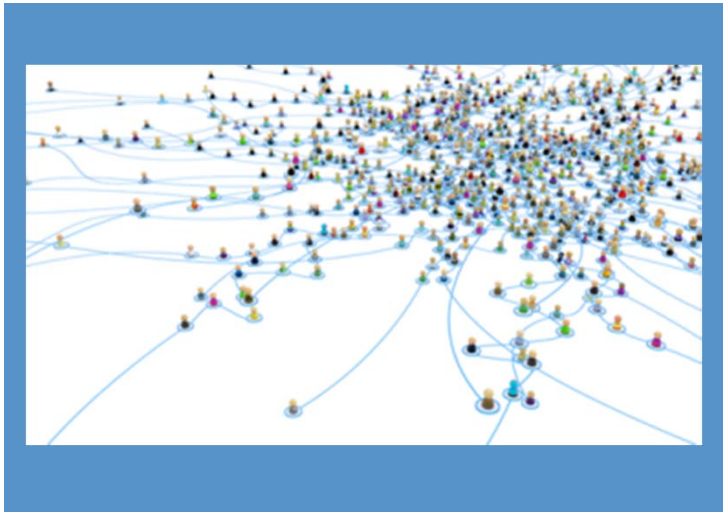
IRSN
INSTITUT
DE RADIOPROTECTION
ET DE SÛRETÉ NUCLÉAIRE

Faire avancer la sûreté nucléaire

Methodologies to support the prognosis of a developing situation and challenges in applying these during a response

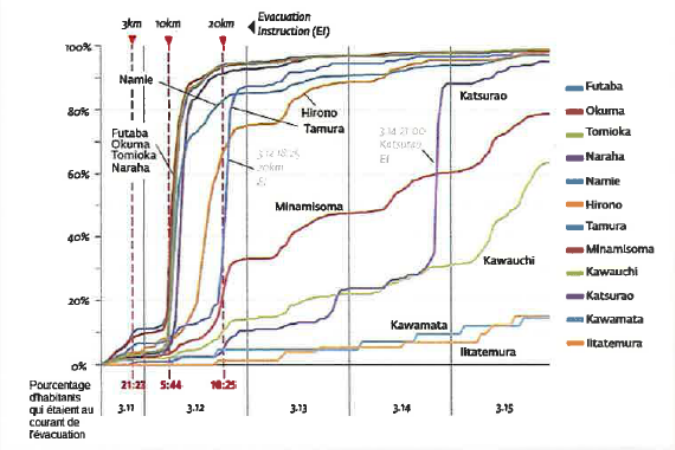
O. Isnard
IRSN
Radiation Protection Division – Emergency
Emergency Response Department



A prognosis, why?

Protection measures will take time to be fully implemented. The evacuation process includes:

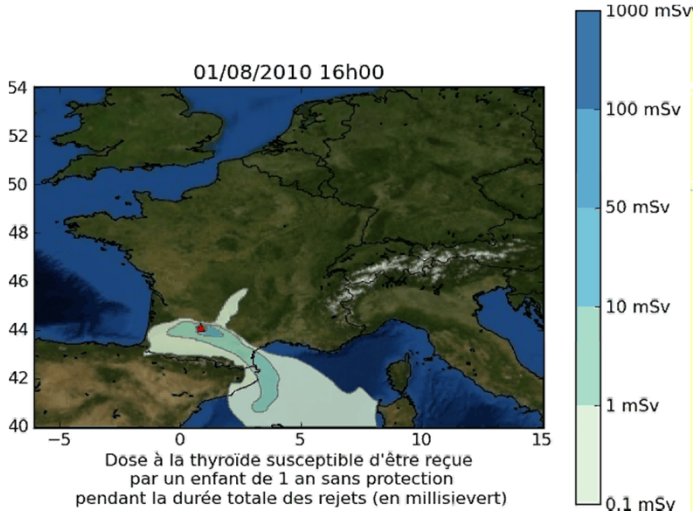
- Detection, assessment of the accident -
- Decision of evacuation, including the extend – **2 to 6 hours**
- Alarm of the population to be evacuated - **depends**
- Reaction of the population – **2 to 6 hours**
- Transportation of the evacuees to other locations – **up to 36 hours**



A prognosis, why?

Meteorological conditions can change dramatically during the event and the consequences depend for a large part on this conditions:

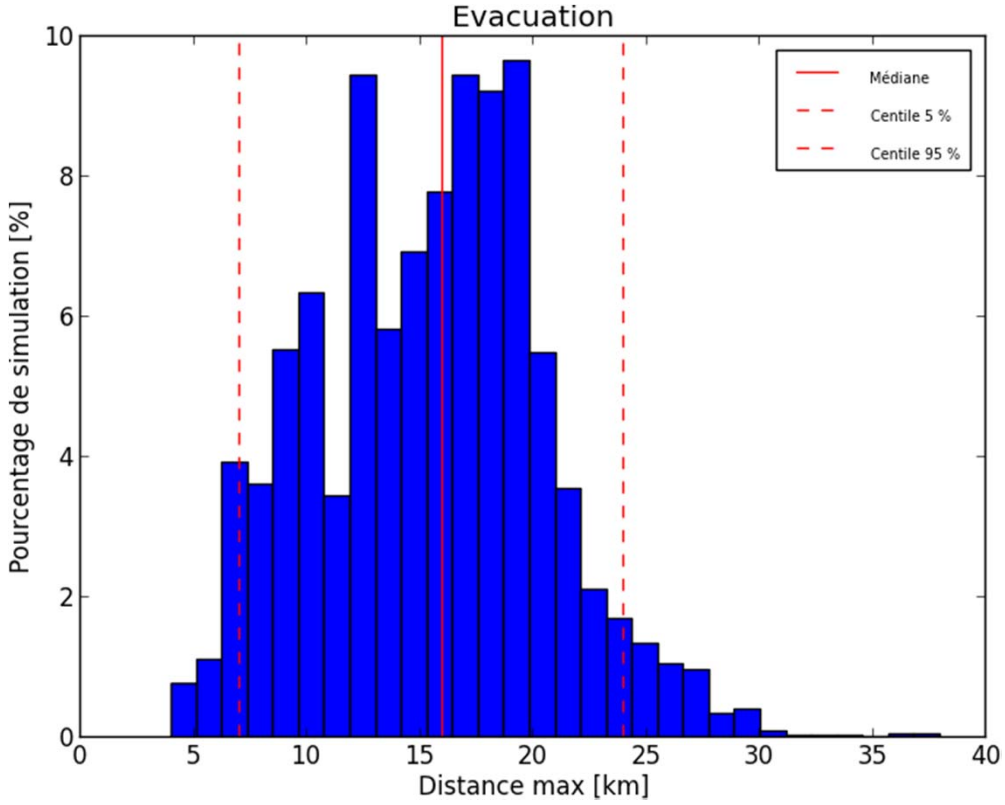
- Planning shall be seen as a starting point
- Decision shall be adapted to the accident **and** the meteorological conditions



