HUMAN FACTORS IN THE CANADIAN NUCLEAR INDUSTRY: FUTURE NEEDS

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Abstract

Currently the industry is facing refurbishment and new builds. At present most licensees in Canada do not have sufficient numbers of Human Factors staff. As a result, the activities of the CNSC are too often focused on providing guidance regarding the application of Human Factors, in addition to reviewing work submitted by the licensee. Greater efficiencies for both the licensee and the CNSC could be realized if licensee staff had greater Human Factors expertise. Strategies for developing Human Factors expertise should be explored through cooperative partnerships with universities, which could be encouraged to include Human Factors courses specific to nuclear.

AT PRESENT

Currently only some of the larger licensees in Canada have Human Factors specialists permanently on staff, and those resources seem generally insufficient for the volume of work under way. Over the next decade the nuclear industry in Canada will be facing an enormous amount of work in new builds, refurbishments, the management and disposal of radioactive waste and, potentially, decommissioning. In addition, smaller licensees in Canada often struggle trying to locate and engage Human Factors consultants, and since the number of Human Factors consultants working in the nuclear industry is small, these licensees often end up trying to do the Human Factors work themselves. Because of these limited resources, the scope of work handled by staff doing Human Factors work at both large and small licensees is often restricted to very specific aspects of design. This overlooks other important issues not related to design, but which are important Human Factors considerations. While the Canadian Nuclear Safety Commission (CNSC) is sympathetic to the situation, the fact of the matter is this: there are not enough Human Factors specialists available to licensees in the nuclear industry in Canada. This unavailability of Human Factors specialists will certainly be a challenge for the future.

THE PROBLEM

Ideally a licensee would have Human Factors specialists available to them for the various projects being contemplated. Such a specialist would be involved in the project from its inception, and Human Factors would be built into the engineering design process throughout. As part of a well-running engineering process, for a new design project or a major design change, the Human Factors specialist would prepare for submission to the CNSC various documents like a Human Factors Engineering Program Plan (HFEPP) and a Verification and Validation Plan (V&VP). The Human Factors specialist would have no difficulty interpreting regulatory documents like G-276 (Human Factors Engineering

Program Plans) and G-287 (Verification and Validation Plans). They would understand correctly the principles of Human Factors, what is required in HFEPPs and V&VPs, and would indicate appropriately in the submissions the rigor and depth that is necessary for completing the Human Factors work. This would include discussion of when and what type of analytical methods would be used, the areas of focus, etc. Competence in Human Factors would result in the submission of an HFEPP (and other documents) that meets CNSC expectations.

In a situation where a licensee does not possess adequate Human Factors expertise, however, Human Factors specialists at the CNSC find themselves having to spend more time than is desirable guiding licensee staff in carrying out Human Factors activities. This usually includes more than just stating CNSC requirements, and at times can almost breach the boundary between reviewing the work and telling the licensee how to do the work. Often it can involve CNSC staff trying to explain to licensees what the various analytical methods are that could be used, how they should be applied, where to focus the efforts, how the results should be used, and so forth. Normally the role of CNSC Human Factors staff is to define expectations for Human Factors as applied to the work done by licensees, to communicate those expectations, and to review submissions made by licenses in response to those expectations. Licensees are expected to already have Human Factors expertise at their disposal. Without adequate involvement of licensee Human Factors specialists in the various projects, however, certain tasks may not be done, or may be done incorrectly, in other words, done in a manner that does not meet acceptable international Human Factors standards for best practice. Such a situation is time-consuming, inefficient, and very frustrating for both parties, not to mention that submissions or applications made to the CNSC may be found unacceptable. On the other hand, successful applications characteristically exhibit quality Human Factors work. More qualified Human Factors specialists available to licensees would mean less time spent by the Regulator doing such activity, and more efficient and cost-effective time spent regulating. This would result in savings by the licensee in terms of regulatory effort, and also in the amount of effective time spent by licensee staff doing Human Factors work (since they would be more efficient at doing it). The more important direct and significant consequences, though, would be a reduction in human error, and the optimization of safe operations. While CNSC staff members want licensees to succeed, they are limited in how far they can, and should, go in helping a licensee with Human Factors work. CNSC Human Factors staff can state the expectations, and what type of submissions and the content of those submissions would likely satisfy the expectations, but they have to draw a fine line between saying what to do and how to do it. To do otherwise presents a conflict of interest. Unfortunately, licensees sometimes see this as the Regulator being uncooperative or even obstructionist. This is not the intention of CNSC Human Factors staff.

