Implementation of Common Industry Safety Analysis Codes

by

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Submitted to the
Twentieth Annual Conference of the Canadian Nuclear Society
Montréal, Québec, Canada
May 30 - June 2 1999

The safety analysis of CANDU reactors requires large and sophisticated computer codes. In the early days of CANDU, these were developed by the designer. As utilities, particularly Ontario Hydro, took over more of the project execution of their reactors, and had to maintain the safety analysis of the operating units, they developed customized versions of these codes, or new codes completely. The net result was that two complete code suites were being developed and maintained.

Although the codes in these suites had been validated against experiment as they were developed and used, the methods were not formal and were therefore difficult to audit for completeness. The Canadian nuclear industry therefore began a programme of formal validation and verification in the mid 1990s, the objectives of which were to demonstrate a very low likelihood of significant errors or unquantifiable uncertainties in the codes, and to provide a documentation base which would demonstrate to a regulator that the job was done properly. In addition AECL wished to demonstrate to its foreign customers that the CANDU codes had undergone a thorough and formal validation.

It was quickly apparent that the formal validation/verification was costly; and that substantial savings in both manpower and expenses were there for the taking if the efforts could be combined. AECL and the utilities therefore began a systematic evaluation of all safety analysis codes, with a view to selecting a reference code *and* code version to be validated, verified, and used by the entire industry. This code would then be called an “Industry Standard Tool”, or IST. Other less quantifiable advantages of adopting ISTs were: best use of scarce specialized expertise both in the industry and at the regulator; consistent positions internationally and domestically; synergy among code developers at utilities and AECL; and ease of sharing work among organizations.

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The bases of code selection were however to be technical and business-oriented. An industry-wide Steering Committee was set up to determine policy, and make final decisions on the technical and business cases in each discipline; and expert Working Groups were tasked with detailed evaluation. The process was as follows:

- candidate disciplines for selection of an IST were identified by the Steering Committee, the Working Groups, or individuals
- the Steering Committee decided if the opportunity was worth pursuing, and if so, struck a special Working Group to review the discipline in detail
- the Working Group determined the technical requirements across the industry; assessed candidate codes against these requirements; estimated the amount of work required; developed a preliminary business case showing the net savings to be achieved by adopting a single IST versus proceeding separately; and made a recommendation on the code.
- the Steering Committee endorsed the recommendation
- the Working Group then developed a detailed implementation plan and schedule (Programme Execution Plan, or PEP) which listed the work required to implement the IST, the schedule, and the sources of manpower, broken down by task and organization. Approval of this PEP by the Steering Committee finalized and formalized the plan.

The result was successful in almost all areas, except for system thermohydraulics, where the investment required either to converge on a common tool, or for one party to switch tools, was so large as to make the business case marginal.

Once an IST had been adopted, the PEP was executed by the participants. Most PEPs are now in place and are beginning to be executed.

For each IST, a “host” organization is nominated, charged with controlling and maintaining the authorized IST version, determining user requirements through User groups, and co-ordinating development, verification, and validation. The actual work on each code is not restricted to the host, but is done by each organization in accordance with the PEP. The QA requirements are set by the host, but must meet those of participating organizations, with the host treated as a third-party code supplier.

To date the following tools have been adopted as ISTs:

Discipline	*IST Computer Code*
Lattice Physics	WIMS-IST
Core Physics	RFSP-IST
Containment Themohydraulics	GOTHIC-IST
Moderator Circulation	MODTURC-CLAS-IST
Fuel Initial Conditions	ELESTRES-IST
Fuel Transient Behaviour	ELOCA-IST
Moderator Behaviour for In-Core Break	TUBRUPT-IST
Fission Products from Fuel	SOURCE-IST
Fission Products in Containment	SMART-IST
Severe Core Damage	MAAP-CANDU-IST

Further IST candidates are under discussion and development.