A prognosis, why?

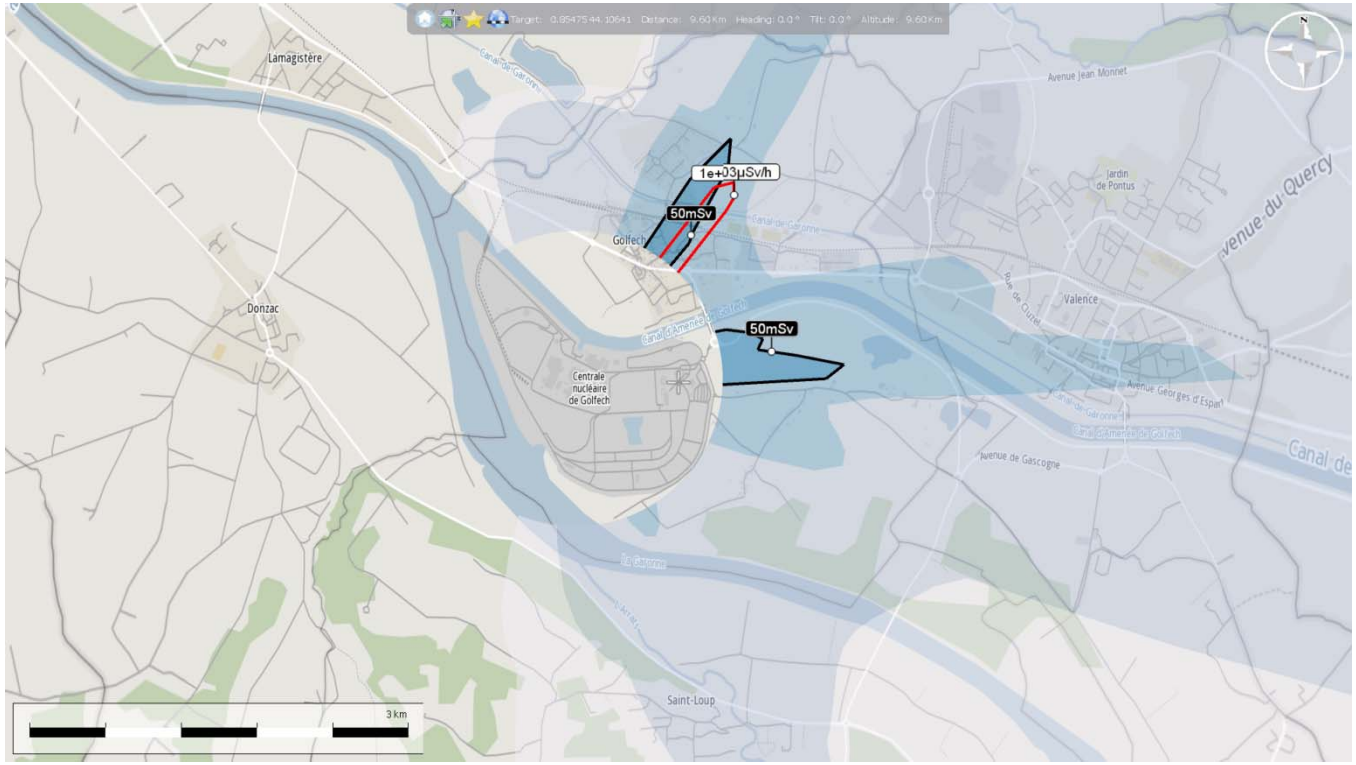
Example of evacuation depending on meteorological conditions:

- Median: 16 km
- Percentile 5 % : 7 km
- Percentile 95 % : 24 km



A prognosis, why?

