NOTE FROM THE EXECUTIVE BOARD

It is indeed a great honour to welcome you all to the Committee for Legalisation of Banned Technologies at VITTUC 2017. We congratulate you on your decision for being a part of the CLBT. The executive board will leave no stone unturned to assure quality debate in the committee.

To the veterans of MUN, we promise you a very enriching debate that you've never experienced before and to the newcomers, we are really excited to be a part of your maiden voyage.

The agenda to be discussed in CLBT has a very wide scope and is very imperative to discuss in the current times where the need for energy sources is increasing exponentially. The study guide just gives the gist of the agenda and does not exhaust it. Also, any point mentioned in the study guide cannot be used to substantiate the speeches of the delegates.

You are the representative of your allotted country/company and it is our hope that you put in wholehearted efforts to research and comprehensively grasp all important facets of the diverse agenda. All the delegates should be prepared well in order to make the council's direction and debate productive.

Reuters, Government Reports, UN reports shall be considered as credential proofs in committee while any further reports from Regional/International News Agencies shall be considered as persuasive proof.

Delegates will be allowed to bring laptops, tablets or any other electronic devices to the council but will not be allowed to access internet when the lines of communication will be closed. In the end, have fun in the committee and make yourself comfortable without getting intimidated by your Executive Board and fellow delegates which shall ensure better flow of debate. Feel free to contact us in case of any doubts or discrepancies.

Samarth Kapur
Chairperson

Sabiq Ali Chaudhary
Vice-Chairperson

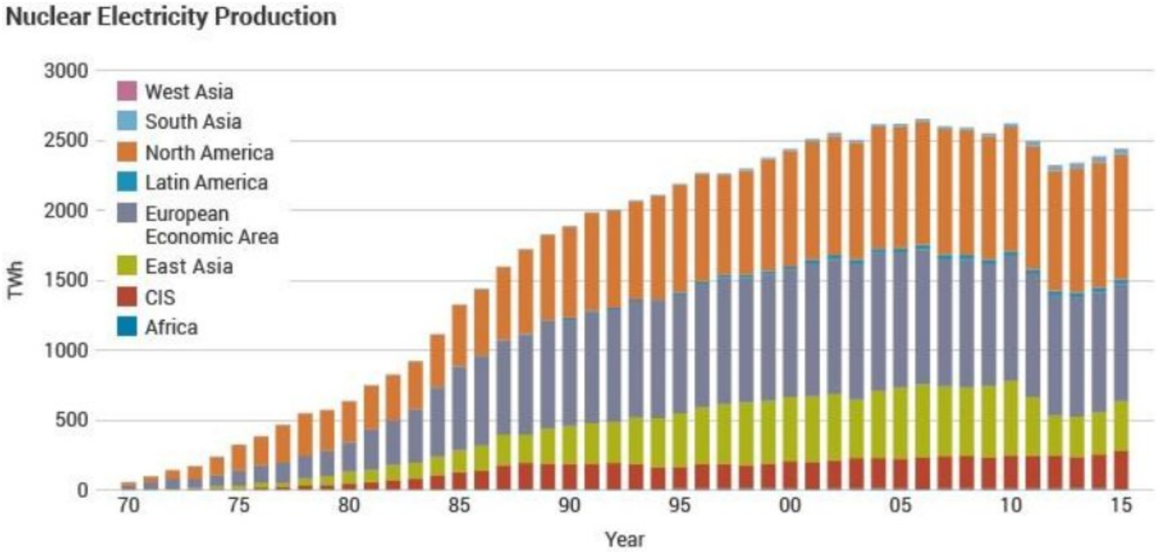
INTRODUCTION TO THE AGENDA

Nuclear technology uses the energy released by splitting the atoms of certain elements. It was first developed in the 1940s, and during the Second World War to 1945 research initially focussed on producing bombs which released great energy by splitting the atoms of particular isotopes of either uranium or plutonium.

In the 1950s attention turned to the peaceful purposes of nuclear fission, controlling it for power generation. Today, the world produces as much electricity from nuclear energy as it did from all sources combined in the early years of nuclear power. Civil nuclear power can now boast 17,000 reactor years of experience and supplies almost 11.5% of global electricity needs, from reactors in 31 countries. In fact, through regional transmission grids, many more than those countries depend on nuclear-generated power.

Many countries have also built research reactors to provide a source of neutron beams for scientific research and the production of medical and industrial isotopes.

Today, only eight countries are known to have a nuclear weapons capability. By contrast, 55 countries operate about 245 civil research reactors, over one-third of these in developing countries. Now 31 countries host some 447 commercial nuclear power reactors with a total installed capacity of over 390,000 MWe . This is more than three times the total generating capacity of France or Germany from all sources. About 60 further nuclear power reactors are under construction, equivalent to 16% of existing capacity, while over 160 are firmly planned, and equivalent to nearly half of present capacity.



