Benchmark Problem 2022/2023

ASEAN NPSR 5TH ANNUAL MEETING

Benchmark Problem

- The Benchmark Problem was first proposed in 2017 as a consequence assessment exercise of a hypothetical accident in a virtual nuclear power plant.
- Allows participating member states to compare their consequence assessment capability
- Enables the researchers to better understand the regional capability in accident analysis capability
- Regional platform for exchange of information in atmospheric dispersion and dose assessment

Goals of Benchmark problem

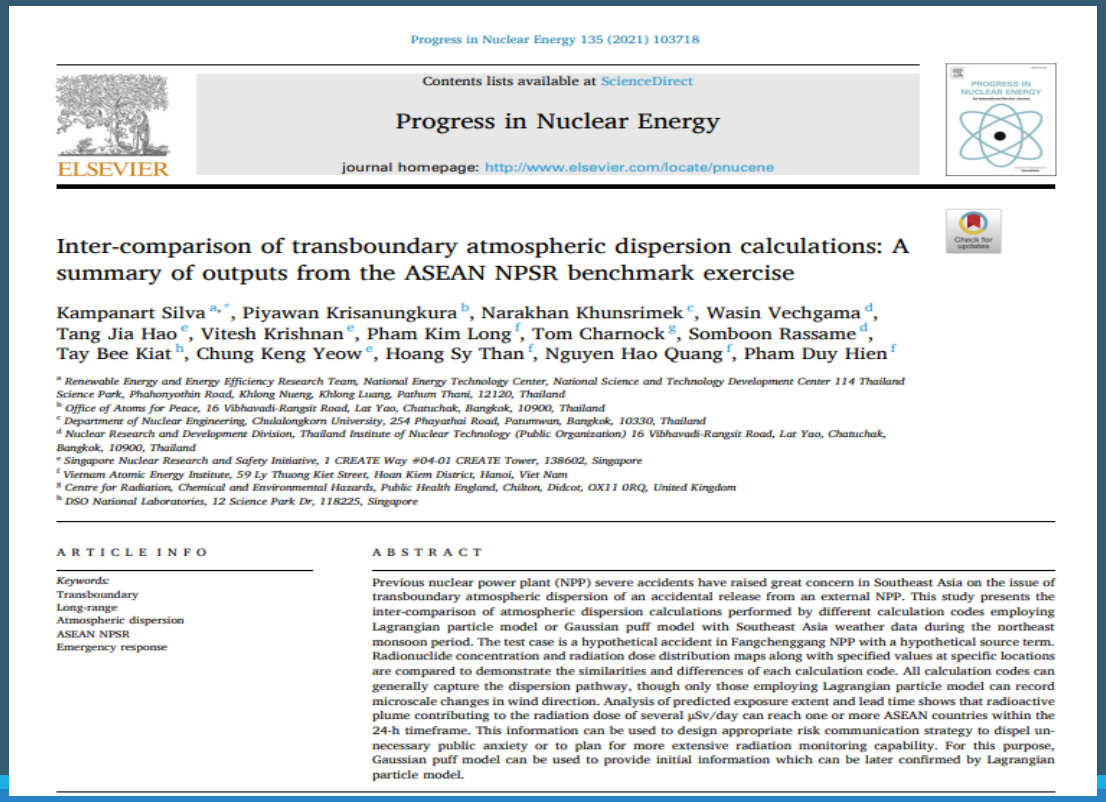
1. To fulfill the needs and address the gaps of countries in the ASEAN region in R&D
2. To strengthen the capability in R&D of the Member States in order to be able to provide the technical support for decision making
3. Satisfy participating member state interest/needs in this area

Past benchmark problem

- Transboundary atmospheric dispersion from a hypothetical accident.
- Joint effort between Thailand, Singapore, Vietnam and Tom Charnock(UK).
- Intercomparison done between atmospheric dispersion calculations code performed by different countries over a fixed scenario.
- A test scenario of a hypothetical accident in Fangchenggang NPP with a hypothetical source term.
- Variety of atmospheric dispersion codes utilizing Lagrangian particle model and Gaussian puff model was compared.