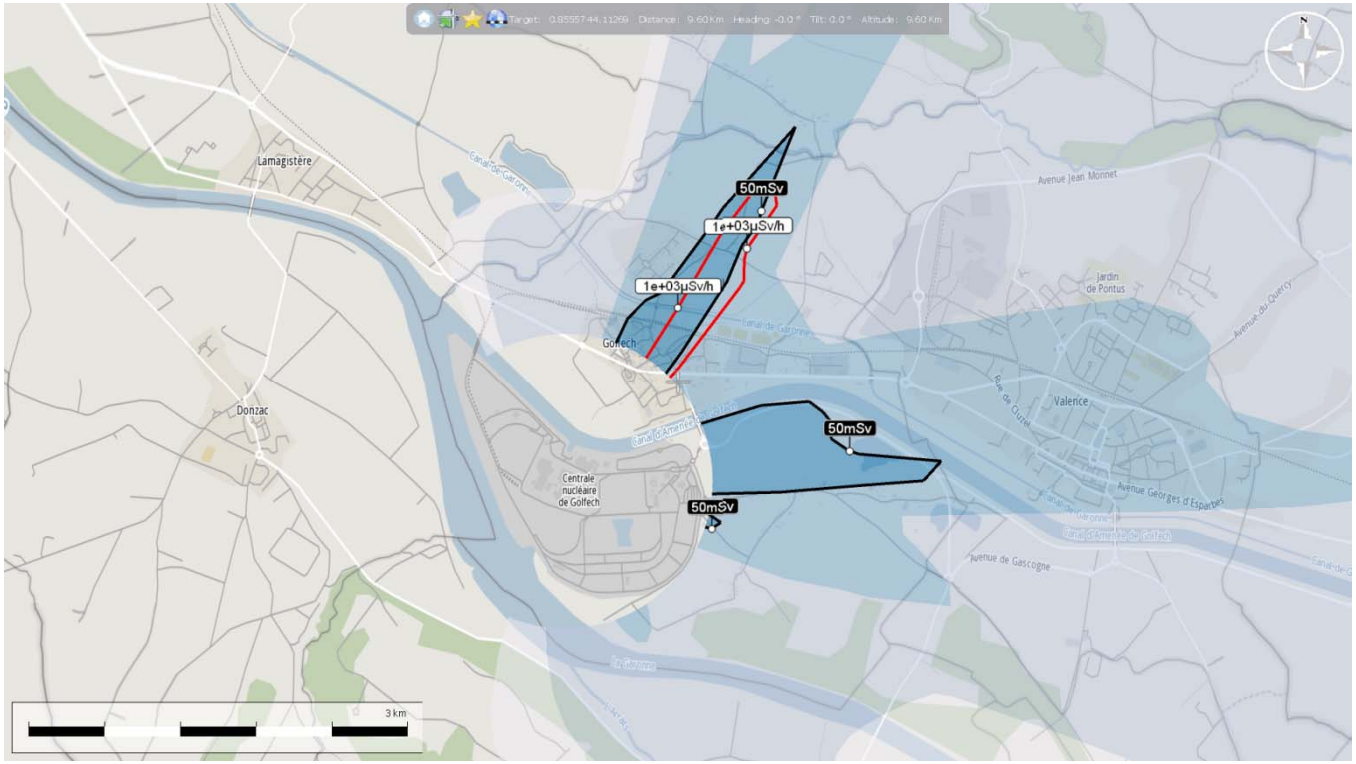
Using measurement (dose rate, OIL1) is generally unsufficient



+24h

A prognosis, why?

Using measurement (dose rate, OIL1) is generally unsufficient



+30h

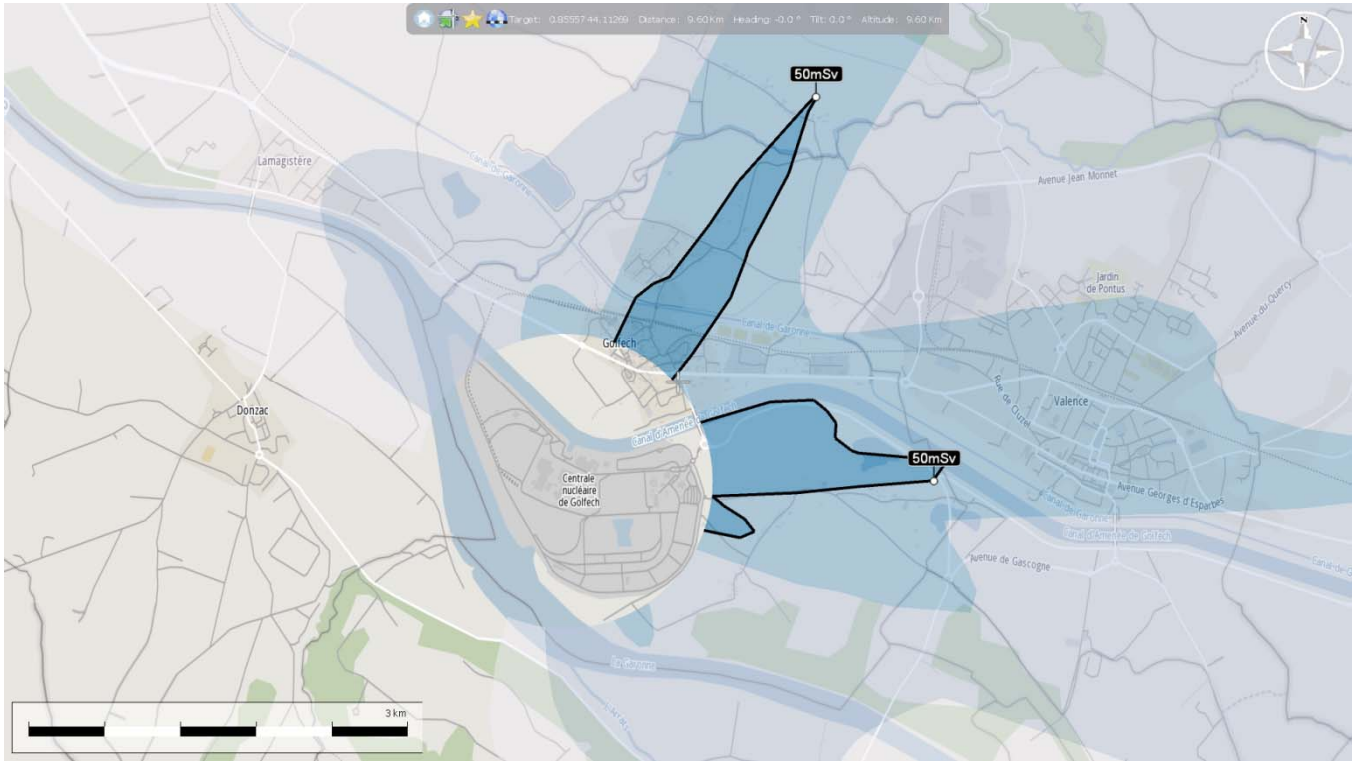
A prognosis, why?

Using measurement (dose rate, OIL1) is generally unsufficient

+36h

A prognosis, why?

Using measurement (dose rate, OIL1) is generally unsufficient



+42h

A prognosis, why?

