



Safety culture in the nuclear industry

a constant priority

Safety culture reflects the concerted effort taken at all levels of management and execution to collectively ensure the safe operation of a facility. It covers all organisations and industries, not just nuclear. But because not everything can be written in the rule book, and because nuclear safety has to anticipate issues before they are even thought of, it is up to each individual to continually develop their own safety culture, rather than simply complying with regulatory imperatives.

Jean-François Bossu **Nuclear Risk Management Director**

A nuclear engineer and former Officer in the French Navy, Jean-François has fifteen years' experience in the operation and maintenance of marine propulsion nuclear reactors. For the past twenty years he has worked on complex nuclear systems projects and nuclear safety control and audit missions. He has also recently become a member of the permanent working groups of experts in nuclear reactors and power plants set up by the French Nuclear Safety Authority (ASN).



The risks and rewards of nuclear power

The advantages of nuclear power are well known in our day and age. It is a carbon-free energy, with uninterrupted production and controlled and foreseeable production costs. Nuclear waste is managed very carefully and solutions now exist for reducing its volume and the related hazards. In an increasingly electric and digital world, the uses of electricity are changing, but the trend is very clear: worldwide electricity consumption is increasing in line with global population growth. According to a report published by Bloomberg New Energy Finance (BNEF), global electricity demand is expected to rise by 57% by 2050.

“More than ever before, tomorrow’s nuclear industry has to be ultra-safe”

Solar and wind power are part of the electricity production mix, but their average capacity is still low, and, more importantly, they can only provide intermittent supply. These energies therefore still need to be backed up by a high-capacity production source that can be efficiently and effectively managed. Because even if we smooth out energy consumption across the grid, in the way that “smart cities” do for example, it won’t be enough to completely make up for the fluctuating power output

of renewables. That’s why even countries where sunlight is readily available – like Turkey, Saudi Arabia and Egypt – are moving towards nuclear energy.

Nuclear power will therefore play a central role in the global energy mix during this century. However, its growth will be dependent on it being accepted by all populations across the globe – populations who are placing increasing importance on safeguarding the environment and protecting their own safety in the face of industrial risks. More than ever before, tomorrow’s nuclear industry has to be ultra-safe.

Reassuring people is no longer enough. Gone are the times when people based their trust on reputation or perceived quality.

Today they want to see how nuclear facilities will hold out against all conceivable hazards, which since Fukushima, go beyond what is either known or foreseeable. Nuclear facilities need to be totally resilient, run by highly qualified people and underpinned by a robust nuclear safety culture. And obviously, they need to be placed under the oversight of independent authorities that are completely free of any form of pressure and are capable of making safety judgments about both nuclear systems and

nuclear operators. In France for example, the independent regulatory authority is the Nuclear Safety Authority (Autorité de Sûreté Nucléaire –ASN).

Nuclear security or nuclear safety?

Nuclear security is defined by law and responds to the public need for a guaranteed safe and healthy environment, irrespective of how facilities are actually run. For national governments this means making sure that risks and hazards are kept to a minimum and, in all cases, below the levels deemed acceptable by populations as indicated in the results of public consultations.

The risk management process leads to the implementation of preventive actions to ensure nuclear safety and protection against radiation, as well as measures to mitigate the consequences of any incidents, with the anticipation of any malicious acts and the preparation of crisis management systems. Nuclear security is always the responsibility of the nuclear operator. It is the operator that, under the supervision of the country’s safety authority, establishes the technical and organisational measures designed to reduce the probability of an incident as well as limiting the consequences should any incident actually occur. This approach is followed throughout the lifespan of a nuclear facility, from design to decommissioning.

Technical measures are clearly where engineers have an important role to play, because they are the ones who need to design and then modify systems that are safe and



can resist all forms of damage and deterioration over time. Engineers prepare safety analyses which cover the whole process, from the initial examination of a potential site through to assessments of the facility's operations and its resistance to the widest range threats and attacks. These safety analyses have to be regularly carried out throughout the facility's lifespan so as to ensure that in real-life operations its installations are operating in accordance with the analytical data.

The analyses are underpinned by design, manufacturing and control standards that enable the applicable requirements to be standardised across all levels of the sub-contracting chain. Standardisation helps reduce the risk of failure to communicate directives.

Nuclear quality

Nuclear operators have an absolute obligation when it comes to reducing risks. This obligation is met by respecting general principles and the specified requirements for each component of a facility identified as important for protecting the interests defined by law. In line with the guidance of the International Atomic Energy Agency (IAEA), the regulations in force in the IAEA's Member States all constitute a set of provisions imposing controls designed to detect and correct discrepancies in a transparent and traceable way.

