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SAPIUM - Selection of adequate test database for IUQ

Philippe Fillion

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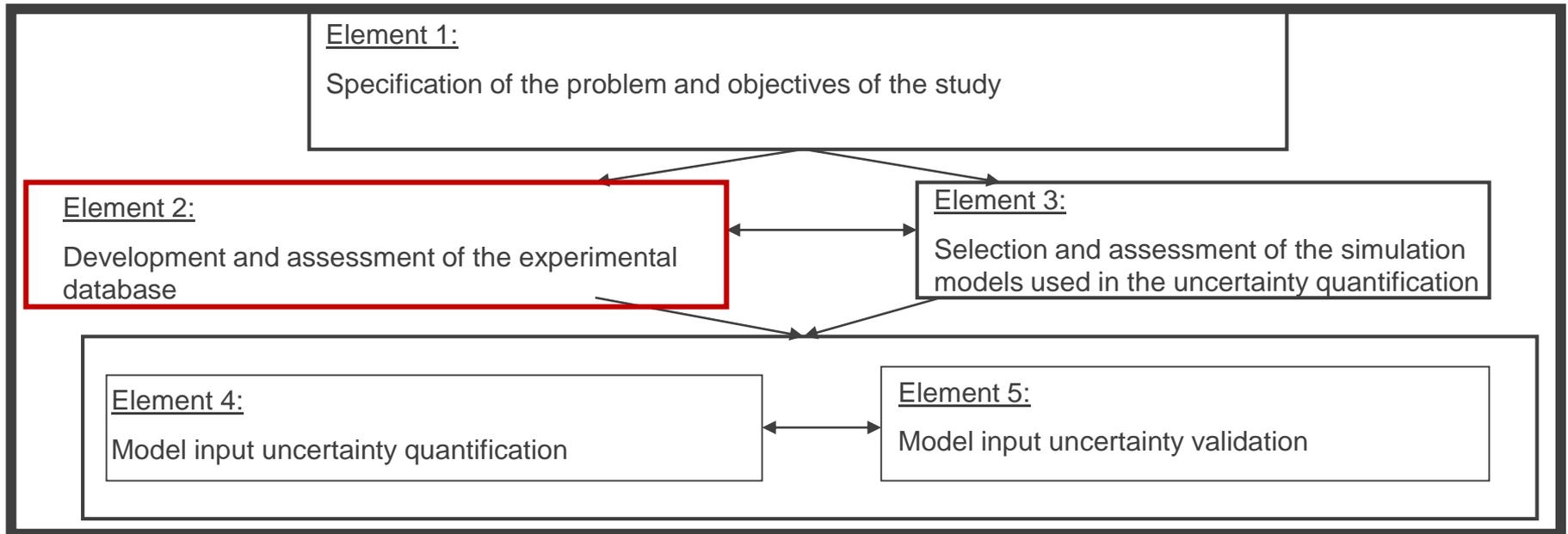
SAPIUM