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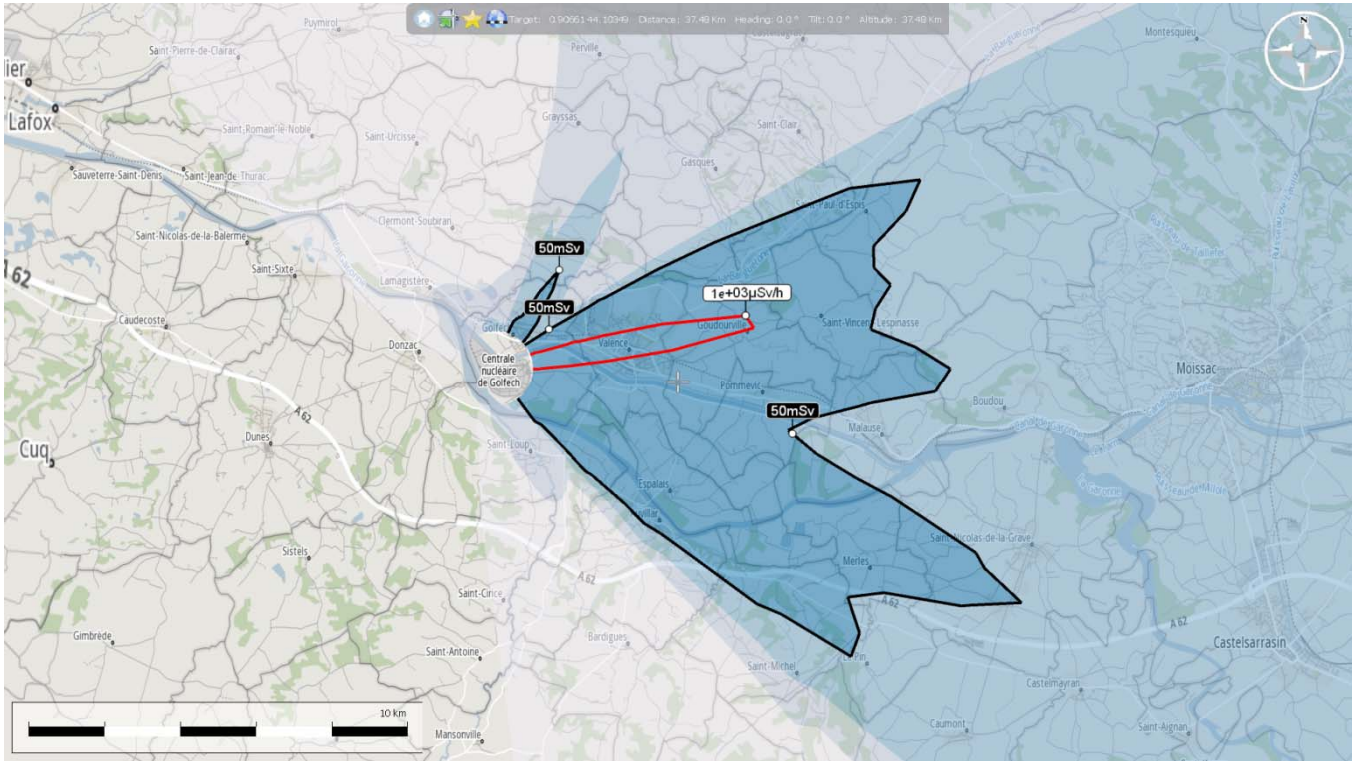

+48h

A prognosis, why?

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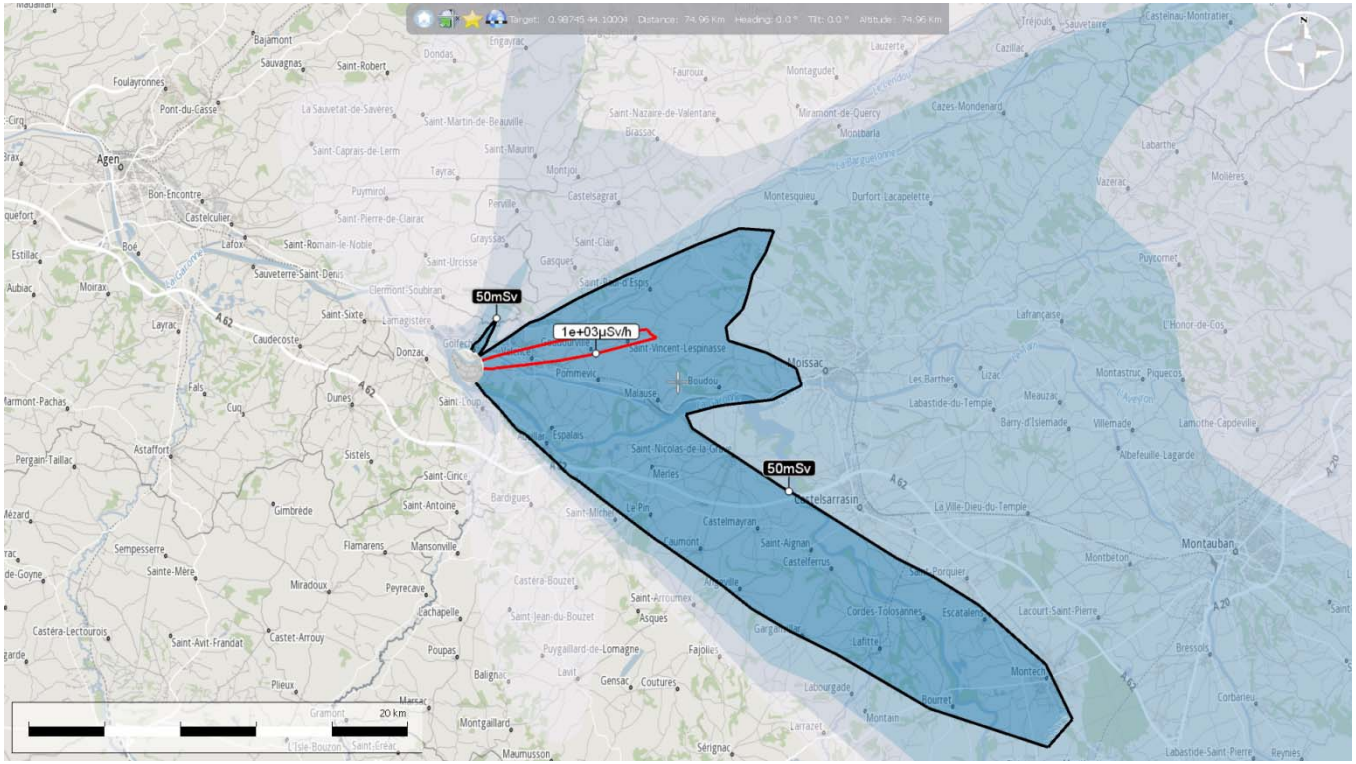

+54h

A prognosis, why?