Sixteen countries depend on nuclear power for at least a quarter of their electricity. France gets around three-quarters of its power from nuclear energy, while Belgium, Czech Republic, Finland, Hungary, Slovakia, Sweden, Switzerland, Slovenia and Ukraine get one-third or more. South Korea and Bulgaria normally get more than 30% of their power from nuclear energy, while in the USA, UK, Spain, Romania and Russia almost one-fifth is from nuclear. Japan is used to relying on nuclear power for more than one-quarter of its electricity and is expected to return to that level. Among countries which do not host nuclear power plants, Italy and Denmark get almost 10% of their power from nuclear.

In electricity demand, the need for low-cost continuous, reliable supply can be distinguished from peak demand occurring over few hours daily and able to command higher prices. Supply needs to match demand instantly and reliably over time. There are number of characteristics of nuclear power which make it particularly valuable apart from its actual generation cost per unit – MWh or kWh. Fuel is a low proportion of power cost, giving power price stability, and is stored onsite (not depending on continuous delivery). The power from nuclear plants is dispatchable on demand, it can be fairly quickly ramped-up, it contributes to clean air and low-CO_2 objectives, it gives good voltage support for grid stability. Reactors can be made to loadfollow. These attributes are mostly not monetised in merchant markets, but have great value which is increasingly recognised where dependence on relatively unpredictable intermittent sources has grown.

NEED FOR NEW GENERATING CAPACITY

There is a clear need for new generating capacity around the world, both to replace old fossil fuel units, especially coal-fired ones, which contribute a lot of CO_2 emissions, and to meet increased expectations for electricity in many countries. There are about 127,000 generating units worldwide, 96.5% of these of 300 MWe or less, and one-quarter of the fossil fuel plants are over 30 years old. There is scope for both large new plants and small ones to replace existing units 1:1, all with near-zero CO_2 emissions.

World Nuclear Association projections suggest a 30% increase to 510 GWe in operation in 2030 and overall 41% increase to 552 GWe in 2035. (Low and high projections are 376 and 643 GWe for 2030, and 367 and 720 GWe for 2035.)

The OECD International Energy Agency publishes annual scenarios related to energy. In World Energy Outlook 2016 they have an ambitious '450 Scenario' to constrain CO2 emissions. The World Nuclear Association has put forward a more ambitious and effective scenario than this, proposing the addition of 1000 GWe of new nuclear capacity by 2050, to provide 25% of electricity then (10,000 TWh) from 1250 GWe of capacity (after allowing for 150 GWe retirements by then). This would require adding 25 GWe per year from 2021, escalating to 33 GWe per year, which is not much different from the 31 GWe added in 1984, or the 1980s overall record of 201 GWe total. Taking nuclear power output to a quarter of the world total electricity production would have a very positive effect on air quality, reducing CO2 emissions, and boosting energy security without the complications of working around dispersed and intermittent renewable sources.

INTRODUCTION TO IAEA

Widely known as the world's "Atoms for Peace" organization within the United Nations family, the IAEA is the international centre for cooperation in the nuclear field. The IAEA serves as an intergovernmental forum for scientific and technical co-operation in the peaceful use of nuclear technology and nuclear power worldwide. The programs of the IAEA encourage the development of the peaceful applications of nuclear technology, provide international safeguards against misuse of nuclear technology and nuclear materials, and promote nuclear safety and nuclear security standards and their implementation.

HISTORY OF IAEA

The IAEA was created in 1957 in response to the deep fears and expectations generated by the discoveries and diverse uses of nuclear technology. The Agency's genesis was U.S. President Eisenhower's "Atoms for Peace" address to the General Assembly of the United Nations on 8 December 1953.

The U.S. Ratification of the Statute by President Eisenhower, 29 July 1957, marks the official birth of the International Atomic Energy Agency. In the press conference following the signing ceremony in the Rose Garden of the White House in Washington, D.C., President Eisenhower evoked his address to the UN General Assembly in December 1953, at which he had proposed to establish the IAEA. In October 1957, the delegates to the First General Conference decided to establish the IAEA's headquarters in Vienna, Austria.

IAEA IN RELATION TO SUSTAINABLE DEVELOPMENT GOALS

The IAEA plays an active part in helping the international community achieve the 17 Sustainable Development Goals (SDGs). It helps countries to use nuclear and isotopic techniques and thereby contribute directly to attaining nine of the 17 Goals:

- End hunger, achieve food security and improved nutrition and promote sustainable agriculture

- Ensure healthy lives and promote well-being for all at all ages

- Ensure availability and sustainable management of water and sanitation for all

- Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

- Take urgent action to combat climate change and its impacts

- Conserve and sustainably use the oceans, seas and marine resources for sustainable development

- Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

- Strengthen the means of implementation and revitalize the global partnership for sustainable development

ADDITIONAL PROTOCOL

The Additional Protocol is not a stand-alone agreement, but rather a protocol to a safeguards agreement that provides additional tools for verification. In particular, it significantly increases the IAEA's ability to verify the peaceful use of all nuclear material in States with comprehensive safeguards agreements.
In May 1997, the IAEA Board of Governors approved the Model Additional Protocol contained in INFCIRC/540 and requested the Director General to use this model as a standard text for the conclusion of additional protocols to comprehensive safeguards agreements.