Selection of adequate test database for IUQ

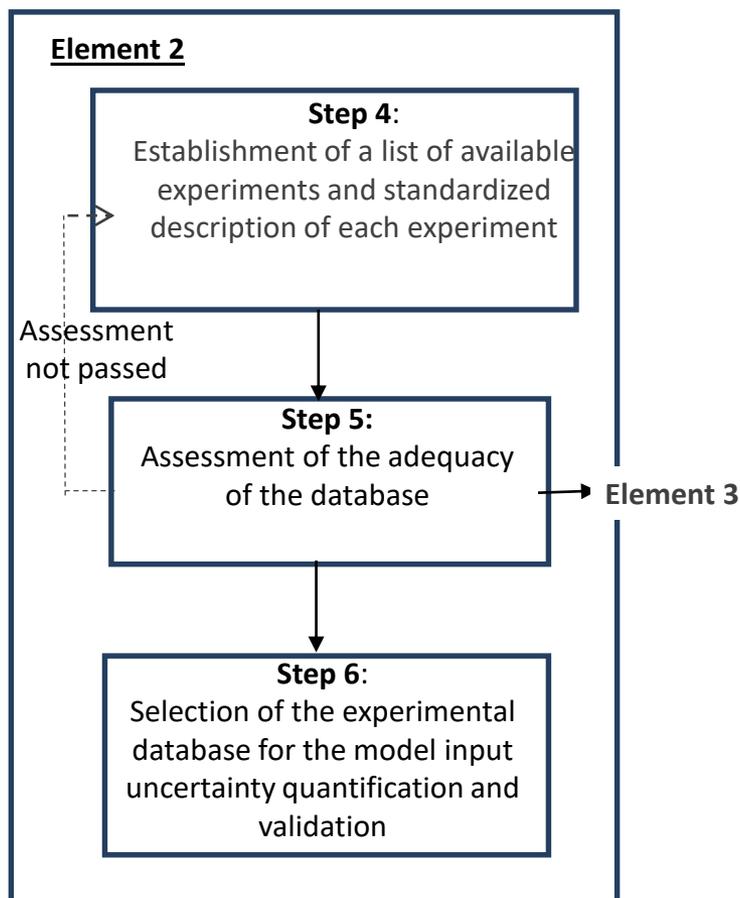
SAPIUM special session, NURETH-19, March 6-11 2022, Brussels, Belgium / Online conference

Philippe Fillion

SAPIUM PROJECT: ELEMENTS OF THE METHODOLOGY



Element 2: Development and assessment of experimental database



Collect all available experiments coming from SETs, IETs and CETs. Various scales IETs are mandatory for the application to the reactor case.

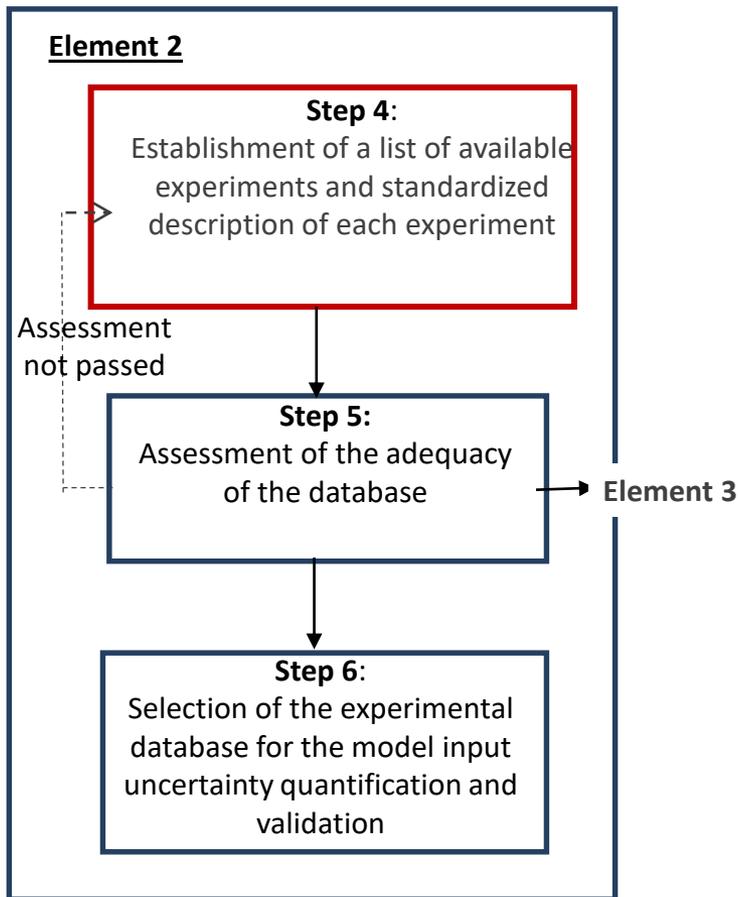
Dependency of the experimental database with respect to the reactor transient: balanced mixture of specific and generic approach.