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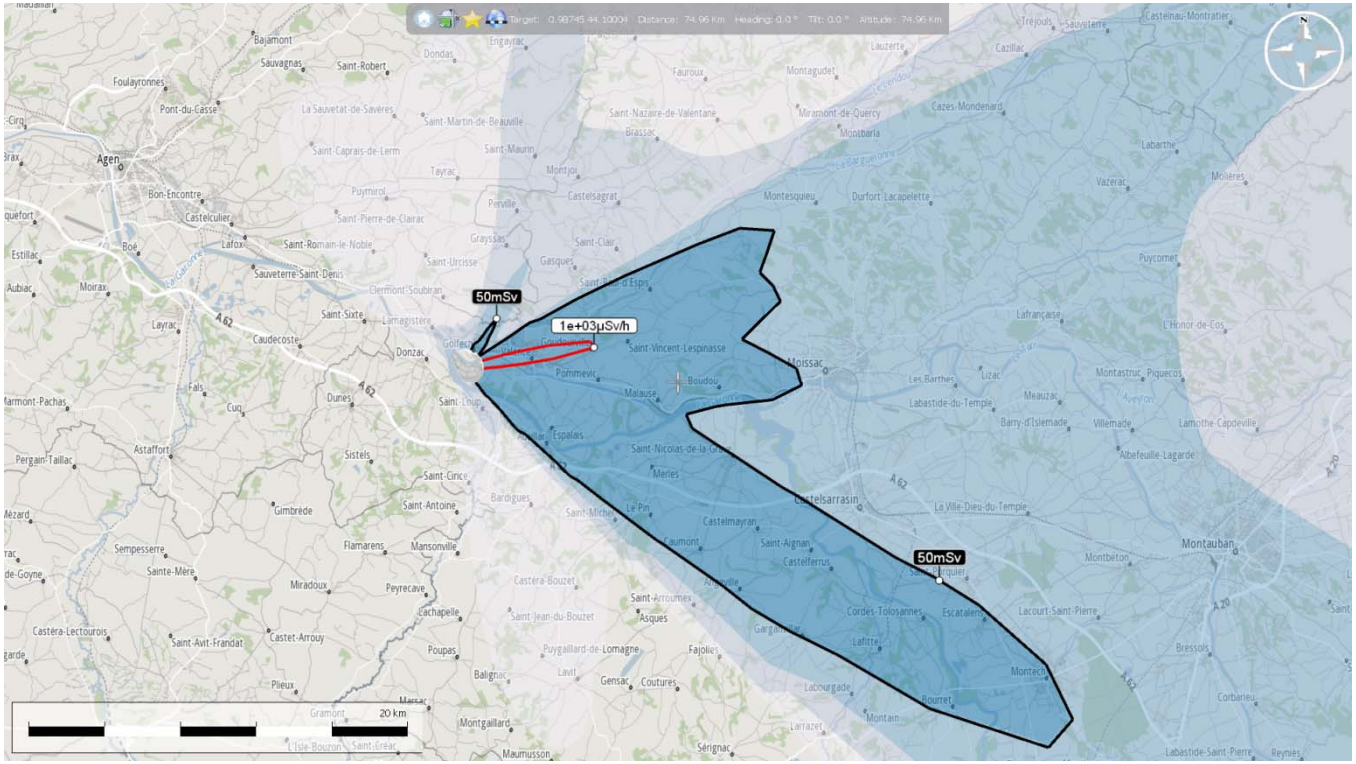

+60h

A prognosis, why?

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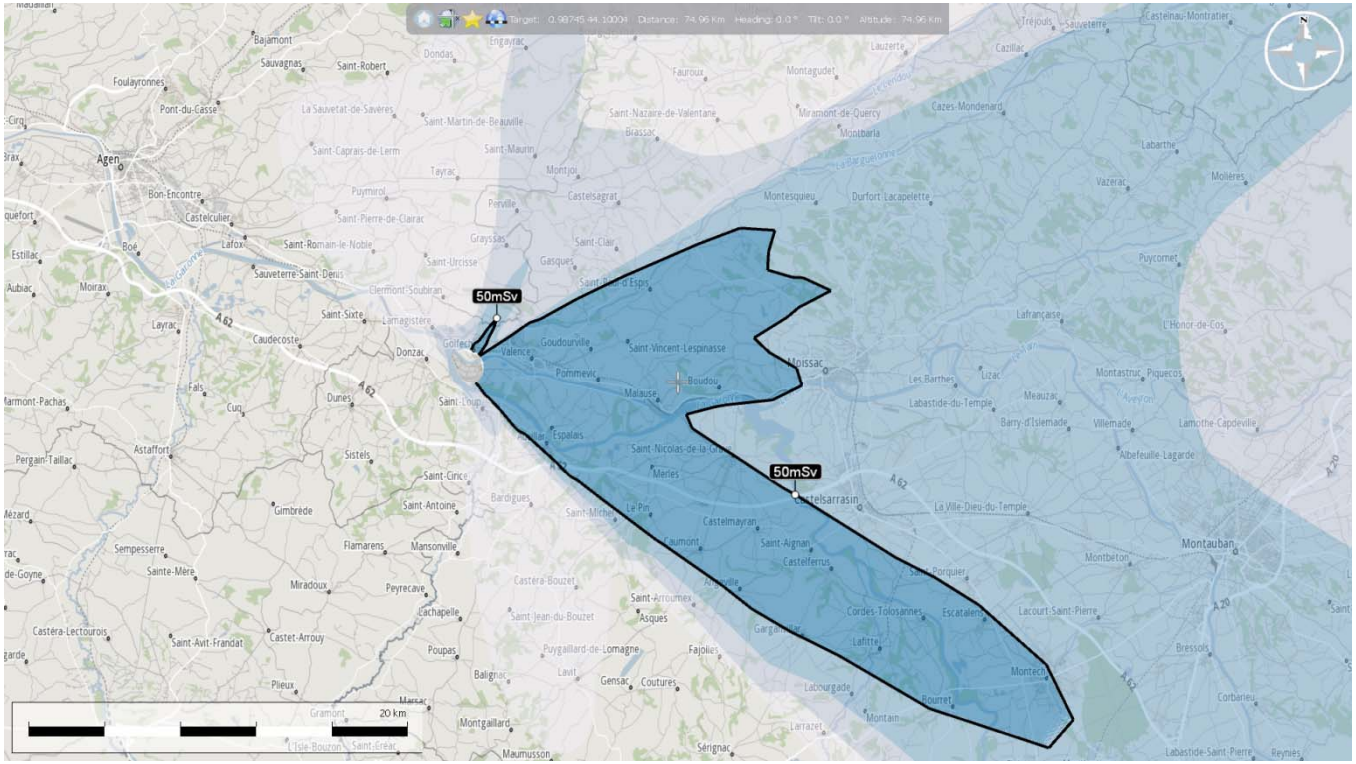


