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ENEA Activities in the Field of Emergency Preparedness and Response in the Aftermath of the Fukushima Accident

International Experts Meeting on Strengthening Research and Development Effectiveness
In the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant
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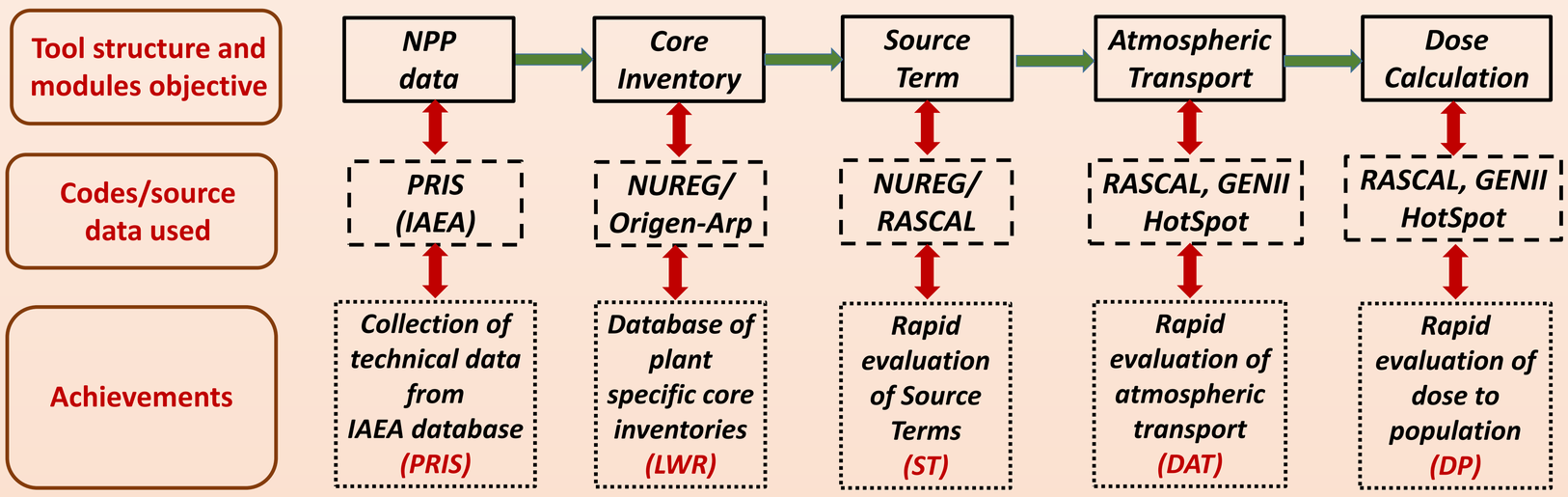
1. Introduction

The Fukushima accident prompted the Bologna ENEA – UTFISSM research group to a stronger commitment to several activities in the EP&R field with the objectives of:

a) Development of dedicate tools for a fast prediction of severe accident off-site consequences in foreign NPPs situated at less than 200 km from the Italian national border;
b) Evaluation of the Fukushima accident Source Term (ST) using RASCAL 4.2 – 4.3 codes.

2. Activities

a) The general structure of the severe accidents fast prediction tool consists of a series of computational modules each performing a specific task:



b) The Fukushima accident ST was evaluated using the RASCAL 4.2 code. The analysis was carried out for each unit. The choice of dominant release sequences and of the input parameters is based on ENEA hypothesis and on the information available in the scientific literature.