STATUS OF ADDITIONAL PROTOCOL

As of December 2016, Additional Protocols are in force with 129 States and Euratom. Another 17 States have signed an Additional Protocol but have yet to bring it into force. One State provisionally applies an Additional Protocol to its comprehensive safeguards agreement, pending its entry into force.

STRENGTHENING THE IAEA'S SAFEGUARDS IMPLEMENTATION

The IAEA's experience in Iraq and the Democratic People's Republic of Korea in the early 1990s demonstrated that, although IAEA safeguards had worked well with regard to verification activities on declared nuclear material and facilities, it was not well-equipped to detect undeclared nuclear material and activities in States with CSAs.

At the end of 1993, the IAEA embarked on a broad programme to further strengthen safeguards implementation under CSAs by enhancing the IAEA's ability to detect undeclared nuclear material and activities. As part of the so-called Programme 93+2, measures designed to strengthen the effectiveness and efficiency of IAEA safeguards for States with CSAs were presented to the IAEA Board of Governors.

CORPORATE INVOLVEMENT IN NUCLEAR ENERGY

Nuclear science and technology face unique challenges with regard to public understanding and acceptance. It is generally recognized that nuclear applications contribute significantly to society through the generation of electrical energy and in medical and industrial applications. However, some stakeholder groups view these benefits as being outweighed by the issue of nuclear waste or by association of beneficial applications with nuclear weapons. Additionally, the fact that radiation is an invisible hazard; dread of its potential health effects often lead to perceptions by the public that the risks of nuclear energy are much greater than the risks that experts attribute to nuclear energy. Coupled with this is the nature of the nuclear industry as a major, long term political and economic commitment, highly technological and heavily dependent on hard scientific knowledge to deliver energy for consumers. These qualities make clear understanding or outright support by the general public difficult to obtain.

If nuclear programmes are to develop beyond current levels, it is essential that there is a common understanding of the associated issues among all stakeholders; both those immediately affected by proposed or operating facilities and those who simply benefit from them indirectly. Such understanding cannot exist without the availability of balanced information and appropriate stakeholder involvement in the decision making process.

Increased public participation in decisions can promote a greater degree of understanding of the issues and can help to develop appreciation of the actual risks and benefits of nuclear energy as compared to the risks and benefits of other energy sources. In order to develop and enhance public confidence, it is vital to provide suitable opportunities for stakeholders.

Of course, effective stakeholder involvement is not in itself a guarantee that a nuclear programme will be successfully implemented or a particular facility developed. However, increasing stakeholder involvement is a necessary condition for sustainability in most Member States that have nuclear power programmes. Governmental support is often dependent on stakeholder confidence, as national governments generally do not press ahead with nuclear programmes in the face of significant public opposition. Government support can be sustained through a positive and supportive political atmosphere, which includes appropriate stakeholder involvement.

. Two models of decision making can be observed in Member States. One holds that decisions about issues that are national in scope should be made at a national level, whereas another holds that where a national policy disproportionately affects a specific locality, then that locality should be given a disproportional role in related decisions. The transition between national policy decision making and local involvement in decision making is treated differently in Member States. However, stakeholder involvement can be vital in gaining and maintaining public support in either case.

Raising the importance of stakeholder involvement in decision making, particularly with reference to issues concerning waste management, has not long been in use in many Member States. Experience is beginning to remove doubts about the efficacy of this approach. Public consultation with the local community near proposed nuclear facility sites in the decision making process, has provided these communities some degree of control over their future. This will remain true for all nuclear facilities but especially in Member States with little or no prior use of nuclear energy.

It is important to emphasize the different levels of engagement that should be considered for stakeholder involvement. The spectrum ranges from: remaining passive with no engagement; to monitoring stakeholders views; informing; consulting; involving through working directly with stakeholders to ensure their concerns are understood; to collaboration where stakeholders are full partners in finding mutually agreed solutions. In a 8 stakeholder involvement strategy and plan, it is quite feasible that all of these levels might be used for different stakeholder groups.

INVOLVEMENT OF STAKEHOLDERS IN DECISION MAKING PROCESS

For the purposes of clarity in this report, decision making processes associated with nuclear facilities and their associated requirements with respect to stakeholder involvement have been divided into four nuclear facility/programme life cycle stages:

(1) Introduction of nuclear power programmes or new nuclear facilities;

(2) Operation of nuclear facilities;

(3) Expansion or extension of nuclear facility operation;

(4) Planning and implementation of nuclear facility decommissioning.