This illustrates the vital need for quality in all nuclear activities. Most players in the sector already have ISO 9001 certification, which

sets requirements for quality management systems. And recently a new standard was released – ISO 19443 – which contains specific requirements for the application of ISO 9001 in the nuclear industry and encompasses the international guidance issued by the IAEA and other leading standards such as the US Nuclear Quality Assurance (NQA) standards.

of the risk analyses performed on nuclear installations and systems. Developing a safety culture concerns all players in the nuclear industry. In each of IAEA's Member States, operators, sub-contractors, engineers and administrations constitute a community serving nuclear safety, which goes well beyond a simple ecosystem. This allows a common core of nuclear safety concepts to be applied in all

“The recently issued quality standard, ISO 19443 – which is specific to the nuclear industry – encompasses the international guidance issued by the IAEA as well as NQA and other leading standards”

In France, the nuclear operator, EDF – one of Assystem's key partners – is putting in place an industrial excellence plan – “excell” – for its entire nuclear business. The main focus of this plan is on the quality of construction and on-site assembly. Assystem is helping with this process, using systems engineering and digital solutions in the safety assessments it is producing as part

countries alongside local experience and needs.

Nuclear safety culture

When international bodies refer to “safety culture” they mean behaviours and attitudes in relation to addressing nuclear risks. Defined in particular by the IAEA, safety culture reflects the concerted effort



taken at all levels of management and execution to collectively ensure the safe operation of a facility. It is a mix of attention, care and rigour but also incorporates technical culture, intellectual curiosity, know-how, awareness and decision-making.

Naturally, safety culture is not just specific to the nuclear industry. Similar approaches are used in other high-risk industries (such as public transport, chemicals and pharmaceuticals) and in the medical sector. In all of these domains, there are protocols and procedures that make up a vast and detailed regulatory framework. Everything

It cannot be denied that maintaining over the long term the focus – and also the skills – needed to develop a safety culture is very difficult. That is why not only regulatory authorities, but also internal controllers (inspectors, quality departments) play such an essential role in the nuclear industry. Accepting these controls is, in itself, an expression of safety culture.

Safety inspections and assessments alone are not sufficient for achieving and maintaining the extremely high level of control needed and expected for nuclear risks. Nuclear safety is an ongoing

organisational factors (HOF) in high-risk activities. Out of the three pillars of nuclear safety culture – a rigorous and prudent approach, a questioning attitude and clear communication – this third pillar isn't necessarily the easiest. Feedback from on-site activities and management reporting necessarily go hand in hand with one another. Consequently, managers not only need to be rigorous, they also need to build up relations of trust.

Managing nuclear risks over the long term

As mentioned in the introduction above, nuclear energy is on course for worldwide growth, provided it can demonstrate ultra-high levels of security and therefore fully controlled nuclear safety. That is exactly why generation III+ reactors were developed. And a range of other factors also contribute to the overall safety process.

Demand for electricity is growing and it is becoming a basic commodity, not only as a source of energy but also because it is indispensable for today's new consumer usages such as data exchange. This means that people will expect to have access to a reliable power supply. Because production and distribution of electricity has to be both safe and reliable, safety improvements will have to be made without any interruption in service. Hence the importance of engineering, because it seeks to eliminate anything that could lead to the simultaneous stoppage of several units of a facility. All of these factors clearly demonstrate the need to carefully manage the long-term life of existing

“**Accepting the multiple controls necessary in the nuclear industry is, in itself, an expression of safety culture**”

is highly regulated and thought out in advance. But because not everything can be written in the rule book, and because nuclear safety has to anticipate issues before they are even thought of, it is up to each individual to fully understand what safety entails and the challenges it represents. This means that everyone has to continually develop their own safety culture without waiting for regulatory imperatives such as inspections or ten-year audits.

process, a collective effort that involves each and every player in the industry, whatever their position in the sub-contracting chain and whatever their professional domain. It's all about teamwork, steered by strong management. And strong management doesn't just mean being rigorous – a good manager needs to know how to be kind and caring too. That is the whole importance of taking into account human and



reactors and therefore their ageing process, which requires close control over their operation and maintenance.

Going forward, nuclear power is also going to be the primary energy source for increasingly diverse usages, such as heat production (as it is already the case in China), seawater desalination and hydrogen production. For the latter use, processes are going to be needed that ensure the safety of both the nuclear power operation and the production of hydrogen. These new usages are obviously going to lead to new angles of approach to safety analyses.

As usages diversify, new types of reactors will have to be designed, such as new forms of fusion reactors, fast-neutron reactors, very-high-temperature reactors, and reactors using fuel sources other than uranium. Choices will have to be made to strike that all familiar balance between safety improvement and financial resources. For example, using groups of Small Modular Reactors (SMR) – which are smaller than conventional reactors – only makes sense if the reduction in size allows technological break-throughs and design and build gains without in any way impacting safety. Lastly, and very importantly, the reactors of the future are going to have to be operated by many new market entrants, which means they'll need a high level of intrinsic safety.

What remains fundamentally clear is that nuclear safety will play a central role in all of these developments as it is an essential link in the chain of environmental safety and protection. So much so that safety culture expertise will undoubtedly be highly sought after among future nuclear technicians and engineers. ■

“Accepting the multiple controls necessary in the nuclear industry is, in itself, an expression of safety culture”