3. Outcomes

***NPP data*:** technical reactor data (e. g. power, burn-up, assembly type, enrichment, etc.) were collected for all Italian border foreign NPPs;

***Core inventory*:** calculation of core inventories at Middle Of Cycle (MOC) of the equilibrium fuel cycle , the core inventories for the first 24 hours since SCRAM and the decay power for the first 30 days since SCRAM;

***Source term*:** characterization of the dominant severe accident sequences for LWR NPPs and collection of the integral severe accident parameters for NUREG-based calculation of the ST;

***Database*:** database for collecting the core inventories and a specific module for the automatic retrieval of realtime and forecast weather conditions from a list of preselected weather stations;

***Fukushima ST*:** calculation of the Fukushima ST. The results are in good agreement with those publicy available. Full report: *http://openarchive.enea.it/bitstream/handle/10840/4840/UTFISSM-P000-017_rev.1.pdf?sequence=4*

4. Future development

***Terrain maps*:** *production of a large-scale maps with terrain height and roughtness data;*

***Radiological networks*:** link of the emergency database with national or european-level radiological networks (RESORAD, REMRAD, EURDEP, CTBO, etc.);

***Fukushima consequences*:** simulate the atmospheric dispersion of the Fukushima accident Source Term.

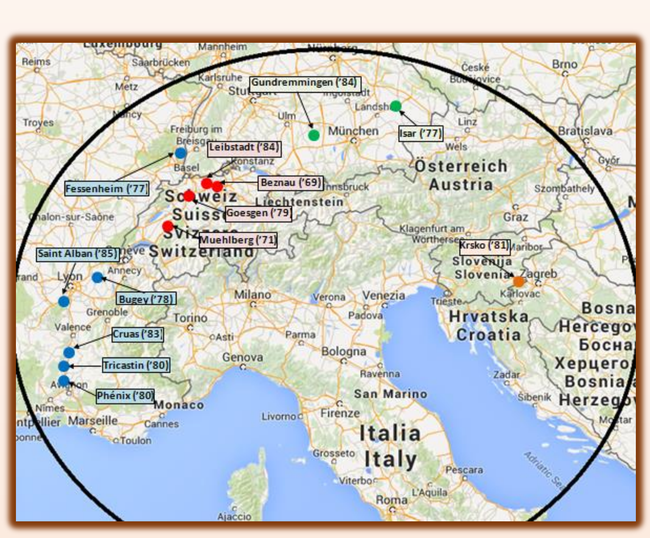


Figure 1: NNPs far from Italian border less than 200 km

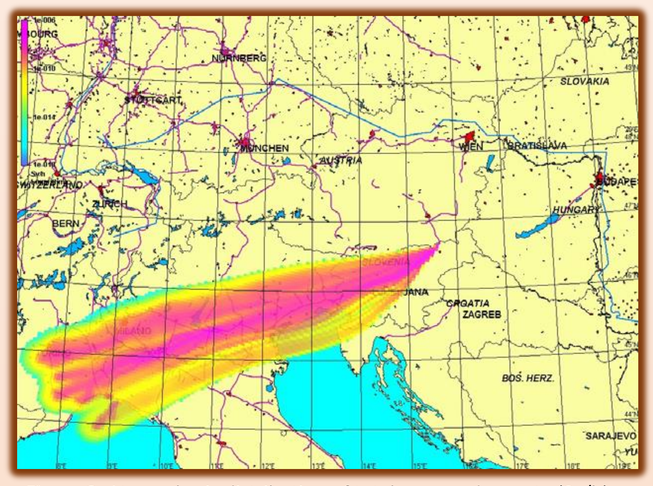


Figure 2: Atmospheric distribution of total gamma dose rate (Sv/h) from Krsko NPP – (ARGOS Code, NAEA, Poland)

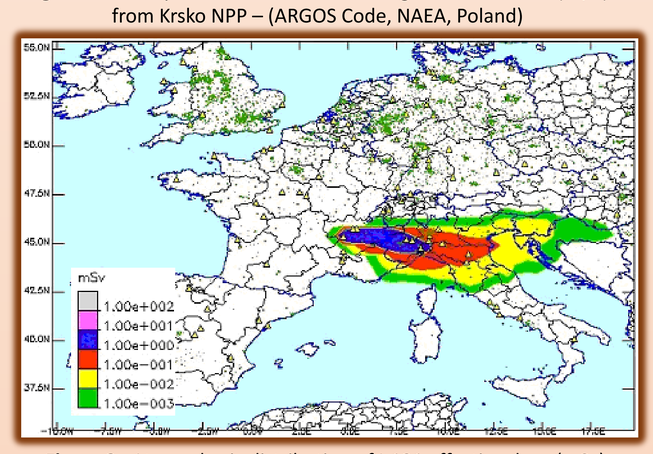


Figure 3: Atmospheric distribution of I-131 effective dose (mSv) from St. Alban NPP – (ARIES Code, ISPRA, Italy)