This sequence reflects the now well accepted principle of ‘stepwise decision making’ being adopted in most countries with regard to nuclear facility development, during which involvement may take the form of sharing information, consulting, dialoguing, or deliberating on decisions. In many Member States, the process was originally developed as a way of fostering stakeholder involvement in siting and operating waste disposal facilities. It is now being applied to all nuclear facilities, with public involvement an integral part, beginning with listening more to the public and their concerns.

The stakeholder involvement approach is in direct contrast to the earlier ‘decide, announce, defend (DAD)’ approach to making decisions about major projects in the nuclear field. Using a DAD approach, industry and government carry out early steps in private, with little or no public discussion, followed by an announcement of the result of the deliberations and a programme of ‘selling’ the decision to the public, regulators and planning authorities.

Exactly who the decision makers are in each stage will vary country to country depending on national legislation, regulations, and norms. However, often the main decision maker in the first phase is the national government, whose task it is to introduce a nuclear power programme and establish a regulatory body. While the last three phases, encompass a number of decision makers, government ministries, the operator/owner operator, and the regulatory body. Even local authorities may, in the second phase, be regarded as a decision maker, though; normally it is rather one of the main stakeholder groups. All of the above mentioned bodies should continually interact with stakeholders and appropriately involve them in the decision making processes.

In the course of facility construction and operation, the main challenges in terms of public support include meeting expectations for greater quality of life by members of the host community, mitigating construction nuisances, accommodating a growing population through the many years that a facility is in operation and assuring safe operation of the facility. During decommissioning of a facility, these challenges include development of alternative site uses and continued trust and confidence in the operator and regulator developed by the public during operation. The impacts of facility closure on the local community should not be underestimated. Experience shows that, even where a local community was originally against the development of a nuclear facility, they are usually also against its closure, especially if there are no plans for a replacement.

The issue of waste management actually transcends all of these stages in that it causes concerns whenever nuclear facilities of any kind are proposed. The slow progress in developing final disposal facilities in most Member States means that stakeholder discussions will need to address radioactive waste disposal. It should be noted, that while most nuclear facilities have a life time of less than a century, repositories are designed to carry out their function from several centuries to tens of thousands of years. Thus, with regards to stakeholder involvement, these activities require different justification and communication.

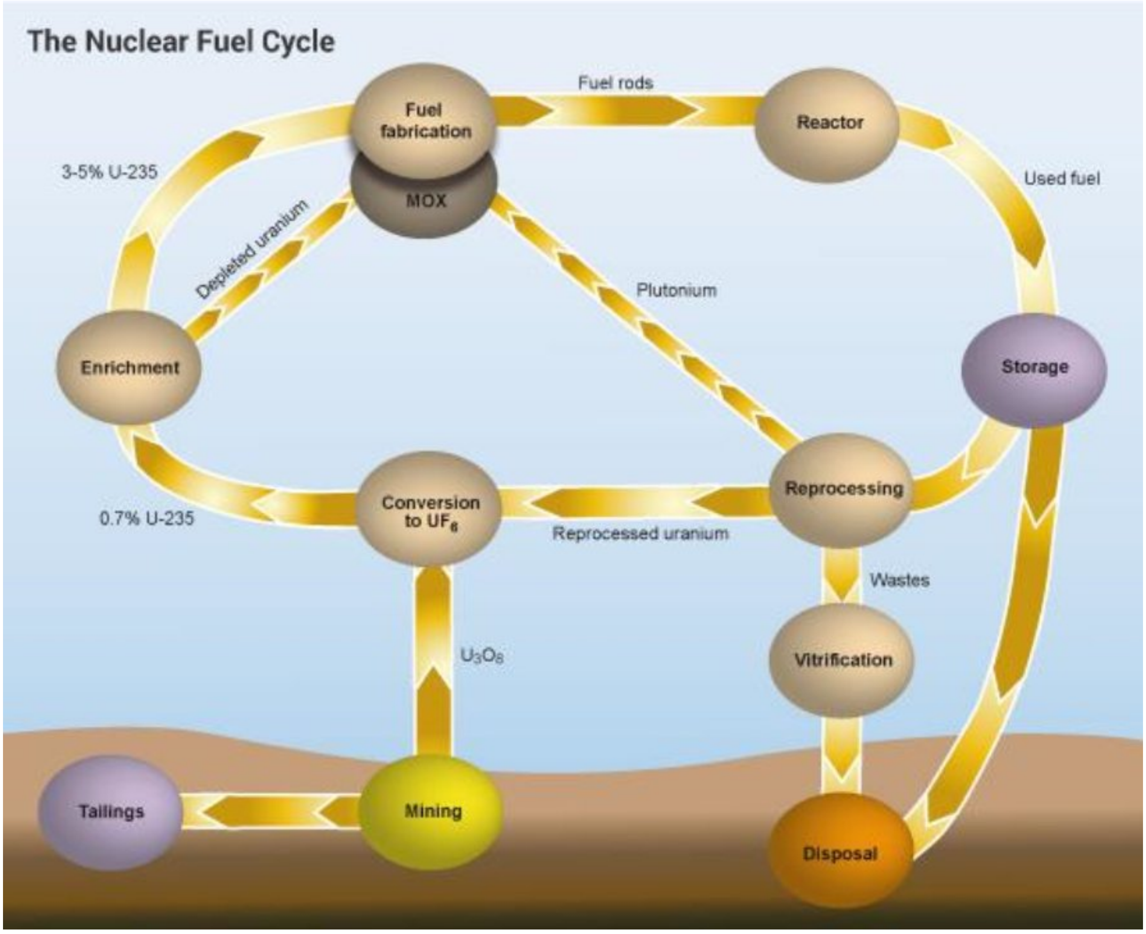
It is important to emphasise that stakeholder involvement is now a mandatory component of various international conventions and treaties that detail the role of governments and developers in the strategic environmental assessment (SEA) and environmental impact assessment (EIA), not just for nuclear facilities. Development of a major national policy, such as the introduction of a nuclear programme, is subject to SEA requirements, and specific facilities and activities are subject to EIA requirements. While not all Member States are signatories to the relevant conventions and treaties; such as Aarhus, Espoo, EURATOM or various EU Directives, 9 many of these instruments incorporate responsibilities to neighbouring countries. As such, many Member States will find themselves obligated to incorporate at least some level of stakeholder involvement during the 4 stages outlined in this section.