+66h

Objectives

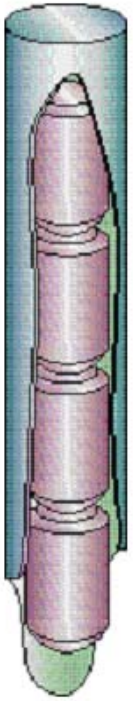
- To structure the working method of the Emergency Technical Teams
- To facilitate dialog with the plant operator (common method)
- To share information with other Emergency Teams
- To satisfy the authorities requirements in a nuclear emergency

Based on a 2 steps approach: Assessment of the situation, then Prognosis of possible developments

Example with the French Approach (for PWR)

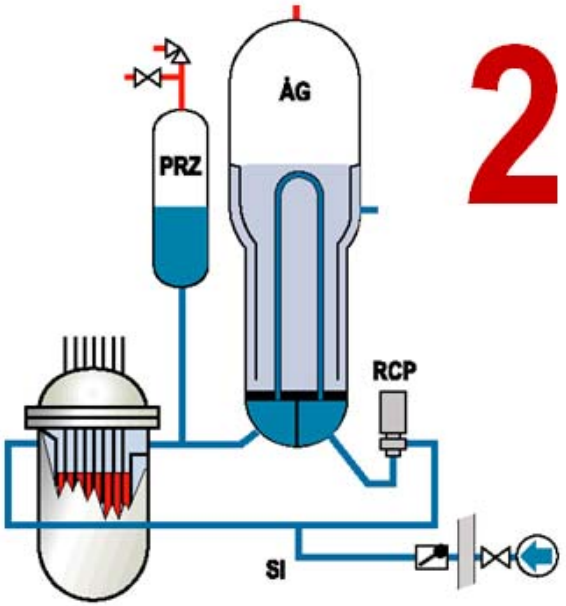
3 safety barriers

FUEL AND CLADDING



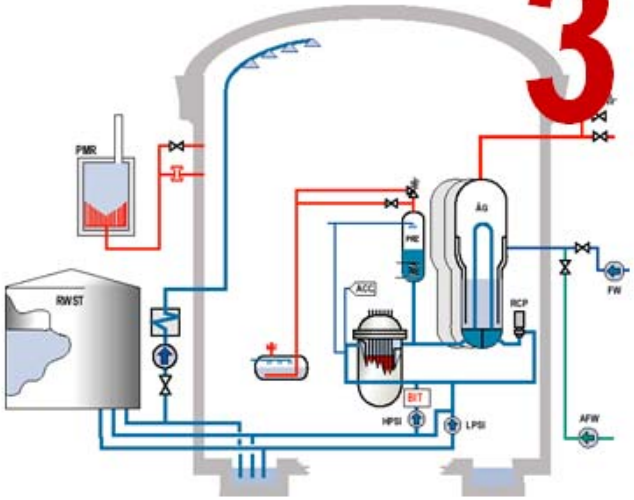
1

PRIMARY SYSTEM ENVELOPE BOTH INSIDE AND OUTSIDE CONT.