Past benchmark problem

- Progress in Nuclear Energy: Inter-comparison of transboundary atmospheric dispersion calculations: A summary of outputs from the ASEAN NPSR benchmark exercise



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Inter-comparison of transboundary atmospheric dispersion calculations: A summary of outputs from the ASEAN NPSR benchmark exercise

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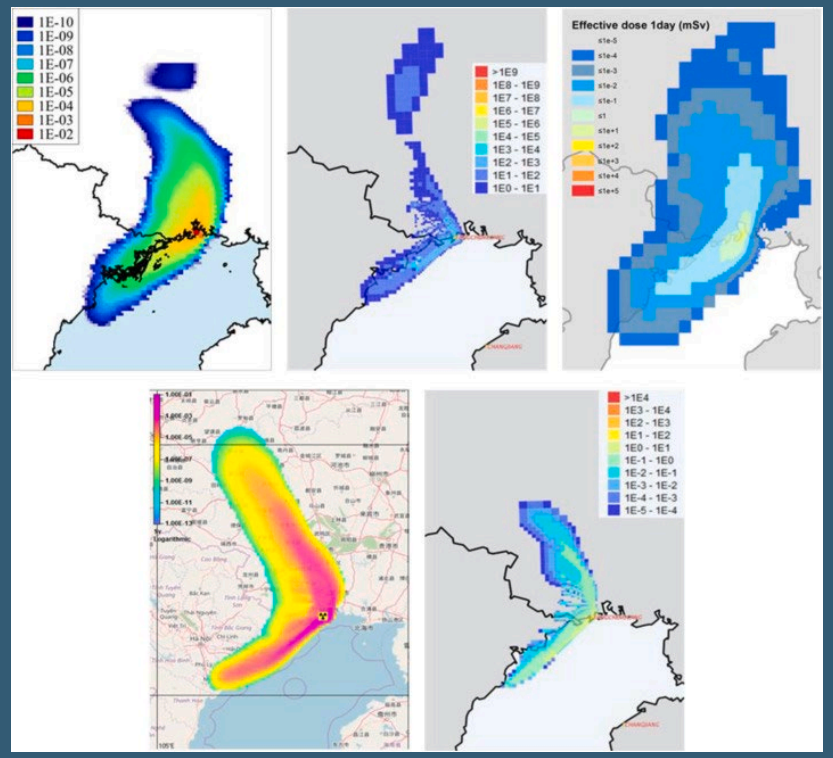
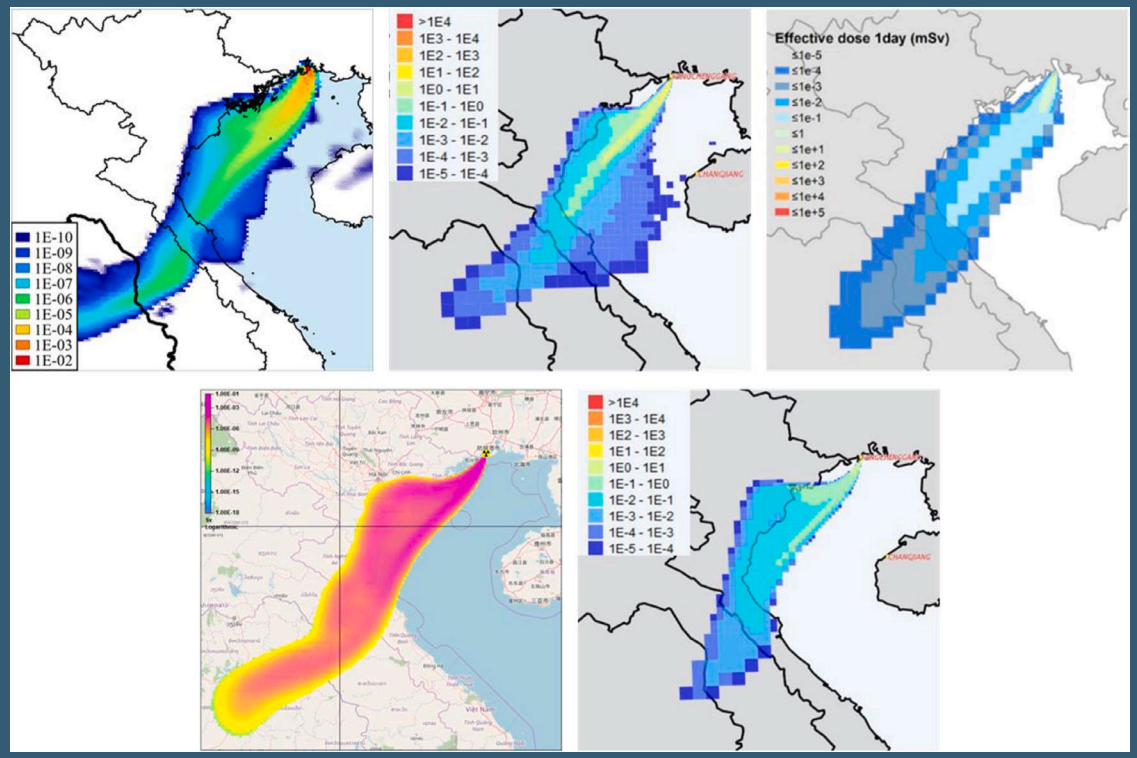
ABSTRACT