THE NUCLEAR FUEL CYCLE

The various activities associated with the production of electricity from nuclear reactions are referred to collectively as the nuclear fuel cycle. The nuclear fuel cycle starts with the mining of uranium and ends with the disposal of nuclear waste. With the reprocessing of used fuel as an option for nuclear energy, the stages form a true cycle.

To prepare uranium for use in a nuclear reactor, it undergoes the steps of mining and milling, conversion, enrichment and fuel fabrication. These steps make up the 'front end' of the nuclear fuel cycle.

After uranium has spent about three years in a reactor to produce electricity, the used fuel may undergo a further series of steps including temporary storage, reprocessing, and recycling before wastes are disposed. Collectively these steps are known as the 'back end' of the fuel cycle.



INTERNATIONALISATION OF NUCLEAR FUEL CYCLE

The debate over the past years on how to limit national ownership and control of nuclear fuel-cycle facilities is largely a response to the perceived risk of a growing number of countries to acquire these sensitive technologies. This prospect is seen as a challenge to the non-proliferation regime by leading nuclear weapon states and their allies, by non-weapon states seeking both to stem proliferation and to abolish nuclear weapons, and by states and international bodies seeking to promote the peaceful uses of nuclear technology.

In June 2004, IAEA Director General M. ElBaradei appointed an international group of experts to consider “possible multilateral approaches to the civilian nuclear fuel cycle.” El Baradei had previously acknowledged that the shortcomings of the non-proliferation regime were becoming more evident because nuclear-weapons technologies are more difficult to control today than they were in the past. He warned that “should a state with a fully developed nuclear fuel-cycle capability decide, for whatever reason, to break away from its non-proliferation commitments, most experts believe it could produce a nuclear weapon within a matter of months.” To limit this possibility, ElBaradei reintroduced the idea of restricting reprocessing and enrichment exclusively to facilities that are under multinational control.

In broadest terms, two different strategies can be distinguished to discourage the development of new national nuclear fuel-cycle capabilities: ensuring fuel supply to address energy-security concerns and balancing rights and obligations under the Non-Proliferation Treaty (NPT).

Internationalisation of Nuclear Fuel encouraged the idea of Nuclear Fuel Banks. A nuclear fuel bank is reserve of low enriched uranium (LEU) for countries that need a backup source of LEU to fuel their nuclear reactors. Countries that do have enrichment technology would donate enriched fuel to a "bank", from which countries not possessing enrichment technology would obtain fuel for their power reactors.

The concept of providing an assured supply of nuclear fuel, and thus avoiding the need for countries to build indigenous nuclear fuel production capabilities, has long been proposed as a way to curb the proliferation of nuclear weapons and, eventually, eliminate them altogether. Austria, Russia, the European Union, the United States, and others have supported various concepts of an international fuel bank. Many non-nuclear-weapon states have been reluctant to embrace any of these proposals for varying reasons.

Other than nuclear fuel banks some countries supported multilateral programs where the nuclear enrichment facility will be built in a nuclear weapon state and the state will act as a supplier for the complete bloc however now countries have started going against this idea in fear of situations that the nuclear armed state can cut down supplies to gain political supremacy over other states.