Figure 4: Meteo stations for Krsko atmospheric dispersion calculation

CORE INVENTORY				DECAY INVENTORY									
NUCLIDE	NUREG/ RASCAL 3.0.5	RASCAL 4.0	ORIGEN-ARP (Middle Of equilibrium Cycle)	ORIGEN-ARP [Ci]									
NUCLIDE	ATTIVITA' [Bq]	ATTIVITA' [Bq]	ATTIVITA' [Bq]	MASSA [Kg]	0.5 [h]	1 [h]	1.5 [h]	2 [h]	3 [h]	5 [h]	7 [h]	10 [h]	12 [h]	24 [h]
Ba-140	7.53E+18	6.76E+18	6.98E+18	2.58E+00	1.88E+08	1.88E+08	1.88E+08	1.88E+08	1.87E+08	1.86E+08	1.86E+08	1.84E+08	1.84E+08	1.79E+08
Ce-144	3.98E+18	5.03E+18	4.09E+18	3.47E+01	1.11E+08	1.11E+08	1.11E+08	1.11E+08	1.11E+08	1.11E+08	1.11E+08	1.11E+08	1.10E+08	1.10E+08
Cs-134	2.72E+17	2.38E+17	1.50E+17	3.13E+00	4.05E+06	4.05E+06	4.05E+06	4.05E+06	4.05E+06	4.05E+06	4.05E+06	4.05E+06	4.05E+06	4.05E+06
Cs-136	1.42E+17	2.12E+17	9.40E+16	3.48E-02	2.54E+06	2.53E+06	2.53E+06	2.53E+06	2.52E+06	2.51E+06	2.50E+06	2.49E+06	2.47E+06	2.41E+06
Cs-137	1.74E+17	1.65E+17	2.28E+17	7.07E+01	6.15E+06	6.15E+06	6.15E+06	6.15E+06	6.15E+06	6.15E+06	6.15E+06	6.15E+06	6.15E+06	6.15E+06
I-131	3.98E+18	3.79E+18	3.81E+18	8.30E-01	1.03E+08	1.03E+08	1.03E+08	1.03E+08	1.02E+08	1.02E+08	1.01E+08	1.00E+08	9.96E+07	9.60E+07
I-132	5.68E+18	5.51E+18	5.66E+18	1.47E-02	1.52E+08	1.52E+08	1.51E+08	1.50E+08	1.49E+08	1.46E+08	1.43E+08	1.39E+08	1.37E+08	1.23E+08
I-133	8.10E+18	7.70E+18	7.95E+18	1.90E-01	2.14E+08	2.11E+08	2.09E+08	2.06E+08	1.99E+08	1.87E+08	1.75E+08	1.58E+08	1.48E+08	9.93E+07
I-134	8.95E+18	8.50E+18	9.06E+18	9.18E-03	2.16E+08	1.77E+08	1.38E+08	1.04E+08	5.60E+07	1.42E+07	3.29E+06	3.39E+05	7.22E+04	5.82E+00
I-135	7.10E+18	7.36E+18	7.58E+18	5.80E-02	1.95E+08	1.85E+08	1.75E+08	1.66E+08	1.49E+08	1.21E+08	9.80E+07	7.14E+07	5.78E+07	1.63E+07

