and 16 km³ of tephra
- Low deposition 140 km away
- Over a long time (over one week)



Hazards, which cannot cause an initiating event

QL-5: These events can have an impact on plant safety, but, from a PSA point of view, there is no credible path that leads to core damage as a result of this event's occurrence.

N29 Humidity,
N30 Extreme air pressure,
N32 Low groundwater,
N51 Mist, freezing fog,
N56 Airborne swarms,
N71 Natural radiation,
M3 Missiles from rotating equipment,
M10 Ground transportation: direct impact,
M13 Pipeline: explosion, fire

In addition, Doel Site:

N11 High ground water,
N21 Seawater, human made structures,
N22 Corrosion salt water,
N33 Low seawater level,
N45 Salt spray

Slow/Predictable

QL-4: The anticipation time of the event is long or the increase rate of the strength of the event is low enough

N26 Extreme air temperature*,

N27 Extreme ground temperature*,

N28 Extreme cooling water temperature*,

N38 Recurring soil frost,

N53 Biological fouling,

N57 Infestation rodents.

*applicable to relevant plant operating state

Severity of the hazard

QL-3: An event has a damage potential that is less or equal to another event that the plant is already designed for.

For example:

impact of hail is enveloped by other phenomena such as tornado induced missiles

N12 Obstruction of the river,
N15 Water control structure failure and M23 Flooding: mis-management of dam.

N7 Tsunami,
N14 Large induced waves,
N16 Seiche,
N17 Bore

At the Tihange:

At the Doel site:

Quantitative screening

QN1 and QN-2: Hazards are screened out based on their low frequency of occurrences and/or low contribution to the CDF

N2 Ground motion human triggered,
M18 Excavation construction work,
N41 Tornado,
N42 Waterspout,
N72 Meteorite fall,

M1 Industry: explosion, M11

Transportation: explosion
M24 Fire: human/ technological activity,
M2/5 Industry, Military: chemical release,

M12/14 Transportation/

Pipeline: chemical release
M15/16 Aircraft crash: airport zone / air traffic, M17 Satellite crash.

Quantitative screening: examples

Meteorite fall

- D=100 meters
- Once in 5200 years
- 3.8 Mt of TNT
- 24.8 km
- CDF=7.9E-10 /year

Satellite crash

- 15 000 tons in 56 years
- 100 to 150 ton/year
- Rough estimation
- Earth surface 510.1 million km²
- CDF=2E-09 /year

Quantitative screening: examples

Lightning

- feedback from the commercial NPPs (NUREG/CR-6866)
- Similar technology, but different density of lightning occurrence
- Site specific correction coefficients
- CDF $\approx 1.0E-7$

Solar storm

- Rough estimation of the CDF contribution
- Solar storm of 1859 (Carrington event)
- Hydro-Québec's grid 1989
- large error margin
- CDF $\approx 1.0E-7$

Inclusion

- Inclusion in internal flooding (QL-2)
 - Corrosion
 - High ground water
- Loss of main heat sink
- Loss of off-site power
- External flooding
 - High tides, Storm surges and Wind waves
 - Flash flood, Snow melt, Precipitation, Wind waves, Dam failure

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Conclusions



Conclusions

- Adequate screening criteria
 - Best international practices
- Exhaustive list of hazards:
 - Man-made
 - Natural
- The majority of hazards were screened out
 - Four families of hazards cannot currently be screened out
 - Conservative margins within internal events PSA

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**Thank you for your
attention!**

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