NUCLEAR ACCIDENTS

The three significant accidents in the 50-year history of civil nuclear power generation are:

- Three Mile Island (USA 1979) where the reactor was severely damaged but radiation was contained and there were no adverse health or environmental consequences
- Chernobyl (Ukraine 1986) where the destruction of the reactor by steam explosion and fire killed 31 people and had significant health and environmental consequences. The death toll has since increased to about 56.
- Fukushima (Japan 2011) where three old reactors (together with a fourth) were written off and the effects of loss of cooling due to a huge tsunami were inadequately contained.

These three significant accidents occurred during more than 16,000 reactor-years of civil operation. Of all the accidents and incidents, only the Chernobyl and Fukushima accidents resulted in radiation doses to the public greater than those resulting from the exposure to natural sources. The Fukushima accident resulted in some radiation exposure of workers at the plant, but not such as to threaten their health, unlike Chernobyl. Other incidents (and one 'accident') have been completely confined to the plant.

Apart from Chernobyl, no nuclear workers or members of the public have ever died as a result of exposure to radiation due to a commercial nuclear reactor incident. Most of the serious radiological injuries and deaths that occur each year (2-4 deaths and many more exposures above regulatory limits) are the result of large uncontrolled radiation sources, such as abandoned medical or industrial equipment.

INTERNATIONAL RESPONSE TO CURB NUCLEAR ACCIDENTS

The International Atomic Energy Agency (IAEA) was set up by the United Nations in 1957. One of its functions was to act as an auditor of world nuclear safety, and this role was increased greatly following the Chernobyl accident. It prescribes safety procedures and the reporting of even minor incidents. Its role has been strengthened since 1996 (see later section). Every country which operates nuclear power plants has a nuclear safety inspectorate and all of these work closely with the IAEA.

While nuclear power plants are designed to be safe in their operation and safe in the event of any malfunction or accident, no industrial activity can be represented as entirely risk-free. Incidents and accidents may happen, and as in other industries, will lead to progressive improvement in safety. Those improvements are both in new designs, and in upgrading of existing plants. The long-term operation (LTO) of established plants is established by significant investment in such upgrading.

The safety of operating staff is a prime concern in nuclear plants. Radiation exposure is minimised by the use of remote handling equipment for many operations in the core of the reactor. Other controls include physical shielding and limiting the time workers spend in areas with significant radiation levels. These are supported by continuous monitoring of individual doses and of the work environment to ensure very low radiation exposure compared with other industries.

In both the Three Mile Island (TMI) and Fukushima accidents the problems started after the reactors were shut down – immediately at TMI and after an hour at Fukushima, when the tsunami arrived. The need to remove decay heat from the fuel was not met in each case, so core melting started to occur within a few hours. Cooling requires water circulation and an external heat sink. If pumps cannot run due to lack of power, gravity must be relied upon, but this will not get water into a pressurised system – either reactor pressure vessel or containment. Hence there is provision for relieving pressure, sometimes with a vent system, but this must work and be controlled without power. There is a question of filters or scrubbers in the vent system: these need to be such that they do not block due to solids being carried. Ideally any vent system should deal with any large amounts of hydrogen, as at Fukushima, and have minimum potential to spread radioactivity outside the plant. Filtered containment ventilation systems (FCVSs) are being retrofitted to some reactors which did not already have them, or any of sufficient capacity, following the Fukushima accident. The basic premise of a FCVS is that, independent of the state of the reactor itself, the catastrophic failure of the containment structure can be avoided by discharging steam, air and incondensable gases like hydrogen to the atmosphere.

The Three Mile Island accident in 1979 demonstrated the importance of the inherent safety features. Despite the fact that about half of the reactor core melted, radionuclides released from the melted fuel mostly plated out on the inside of the plant or dissolved in condensing steam. The containment building which housed the reactor further prevented any significant release of radioactivity. The accident was attributed to mechanical failure and operator confusion. The reactor's other protection systems also functioned as designed. The emergency core cooling system would have prevented any damage to the reactor but for the intervention of the operators.

Investigations following the accident led to a new focus on the human factors in nuclear safety. No major design changes were called for in western reactors, but controls and instrumentation were improved significantly and operator training was overhauled.

At Fukushima Daiichi in March 2011 the three operating reactors shut down automatically, and were being cooled as designed by the normal residual heat removal system using power from the back-up generators, until the tsunami swamped them an hour later. The emergency core cooling systems then failed. Days later, a separate problem emerged as spent fuel ponds lost water. Analysis of the accident showed the need for more intelligent siting criteria than those used in the 1960s, and the need for better back-up power and post-shutdown cooling, as well as provision for venting the containment of that kind of reactor and other emergency management procedures.