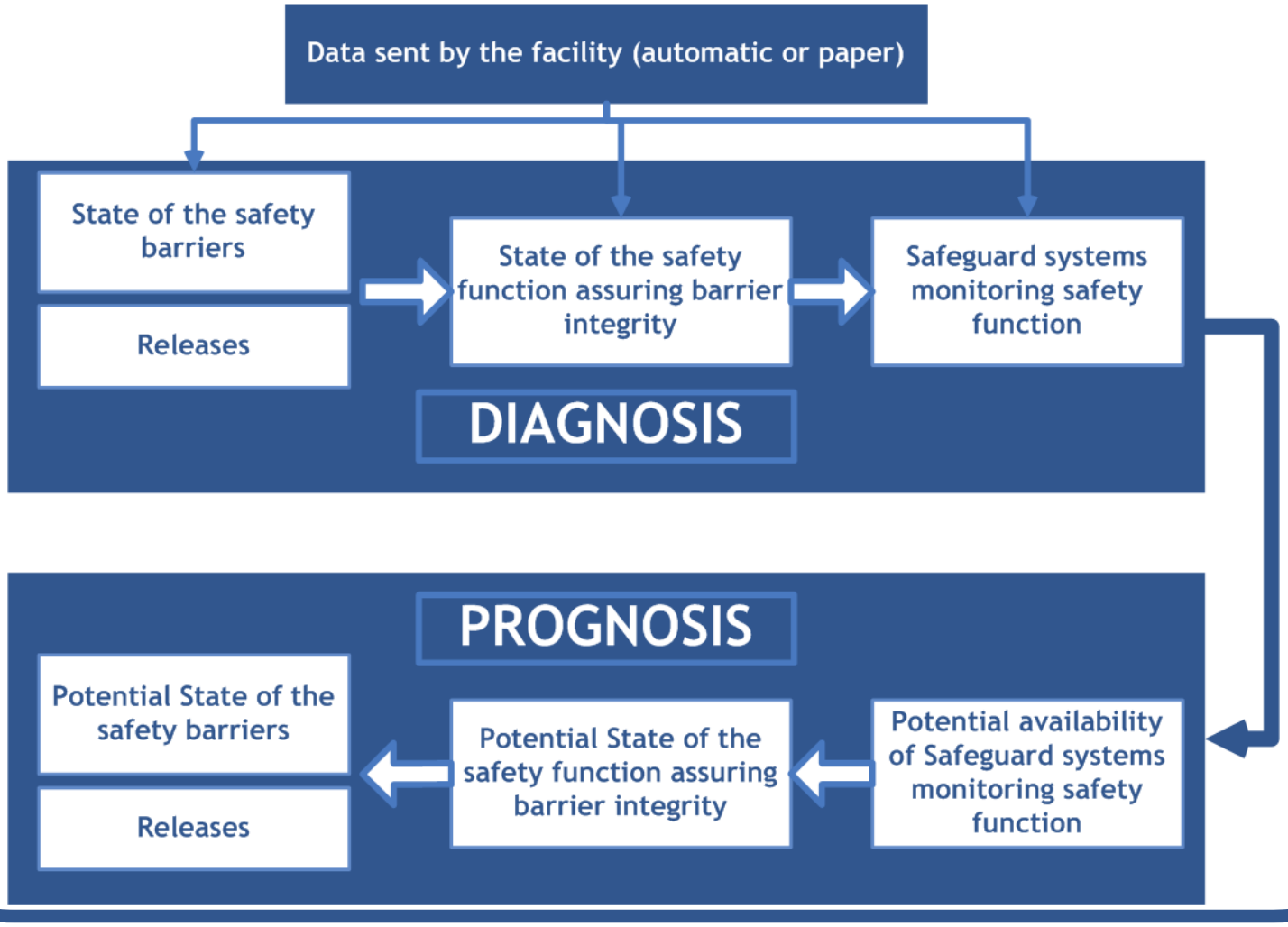
2

REACTOR BUILDING AND ITS EXTENSIONS



3

A common methodology

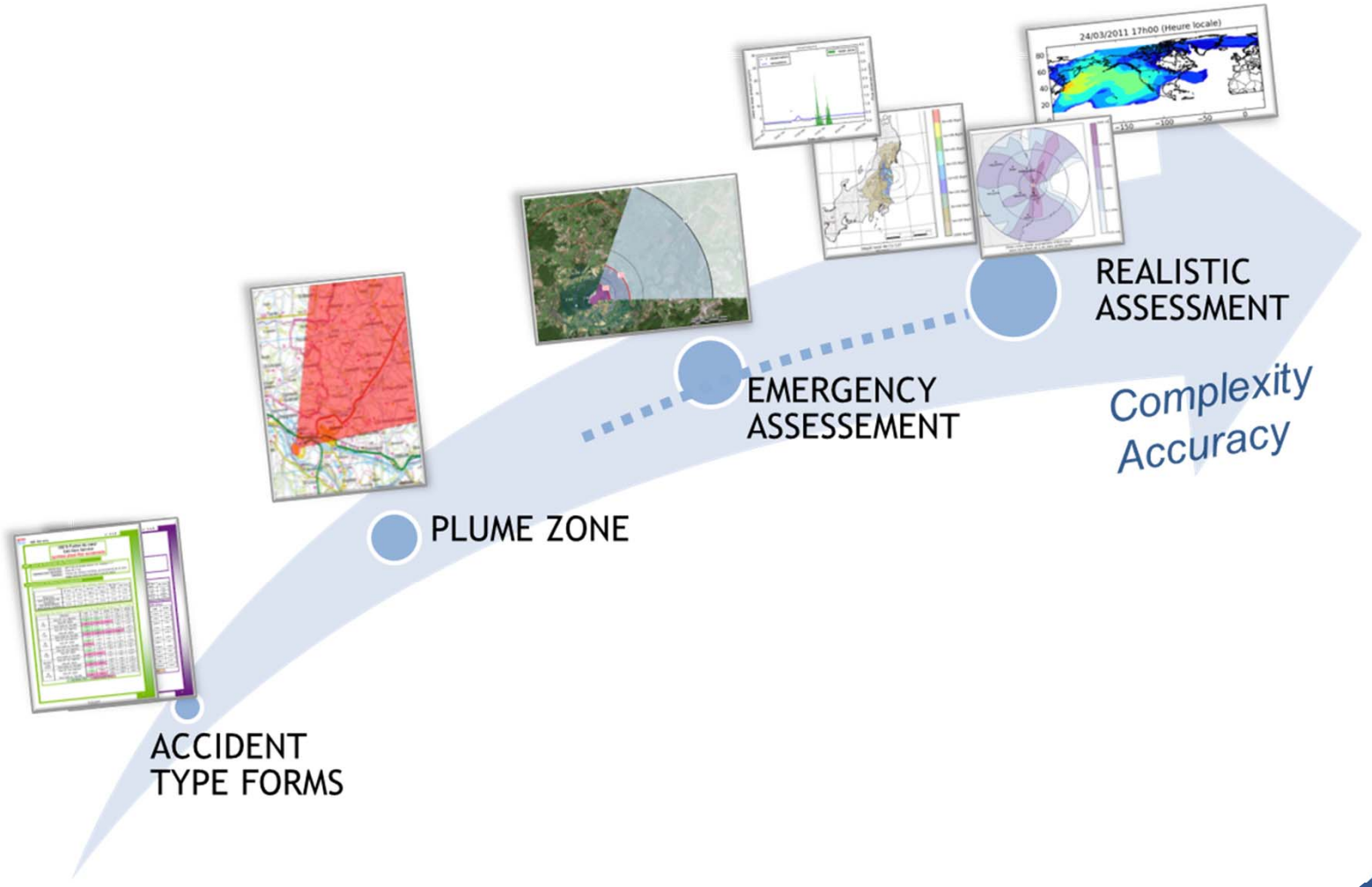


Supported by a grid with a shared language

COUNTRY	NPP SITE	NPP UNIT	COORDINATES LONG/LAT	REACTOR TYPE	DATE	LOCAL TIME	GMT TIME
FRANCE	GRAVELINES	1	0 / 50	Generic PWR			