Introduce a fixed set of criteria for the standardized description including the covered phenomena, the geometry, the scaling effect of the experimental facility and the available measurements with the associated uncertainties.

Use mathematical tools to quantitatively evaluate the adequacy (representativeness and completeness).

In case of a large number of experiments, split the experimental database in two separated parts, one for input uncertainty quantification and one for input uncertainty validation. If the number of experiments is too limited, all available experiments should be considered for the quantification step and the validation step should be adapted (cross-validation).

With courtesy of J. Baccou, IRSN

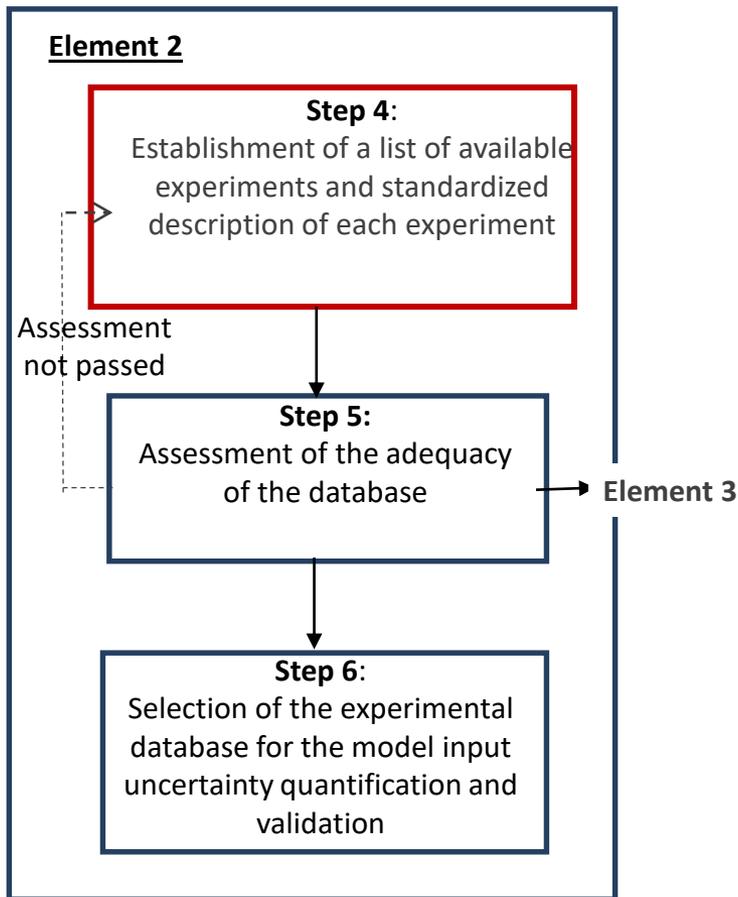


Dependency of the experimental database with respect to the reactor transient: balanced mixture of **specific** and generic approach

In practice, a specific experimental database should be built according to the important phenomena from a PIRT, as suggested in Element 1

A specific database has to be specified at the very beginning how detailed the subdivision of the experimental data base is necessary: parts of transient, different geometry or locations in the facility, presence of specific phenomena. It has to be checked if there are enough experimental data and if variations in the code of each uncertain parameter can be easily realized.