On the matter of expectations and standards, one observation made by the CNSC is that licensees who do not have adequate support by Human Factors specialists seem, for the most part, to be to a large degree unaware of the Human Factors standards and guidance materials that are available and which should be used in doing Human Factors work. Such documents capture what are considered “best practices” in the sense that by

following the guidance presented in such documents one can produce a design that does not force (create) errors during use. As is well known, errors may lead to significant events, which can be very costly. The use of Human Factors standards is, therefore, highly recommended in any Human Factors work. In a nutshell, it pays to do it right, right from the beginning. The US NRC, IAEA, IEEE, IEC and other organizations have Human Factors standards that are applicable to various aspects of design work in the nuclear industry. If a licensee completes the Human Factors work without using acceptable Human Factors standards, or without applying such standards from the earliest stages of design, then any submissions made to the CNSC are likely to be found unacceptable. Qualified Human Factors specialists would know about and be able to use such standards without difficulty, producing documents (and work) acceptable to the CNSC.

To give the situation some context, the CNSC Human and Organizational Performance Division (HOPD) currently has a complement of six full-time Senior Human Factors Specialists, two part-time Senior Human Factors Specialists, and one Human Factors Analyst. While this may sound like a lot, in reality it is not, given the number of licensees covered by the CNSC scope of activities. As a start, CNSC Human Factors staff regulates the nuclear power plants (NPPs), and for each of those there are a number of different issues that must be addressed (such as hours of work, significant events, design changes, human performance, procedures, etc.) In addition to that, some of the NPPs are undergoing refurbishment, and that also requires attention by the CNSC. Regulating the activities of one nuclear power plant requires the full-time efforts of one CNSC Senior Human Factors Specialist for each NPP. CNSC Human Factors staff also regulate research reactors and their associated facilities, accelerators, mines and mills, uranium processing and fuel fabrication facilities, and to some extent industrial radiography matters. Furthermore, there are the new builds, which include not only the power plants, but also accelerator facilities, mines and mills. Finally, there is a degree of decommissioning and disposal-related activity that also requires attention. As a result, the CNSC Human Factors staff has a heavy workload, all the time. The unfortunate result of this, in combination with the significant amount of time and effort that must be spent guiding licensees in the application of Human Factors, is that it makes turnaround time for regulatory reviews and response less than ideal. Given that work done by licensees and by CNSC staff is driven by licensing, priorities for completion of Human Factors reviews and other work must fit into the schedules set by licensing. Under the current circumstances, an application that is likely to succeed is one within which high-quality submissions clearly exhibit the appropriate consideration of Human Factors. If the nuclear industry could acquire a significant force of Human Factors competence, then CNSC Human Factors staff could focus their efforts on the purely regulatory activities, and would be more able to cope with demand. In consequence, licensees would be able to proceed with their various projects in the happy knowledge that the Human Factors work would be of high quality, and that they would be able to obtain approvals more quickly and with savings in time and money.

As you know, applying Human Factors is important to safety, which is important to a smoothly-running operation. It therefore makes good business sense to apply Human

Factors appropriately and efficiently from the earliest moments in a project. The needs of a high-reliability industry such as nuclear require that Human Factors specialists be knowledgeable in the various issues and activities important to carrying out Human Factors work. This includes a competent understanding of analytical methods, human error, and the engineering design process, among other things. In the past, the CNSC Human Factors staff has found themselves in the position of having to explain to licensees, some of which claimed to have *bone fide* Human Factors specialists on staff, the difference between Human Factors verification and validation, how to do a validation exercise, how to do a function analysis and allocation, the difference between task description and task analysis, what should be included in an HFEPP, what type of Human Factors issues should be considered in design work, what Human Factors issues should be considered outside design, and the importance of using widely accepted Human Factors standards. Having more appropriately qualified Human Factors specialists in Canada, and available to licensees, would cut down the oversight work required by CNSC Human Factors staff, vastly improve the quality of Human Factors work enjoyed by the licensees, and would allow for improved efficiencies in the regulatory process.

WHAT TO DO ABOUT IT

A first option would be to ask that universities include training on Human Factors in their nuclear engineering programs. This would not be seen as particularly desirable, however, since it could be expected that only a small subset of the topics and issues relevant to applying Human Factors in the nuclear industry would be taught to nuclear engineers. After all, they went into a nuclear engineering program to become engineers capable of designing nuclear facilities, not to do Human Factors.

A second, more palatable option would be for licensees (namely all types of licensees, not just the nuclear power plants) to develop cooperative partnerships with universities such that the universities may focus on providing newly graduated students with the necessary skills to start work in a Human Factors position at a Canadian nuclear licensee with little in the way of a learning curve. This is different from the current practice of merely recruiting the few Human Factors-qualified students who graduate from existing programs in engineering at the larger universities in Canada. In such a partnership, industrial engineering, engineering psychology, ergonomics, nuclear engineering, or design engineering programs could include a Human Factors stream, or even develop a specialty program in Nuclear Human Factors (that is, Human Factors as applied specifically to the nuclear industry). To be blunt, the issue is about changing and improving the university curriculum, or creating a new program called Nuclear Human Factors, such that more coverage of Human Factors issues important to the nuclear industry in Canada is available. Given the amount of work to be done in the Canadian nuclear industry over the coming years, there would be no lack of employment for students coming out of such a program, either as full-time licensee staff or as independent consultants. In the light of this, it does not seem that it would be problematic to convince universities that such a program would be in demand, unlike some of the others programs that are being phased out due to lack of demand or employment for graduates.