Previous nuclear power plant (NPP) severe accidents have raised great concern in Southeast Asia on the issue of transboundary atmospheric dispersion of an accidental release from an external NPP. This study presents the inter-comparison of atmospheric dispersion calculations performed by different calculation codes employing Lagrangian particle model or Gaussian puff model with Southeast Asia weather data during the northeast monsoon period. The test case is a hypothetical accident in Fangchenggang NPP with a hypothetical source term. Radionuclide concentration and radiation dose distribution maps along with specified values at specific locations are compared to demonstrate the similarities and differences of each calculation code. All calculation codes can generally capture the dispersion pathway, though only those employing Lagrangian particle model can record microscale changes in wind direction. Analysis of predicted exposure extent and lead time shows that radioactive plume contributing to the radiation dose of several μSv/day can reach one or more ASEAN countries within the 24-h timeframe. This information can be used to design appropriate risk communication strategy to dispel unnecessary public anxiety or to plan for more extensive radiation monitoring capability. For this purpose, Gaussian puff model can be used to provide initial information which can be later confirmed by Lagrangian particle model.

Result of benchmark problem



1-day TEDE for January 18th scenario. Top-left: Flexpart; top-middle: JRodos (LASAT); top-right: PACE; Bottom-left: ARGOS; bottom right: JRodos (Rimpuff).



1-day TEDE for November 24th scenario. Top-left: Flexpart; top-middle: JRodos (LASAT); top-right: PACE; Bottom-left: ARGOS; bottom right: JRodos (Rimpuff).

Result of benchmark problem

- Lagrangian and Gaussian models both predict the general pathway of the dispersion plume but Lagrangian models were able to track microscale changes to wind directions.
- Results from the various dispersion software agreed with each other with minute differences.
- Radiation doses recorded from both simulations were much lower than the reference value recommended by the ICRP.
- Nonetheless, such studies would be a helpful to appropriate authorities to evaluate external accidents and devise effective risk communication strategies.

Since then

Discussion has been made to further this project:

5/2021: Discussion in last annual meeting, proposed interest in forecast modelling and dose assessment

8/2021: First discussion to gather future benchmark directions

11/2021: Further cement interest in atmospheric dispersion and dose assessment between lead and Co-lead countries. Also interest in discerning radiation dose impact in both normal operation and emergency operation.