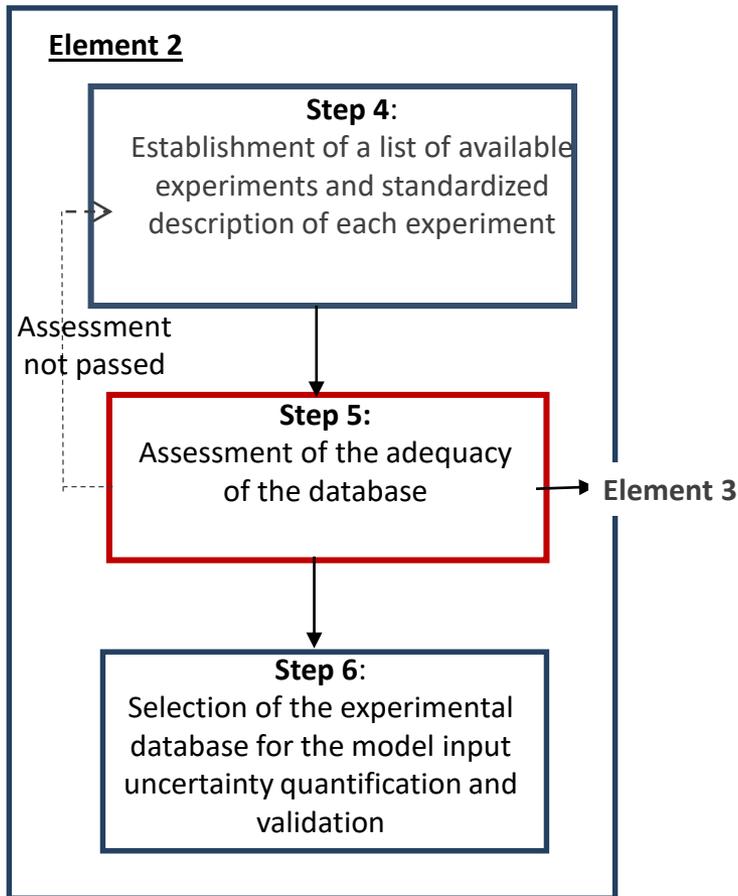
Reference: J. Baccou et al., Development of good practice guidance for quantification of thermal-hydraulic code model input uncertainty, Nucl. Eng. Design (2019)



In order to help at selecting an experiment, a **proposal of the standardized description of a test** is given in the SAPIUM guide

Criteria/items	Test XXX
Type (SET, IET, CET, ...)	
Component and/or reactor if interest	
Working fluid (steam water, simulant fluid ...), Material properties	
Range of main parameters pressure, mass flux, quality or void fraction, heat flux...	
Geometry	
Scale (vertical scale, volume scale wrt component or NPP)	
Covered phenomena	
Covered model	
Validate complete system, subsystem, component	
Available measurements	
Instrumentation (tool used for data measurement)	
Data access condition	
Available documentation/reports	
Publications	

The experimental uncertainties have to be identified
Important for estimation of experimental uncertainties and qualification of measured data is repeatability of the tests.



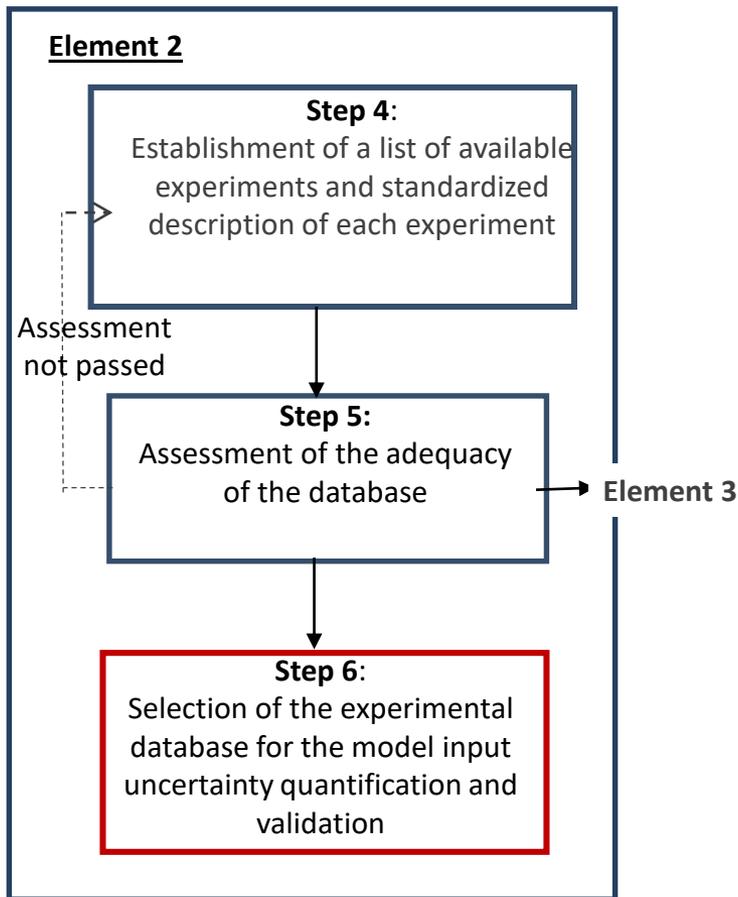
Element 2 requires the introduction of criteria to evaluate the **adequacy** of an experiment that depends on the analyst's objectives.