Nuclear plants have Severe Accident Mitigation Guidelines (SAMG, or in Japan: SAG), and most of these, including all those in the USA, address what should be done for accidents beyond design basis, and where several systems may be disabled. See section below.

In 2007 the US NRC launched a research program to assess the possible consequences of a serious reactor accident. Its draft report was released nearly a year after the Fukushima accident had partly confirmed its findings. The State-of-the-Art Reactor Consequences Analysis (SOARCA) showed that a severe accident at a US nuclear power plant (PWR or BWR) would not be likely to cause any immediate deaths, and the risks of fatal cancers would be vastly less than the general risks of cancer. SOARCA's main conclusions fall into three areas: how a reactor accident progresses; how existing systems and emergency measures can affect an accident's outcome; and how an accident would affect the public's health. The principal conclusion is that existing resources and procedures can stop an accident, slow it down or reduce its impact before it can affect the public, but even if accidents proceed without such mitigation they take much longer to happen and release much less radioactive material than earlier analyses suggested. This was borne out at Fukushima, where there was ample time for evacuation – three days – before any significant radioactive releases.

In 2015 the Canadian Nuclear Safety Commission (CNSC) released its Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures. This was the result of research and analysis undertaken to address concerns raised during public hearings in 2012 on the environmental assessment for the refurbishment of Ontario Power Generation's (OPG's) Darlington nuclear power plant. The study involved identifying and modelling a large atmospheric release of radionuclides from a hypothetical severe nuclear accident at the four-unit Darlington power plant; estimating the doses to individuals at various distances from the plant, after factoring in protective actions such as evacuation that would be undertaken in response to such an emergency; and, finally, determining human health and environmental consequences due to the resulting radiation exposure. It concluded that there would be no detectable health effects or increase in cancer risk

EUROPEAN AND US RESPONSE FOLLOWING FUKUSHIMA ACCIDENT

Aspects of nuclear plant safety highlighted by the Fukushima accident were assessed in the 143 nuclear reactors in the EU's 27 member states, as well as those in any neighbouring states that decided to take part. These comprehensive and transparent nuclear risk and safety assessments, the so-called "stress tests", involved targeted reassessment of each power reactor's safety margins in the light of extreme natural events, such as earthquakes and flooding, as well as on loss of safety functions and severe accident management following any initiating event. They were conducted from June 2011 to April 2012. They mobilized considerable expertise in different countries (500 man-years) under the responsibility of each national Safety Authority within the framework of the European Nuclear Safety Regulators Group (ENSREG).

The Western European Nuclear Regulators' Association (WENRA) proposed these in response to a call from the European Council in March 2011, and developed specifications. WENRA is a network of Chief Regulators of EU countries with nuclear power plants and Switzerland, and has membership from 17 countries. It then negotiated the scope of the tests with the European Nuclear Safety Regulators Group (ENSREG), an independent, authoritative expert body created in 2007 by the European Commission comprising senior officials from the national nuclear safety, radioactive waste safety or radiation protection regulatory authorities from all 27 EU member states, and representatives of the European Commission.

In June 2011 the governments of seven non-EU countries agreed to conduct nuclear reactor stress tests using the EU model. Armenia, Belarus, Croatia, Russia, Switzerland, Turkey and Ukraine signed a declaration that they would conduct stress tests and agreed to peer reviews of the tests by outside experts. Russia had already undertaken extensive checks. (Croatia is co-owner in the Krsko PWR in Slovenia, and Belarus and Turkey plan to build nuclear plants but have none now.)

The reassessment of safety margins is based on the existing safety studies and engineering judgment to evaluate the behaviour of a nuclear power plant when facing a set of challenging situations. For a given plant, the reassessment reports on the most probable behaviour of the plant for each of the situations considered. The results of the reassessment were peer-reviewed and shared among regulators. WENRA noted that it remains a national responsibility to take or order any appropriate measures, such as additional technical or organisational safety provisions, resulting from the reassessment.

The scope of the assessment took into account the issues directly highlighted by the events in Fukushima and the possibility for combination of initiating events. Two 'initiating events' were covered in the scope: earthquake and flooding. The consequences of these – loss of electrical power and station blackout, loss of ultimate heat sink and the combination of both – were analysed, with the conclusions being applicable to other general emergency situations. In accident scenarios, regulators consider power plants' means to protect against and manage loss of core cooling as well as cooling of used fuel in storage. They also study means to protect against and manage loss of containment integrity and core melting, including consequential effects such as hydrogen accumulation.

The European Commission adopted, with ENSREG, the final stress tests Report on April 26, 2012 and issued the same day a joint statement underlining the quality of the exercise. The full report and a summary of the 45 recommendations were published on www.ensreg.eu. Drawing on the peer reviews, the EC and ENSREG cited four main areas for improving EU nuclear plant safety:

- Guidance from WENRA for assessing natural hazards and margins beyond design basis.
- Giving more importance to periodic safety reviews and evaluation of natural hazards.
- Urgent measures to protect containment integrity.
- Measures to prevent and mitigate accidents resulting from extreme natural hazards.