Table 1: Core inventory partial example of an Italian border NPP

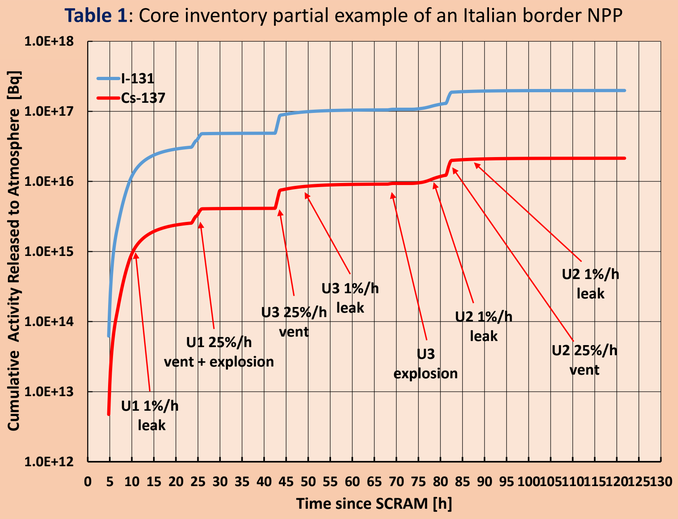


Figure 5: Fukushima ST for I-131 and Cs-137

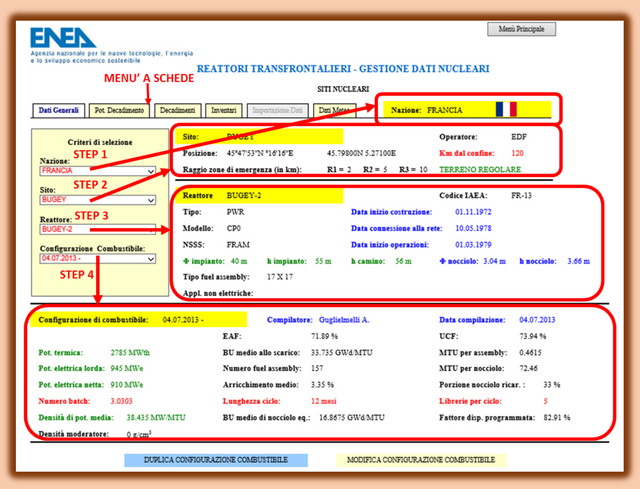


Figure 8: ENEA - core inventory query database

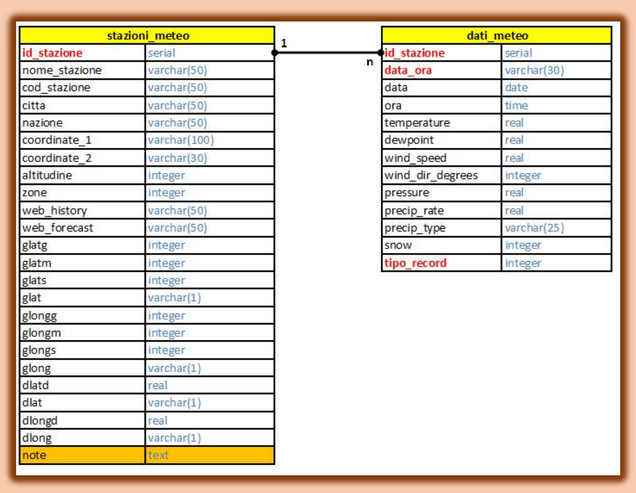


Figure 7: ENEA – meteo tables query database

Work in Progress!

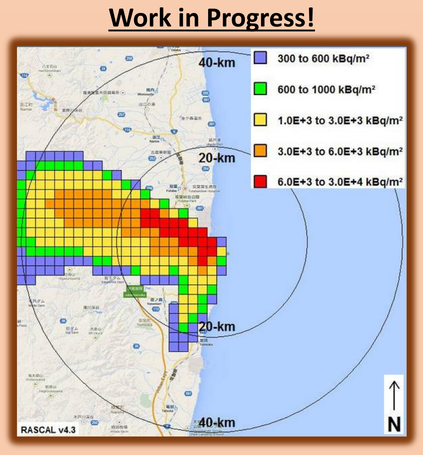


Figure 6: Fukushima surface concentration (KBq/m²) of Cs-137 @ 18/03/11 16:16