Adequacy:

- **Representativeness:** ability of an experiment to provide relevant information for model input uncertainty quantification and validation
- **Completeness:** ability of a set of experiments to fulfill the whole specifications of the problem under study e.g. cover the physical space of interest

Exploitation of formal methods such as multicriteria decision analysis method (ELECTRE, Analytical Hierarchical Process) to objectively and automatically analyze experiments according to their adequacy.

Predictive Maturity Indexes (PMI)] could be used to progress on the definition of adequacy criteria and metrics.

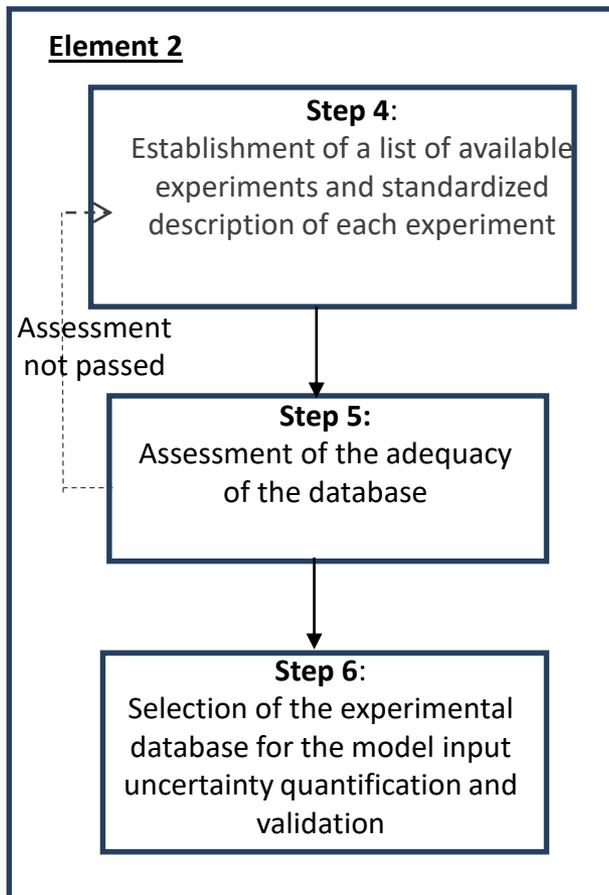


Step 6: **Selection of the experimental database** for the model input uncertainty quantification and the validation according to PIRT (Element 1) and to the adequacy and completeness assessment (Element 2, step 5).

Typical for definition of model input uncertainties is **application of SETs for quantification** of model input uncertainties and **validation** of quantified model input uncertainties **on the basis of IETs**.

Quantification of model input uncertainties on the basis of CETs, when several phenomena occurs simultaneously and several models input uncertainties have to be quantified in the same procedure, is a difficult task.

With increasing accuracy of uncertainty analysis and improving methodologies, CETs are more and more used also for model input uncertainties quantification



Open issue: Adequacy of the experimental database

The quantified model input uncertainties strongly depend on the adequacy of the experimental database.

Two aspects should be further investigated

- quantitative analysis of a database and to the construction of representativeness and completeness indices. Several generic tools are already developed but their extension to the framework of IUQ still remains an open issue
- lack of experiments: impact on the acceptability of the quantified model input uncertainties?



**THANK YOU FOR YOUR
ATTENTION**