NUCLEAR FUEL IN COMPARISON TO CONVENTIONAL ENERGY SOURCES

The nuclear industry has a relatively short history: the first nuclear reactor was commissioned in 1954. Uranium is the main source of fuel for nuclear reactors. Worldwide output of uranium has recently been on the rise after a long period of declining production caused by oversupply following nuclear disarmament. The present survey shows that total identified uranium resources have grown by 12.5% since 2008 and they are sufficient for over 100 years of supply based on current requirements.

Total nuclear electricity production has been growing during the past two decades and reached an annual output of about 2 600TWh by the mid-2000s, although the three major nuclear accidents have slowed down or even reversed its growth in some countries. The nuclear share of total global electricity production reached its peak of 17% by the late 1980s, but since then it has been falling and dropped to 13.5% in 2012. In absolute terms, the nuclear output remains broadly at the same level as before, but its relative share in power generation has decreased, mainly due to Fukushima nuclear accident.

Japan used to be one of the countries with a high share of nuclear (30%) in its electricity mix and high production volumes. Today, Japan has only two of its 54 reactors in operation. The rising costs of nuclear installations and lengthy approval times required for new construction have had an impact on the nuclear industry. The slowdown has not been global, as new countries, primarily in the rapidly developing economies in the Middle East and Asia, are going ahead with their plans to establish a nuclear industry.

TECHNICAL AND ECONOMIC CONSIDERATIONS

Construction costs are a key factor for the final electricity generating costs and many current nuclear projects are significantly over budget. Cost estimates have increased in the past decade from US$1,000 to US$7,000 per kW installed. The stock market value of the world's largest nuclear operator, French state utility EDF, went down by 85 percent over the past five years, while the share price of the world's largest nuclear builder, French state company AREVA, dropped by up to 88 percent. Generally, existing operating nuclear power plants continue to be highly competitive and profitable. The low share of fuel cost in total generating costs makes them the lowest-cost base load electricity supply option in many markets. Uranium costs account for only about 5% of total generating costs and thus protect plant operators against resource price volatility. Using a levelised cost of electricity (LCOE) calculation formula, new nuclear build is generally competitive with other generating options. The 'front-loaded' cost structure of nuclear plants (i.e. the fact that they are relatively expensive to build but inexpensive to operate) has always been an investment risk factor and a financial challenge, especially in competitive electricity markets. Apart from the market related factors, there are other factors that have an impact on the development of nuclear power. On the production side, there are only a few manufacturers in World Energy Resources: Uranium and Nuclear World Energy Council 2013 4.8 the world that are capable of producing heavy forging equipment such as reactor pressure vessels or steam generators.

Nuclear Power: top 5 countries 2011

Nuclear Country	Installed Capacity (MW) 2011	Installed Capacity (MW) 1993	Actual Generation (GWh) 2011	Actual Generation (GWh) 1993
United States of America	98 903	99 041	799 000	610 000
France	63 130	59 032	415 480	350 000
Japan	38 009	38 038	162 900	246 000
Russian Federation	23 643	19 843	122 130	119 000
Korea (Republic)	20 718	7 615	98 616	58 100
Rest of World	119 675	116 726	787 777	722 900
Global Total	**364 078**	**340 295**	**2 385 903**	**2 106 000**

MARKET TRENDS

Each year the IAEA updates its low and high projections for global growth in nuclear power. In the updated low projection, global nuclear power capacity reaches 511 GWe in 2030, compared to a capacity of 370 GWe at the end of 2009. In the updated high projection it reaches 807 GWe . The upward shift in the projections is greatest for the Far East, a region that includes China, Japan and the Republic of Korea. Modest downward shifts in the projections were made for North America and for Southeast Asia and the Pacific. Although today the key drivers and market players defining the future of nuclear power are different from those 20-30 years ago, the emerging non-OECD economies (mainly China and India) are expected to dominate future prospects. Given that they need to use all options to meet their rapidly growing electricity demand and secure certain economic growth levels at high rates, it will constitute a major and potentially costly challenge to rule out the option of using larger shares of nuclear power. Furthermore, these challenges will be amplified by the increasing energy price from other sources, political stability in certain energy producing markets, in addition to carbon emission and climate change concerns. The developing nations (China, Russia and India) seem to have kept most of their planned projects alive. Despite the relatively high costs, recent accidents and growing public opposition in some regions, nuclear power is back on the agenda of many countries, primarily for following three reasons: it has predictable long-term generation costs, as it is not exposed to the volatile fossil fuels markets, and it can enhance energy security and bring along climate-change mitigation benefits. Nuclear’s economic competitiveness depends on local conditions including available alternatives, market structures and government policy.

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