STATUS at 15 h 54	DIAGNOSIS		PROGNOSIS		
Barriers Status	Safety functions status	Systems used for the monitoring of functions	Forecast availability of systems	Forecast status of safety functions	Forecast Status of Barriers
Fuel Matrix and Claddings **No cladding Failure** ☐ **Cladding Failure** ☐ **Core Melt** ☐	• confortable • low • doubtful • satisfactory • degraded • dewatering • doubtful	• control rods • boration: SI, chemical & vol. ctrl sys, makeup, FBA • SI, chemical & vol. ctrl • water reserves (RWST, makeup)	• confortable • low • doubtful • satisfactory • degraded • dewatering • doubtful	• control rods • boration: SI, chemical & vol. ctrl sys, makeup, FBA • SI, chemical & vol. ctrl • water reserves (RWST, makeup)	**Fuel Matrix and Claddings** **No cladding Failure** ☐ **Cladding Failure** ☐ at h **Core Melt** ☐ at h
Primary System **Integral** ☐ **Doubtful** ☐ **Primary break** ☐ ☐ inside reactor building ☐ PZR relief lines ☐ outside containment ☐ SGTR	• controlled or not • adequate or not • doubtful	• SG • break • SI • feed and bleed • Decay heat and Removal system • Component Cooling sys, • Essential Service Water system	• controlled or not • adequate or not • doubtful	• SG • break • SI • feed and bleed • Decay heat and Removal system • Component Cooling sys, • Essential Service Water system	**Primary System** **Integral** ☐ **Doubtful** ☐ **Primary break** ☐ ☐ PZR relief lines opened at h ☐ Outside containment ☐ SGTR
Reactor Building and its Extension **Normal Leakage** ☐ **Doubtful** ☐ **Uncollected leakage** ☐ ☐ penetrations ☐ IRWST ☐ secondary system **Collected leakage** ☐ ☐ RB penetration ☐ connected system **RB depressurization** ☐	• safe • not guaranteed • doubtful	• containment isolation phases 1 and 2 • containment spray • system in service	• safe • not guaranteed • doubtful	• containment isolation phases 1 and 2 • containment spray • system in service	**Reactor Building and its Extension** **Normal leakage** ☐ **Doubtful** ☐ **Uncollected leakage** ☐ ☐ penetrations ☐ IRWST ☐ secondary **Collected leakage** ☐ ☐ RB penetration ☐ connected system isolated at h **RB depressurization** ☐ at h

But also for the dose assessment



As the Accident State

- **The response to a nuclear/radiological emergency is an operation which must be done as partners (operator/public organization)**
- An effective emergency response requires sharing all information between stakeholders of the response. The information to be shared shall be defined during the preparedness phase with the operator and resilient exchange systems put in place
- Technical data from the accident installation shall be transmitted by the operator to public assets in order to cross check vision of the actual state of the installation but also share vision on possible developments.
- Stay humble. Many mistakes or misunderstanding can occur. Sharing vision on the accident is an important process of an effective response

As the Accident State

- **Technical data shall be exchanged but with common objectives in term of technical assessments (share emergency response objectives)**
- Common objectives for the expertise assessments (driver of the expertise)
- Put in place a common expertise methodology to conduct the assessments between the operator and public assets
- The common methodology shall separate the analysis of the current state of the accident installation (**Diagnosis**) and the possible development of the situation (**Prognosis**)
- In the expertise process, room shall be available to compare expertise results and visions to fulfill the response objectives

For the rest of the World

An accident somewhere is an accident everywhere

During the response to the Fukushima emergency (all) MS with expertise capabilities where providing analysis and anticipation scenarios to their strategic/decision level.

- Using pre-calculated source terms (unit, scenario based, real-world accident)
- Using live calculated source terms from analysed data from TEPCO public data available (diagnostic and prognostic)
- Using their National Meteorological Services for weather forecasts at different scale
- Using their national response system (models) for atmospheric transport and for dose assessments

For the rest of the World

Data needed to provide expertise (for domestic use and as a RANET asset) shall be organized and distributed trough a centralized system

The Fukushima accident showed that at some point, the accident state must provide raw data of the on-going accident (installation, environment) to let expertise assets throughout the world use them for their own analysis (needed by MS to take strategic decisions)

- **Avoid too much transfer is of paramount importance to minimize effort from the accident state and to insure consistency of distributed data**
- Accident related data
  - Dynamic data from the impacted nuclear installation
  - Environmental monitoring data on and off-site
- Meteorological data
  - Forecasts at different temporal resolution and spatial scales
  - Observation and Nowcast products

Contribution from different organizations to the Assessment and Prognosis process will enhance the global capabilities to be in a position to understand a developing situation and resulting possible consequences

The provision of several Assessment and Advice to the IAEA/IEC during a response will enable the IEC to combine results to produced concerted messages with the Accident State.

In doing so, the IAEA will stay at a strategic level providing to MS a global overview of the situation and possible developments, enabling requesting MS to plan and to implement adequate responses to the situation

The Assessment and Prognosis process is achievable if potential Accident State commit to provide the necessary technical data (dynamic measurements in the installation) and if WMO and IAEA put in place an mechanism for RANET assets to get access to meteorological forecast products