In the few programs in Canada that focus on Human Factors, students do not learn about the application of Human Factors to any industry in particular. Students are taught the basics of ergonomics, human capabilities and limitations, and some coverage of analytical methods and techniques, depending on the particular program in question. In general, students graduate from such programs in need of a significant amount of time to overcome the learning curve necessary to get in step with the demands of whatever industry they enter. The nuclear industry, existing as a high-reliability industry with its brethren in aviation, petroleum, chemical, and aerospace, requires standards that are more demanding than those seen in many other industries. There is, therefore, a need in this industry for a much broader awareness and consideration of issues significant to the safety of the public, workers, and the environment. Such could be provided, in part, through a specialized course in Nuclear Human Factors. In addition, education at the university level could include the basics of Human Factors in design, but also on the necessity for significant attention to detail and rigor of the application of Human Factors principles and practices in this industry, training development, event analysis, hours of work, procedure development, and other issues of importance.

CNSC Human Factors Specialists recommend that a course in Nuclear Human Factors could cover the following topics:

- Nuclear Safety and Control Act and its Regulations.
- CNSC Human Factors standards, guides, and expectations
- Human Factors methods and analytical techniques,
- Internationally accepted Human Factors standards,
- Human Factors in design,
- Procedures development,
- Hours of work,
- Human performance,
- Human reliability analysis,
- Significant events and root cause analysis, and
- The systematic approach to training program development (SAT).

CNSC Senior Human Factors Specialists welcome the idea of such a program, and would be willing to participate in the development and delivery, in part, of the program. This could include entering into discussion with licensees regarding the expectations that the CNSC has with regard to qualifications and competencies that licensee Human Factors staff should have, what direction the university programs could be encouraged to take, as well as delivery of some of the course material. CNSC Human Factors staff could provide information regarding consideration of the Nuclear Safety and Control Act and its Regulations as relevant to Human Factors. In addition, they could present information regarding CNSC regulatory documentation, international standards and guidance, and the expectations for Human Factors as applied to the various types of facilities and their associated activities. Finally, CNSC staff could discuss what is expected in terms of Human Factors input to design. The university (qualified Human Factors) staff would provide the basic Human Factors material such as coverage of human capabilities and limitations, physical ergonomics, and analytical methods and techniques. All this

material would be relevant to all aspects of the Canadian nuclear industry, and not specific to any one licensee.

Such a program could be seen as a valuable and forward step in improving the safety, efficiency, and cost-effectiveness of the nuclear industry in Canada. One potential vehicle which already exists in Canada, and which could be used to achieve this goal, is the University Network of Excellence in Nuclear Engineering (UNENE), in which the CNSC plays an active role. This alliance of universities, nuclear power utilities, research and regulatory agencies might be in a position to modify their efforts towards assuring not only a sustainable supply of qualified nuclear engineers and scientists, but also Nuclear Human Factors specialists.

WHEN

The time to act is now. The nuclear industry in Canada is just now starting the activities necessary to build new facilities and to refurbish the older ones. Building a new nuclear power plant will take anywhere from four to seven years, after passing the environmental review, while refurbishment could be considered to take a bit less time. By entering into discussions with universities now, and with a year or so to develop and initiate new Nuclear Human Factors programs, fresh graduates ready to hit the pavement running, so to speak, could be available in six years, just in time for the surge of need. In other words, the wheels must start turning now if the industry is to avoid a significant and obvious lack of qualified Human Factors staff that will be needed in the near future.

THE RESULTS

By encouraging universities to develop programs in Human Factors that are relevant to the needs of the nuclear industry, licensee capabilities in Human Factors could be enhanced significantly in the near future. There would be little or no learning curve for new graduates hired or contracted by licensees, yet the CNSC Human Factors staff would enjoy reduced oversight for licensee work, and submissions would be more likely to meet CNSC expectations. Additionally, there would be better coverage of Human Factors issues, a considerable improvement in efficiencies, and savings in cost and effort. Finally, improvements to safety for the public, workers, and the environment could be realized. Licensees currently have the opportunity to choose the direction the future will take as it pertains to the application of Human Factors in the nuclear industry in Canada. CNSC Human Factors staff hopes that this opportunity will not be missed.

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