5/2022: Reaffirm interest in benchmark problem in the network

10/2022: Annual Meeting

Proposal for future work

- With nature of the network, we believe that having a continuation of the benchmark problem would be beneficial
- Taking into consideration:
  - Focus in atmospheric dispersion and dose assessment
  - Forecast assessment
  - Inhalation and Ingestion dose

With that, three proposals:

- Proposal 1: Standard Benchmark problem
- Proposal 2: Timed Benchmark Exercise
- Proposal 3: Regional Benchmark/cooperation exercise

Proposal 1: Standard Benchmark Exercise

- Discussion of a hypothetical scenario including location, date, weather conditions and source term to develop regional capability in atmospheric dispersion and dose assessment.
- Example in the last benchmark problem:
  - Release Amount: I-131 1*10^16 , Cs-137 6*10^13
  - Location: Fangchenggang NPP
  - Date: 18th January and 24th November 2018
  - Calculation domain: 6.5°N – 32.0°N and 95.5–122.5°E
  - Other Information: Release Height at 10 m, stable release over 24 hours.

All participants are to perform a dispersion study and record results such as Integrated air concentration, integrated ground concentration and 1-day TEDE.

Proposal 1: Standard Benchmark Exercise

- Results can also be extended for dose assessment this time especially ingestion and inhalation.
- A more in-depth look can be done to analyze dose in other dose pathways.
- As per recommendation, accident analysis with forecast weather data can be a topic of interest.
- Discussion can be held to further the problem.

Proposal 2: Timed benchmark exercise

- In this proposal, discussion of a hypothetical scenario that emulate the situation of a nuclear accident release to develop regional capability in atmospheric dispersion and dose assessment.
- A scenario will be provided to the participants as if emulating a real accident with limited info.
- The participants will have to attempt on accident analysis based on the limited information provided and researcher will have to use their own expertise for a best guess..
- Information will be slowly released over a period of time.

Proposal 2: Timed benchmark exercise

Example

Stage 1(Day 0):

- Location: Fangchenggang NPP
- Date: 26/10/2022
- Power Plant: LWR
- Release Amount: estimated Cs-137E16

Stage 2(Day +3):

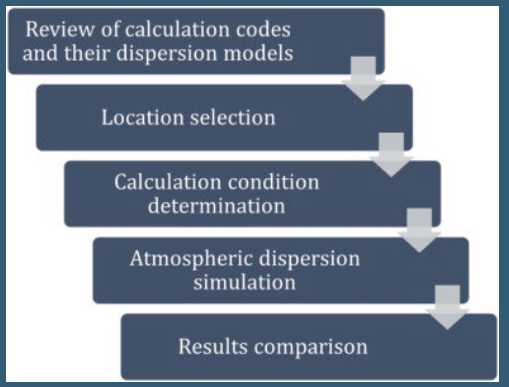
- Location: Fangchenggang NPP
- Date: 26/10/2022
- Power Plant: LWR
- Release Amount: estimated Cs-137E17 & I-131E15
- Release Period: stable over 12 hours, Increase in release for the next 12 hours

Proposal 2: Timed benchmark exercise

- For each stage, results will be collated and compared.
- Elements of the results such as time of submission and assumption will be taken into consideration.
- In this way network will better understand each countries capability while building up confidence in the regional capability.
- Foster a regional responses to future accident analysis and possibility of ensemble results.
- More inputs required from all parties to assess the feasibility of this exercise.

Proposal 3: Regional Benchmark exercise

- Discussion of a hypothetical scenario including location, date, weather conditions and source term to develop regional capability in atmospheric dispersion and dose assessment in a step-by-step manner while adhering to the regional interest and goals.
- Discussion into matters over key subjects for accident analysis.
- Go a step further to look at regional interest in NPP types.
- Develop further into reactor types analysis and dose assessment.
- Interested countries can work together to develop their capabilities together.



Proposal 3: Regional Benchmark exercise

- Overall, a step by step exercise.
- Similar goals to Benchmark problem with extension into Nuclear Power Plant analysis.
- Look closely into inputs from the participating countries.
- Example:
  - Types of power plant: PWR, BWR, HTGR.
  - Location of interest: Fangchenggang, future possible NPP location?
  - Period: Time and Date of interest.

Other matters

- How to encourage participation of the different countries with different expertise?
- Pairing countries to work together?
- Training workshop to support this activities?
- Other difficulties?

These are all just ideas that we have, and we would like to hear from you too!