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The Nuclear Necklace: Fukushima Nuclear Disaster and India's Nuclear Vulnerabilities

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Abstract:

Nuclear power characterized by both high energy density and low-carbon emissions was introduced as an effective source of producing electricity. It is considered as one of the important non-conventional energy source and is expected to play an important role in energy-hungry developing nations. However, the Fukushima Daiichi nuclear incident in 2011, gave a setback to global public acceptance of nuclear power and affected public attitudes toward nuclear energy in many countries including India. Existing scholarship explains the skepticism in public opinion on nuclear power in India post-Fukushima by comparing its desirability and use with other energy sources. In this study, the transformation of public opinion about nuclear energy post-Fukushima will be analyzed to determine how different dimensions of attitudes toward nuclear energy changed after the accident. It will also analyze other issues before the nuclear industry which are influencing the general opinion about nuclear energy in India.

Keywords: Fukushima, Nuclear terrorism, risk management, cyber-attacks.

Introduction:

Nuclear energy generation is playing a crucial role in the 21st century. Nuclear energy generation began more than six decades ago and today forms an important part of electricity generation and industrial infrastructures in various countries of the world. According to the International Atomic Energy Agency, 450 nuclear power reactors in 31 countries provide over 2,563 terawatt hours of electricity annually.[1] India is also one of those countries that presently uses nuclear power for the

[1] International Atomic Energy Agency, "IAEA Reactor Status Reports - Operational & Long-Term Shutdown - By Country," accessed September 20, 2020, https://pris.iaea.org/PRIS/WorldStatistics/OperationalReactorsByCountry.aspx.

generation of energy. In fact, there are seven nuclear plants and twenty two nuclear reactors operational in India, having a capacity of 6,780 MW.[2] Nuclear power accounts nearly 3 per cent of India's domestic electricity generations and forms fifth largest source of electricity in India. Over the years' nuclear energy has contributed significantly towards reducing reliance on conventional sources of energy. And owing to its low greenhouse gas output and low environmental pollution, nuclear power forms an important component of energy mix of many nations. Although generation of electricity through nuclear energy presents several benefits but simultaneously involves risks, as demonstrated by the Fukushima Daiichi Nuclear Power Plant accident on March 11, 2011.[3] It has arguably initiated a global re-examination of the vulnerability of nuclear power plants to such events. The accident raised the question of the viability of nuclear energy as a safe and carbon-free energy option. The Fukushima incident wobbled the global nuclear power industry and debates in many countries addressed whether the benefits of nuclear energy were worth the damage it could cause. It dwarfed nuclear renaissance in various countries including India and countries like—Belgium, Germany, and Switzerland—decided to phase out nuclear energy. It affected the global public acceptance of nuclear power. Before, the Fukushima nuclear incident general attitude of Indian citizens toward nuclear energy was more or less stable. It further confronted the safety assumptions held and disseminated for decades by nuclear experts, corporations, and governments of nuclear nations. It has also raised resentment and fear of nuclear energy. And the studies conducted in various countries after the incident showed majority of the people (70 per cent) showed their resentment on the construction of nuclear reactors. India, historically, considers nuclear energy as a prerequisite for its continuing economic progress, and envisions itself a future world leader in nuclear energy.[4]

Fukushima Nuclear Disaster:

The Fukushima Daiichi nuclear disaster was a major accident initiated by an external event — an earthquake and a resulting tsunami, accompanied by seismic aftershocks in March 2011. The

[2] Catherine Mei Ling Wong, *Energy, Risk and Governance The Case of Nuclear Energy in India* (Luxembourg: Palgrave Macmillan, 2018), 6.

[3] Jaesun Wang and Seoyong Kim, "Comparative Analysis of Public Attitudes toward Nuclear Power Energy across 27 European Countries by Applying the Multilevel Model," *Sustainability (Switzerland)* 10, no. 1518 (2018): 1–21, https://doi.org/10.3390/su10051518.

[4] Nikhil Deb, "The Fukushima Disaster and the Framing of Nuclear Energy in India," *Perspectives on Global Development and Technology* 17, no. 4 (2018): 473–95, https://doi.org/10.1163/15691497-12341489.

accident which was rated 7 on the International Nuclear and Radiological Event Scale (INES) scale led to the shutdown of elven nuclear reactors at four nuclear power plants. The shutdown led to three nuclear meltdowns, hydrogen explosions and release of radioactive contamination. Besides large quantity of the contaminated water with radioactive isotopes was also released in the Pacific Ocean. The accident exposed the vulnerability of the nuclear power plants, thus challenging the existing safety features all over the globe including India also. The Fukushima nuclear disaster received considerable media coverage and reactor meltdown generated fears related to catastrophic nuclear accidents. The nuclear accident in Fukushima has impacted public's perception toward nuclear energy substantially and also had a significant effect on the nuclear policies of many countries. In the aftermath of Fukushima nuclear crisis, civil society groups and people agitated against nuclear power plants (NPPs) in India. The protests overshadowed the benefits of the nuclear energy and declined support for nuclear energy in India. Anti-nuclear protests and campaigns, influenced attitudes and public perception of nuclear energy pressurizing policy makers to review India's nuclear energy policy.[5]

Public Concerns Over Nuclear Energy in India:

Nuclear energy is widely considered as clean and efficient source of energy. Unlike renewable energy sources, it uses a mature technology and produces large amounts of power. It has been marketed as the cheapest alternative to coal-based generation plants, hence employed as one of the key parts in the national energy and electricity plans in various countries.[6] Over the years, nuclear energy has contributed significantly towards the reduction of use of fossil fuels in many countries. India, Japan and South Korea have heavily invested in the development of the nuclear energy, to be considered as an environmental friendly and cost effective source of energy. Nevertheless, the three major nuclear accidents Three Mile Island, Chernobyl, and Fukushima have reduced the level of trust among members of the public and affected the global acceptance of nuclear power. A nuclear accident has a detrimental effect, both direct and indirect, on public acceptance of nuclear technology. The harm from the radioactive materials released is its direct effect. Stigma is the

[5] Kapil Patil, "Public Concerns over Nuclear Energy in India," in *India's Nuclear Energy Programme : Challenges, Prospects and Public Concerns*, ed. Kapil Patil Gupta, Arvind, K.D. Kapur,G. Balachandran, Ist (3: Penguin Books India Ltd., 2014), 77–78.

[6] Raphael Bointner, "Innovation in the Energy Sector: Lessons Learnt from R&D Expenditures and Patents in Selected IAEA Countries, "Energy Policy 73 (October1, 2014):733–47.

indirect effect of a nuclear accident. Stigma refers to a symbol intended to reveal something odd and bad about the person or group's moral standing to which it referred.

Serious nuclear accidents like Fukushima led to strong agitation by the people and civil society groups against the use of nuclear power and increase the negative effect of nuclear energy directly and indirectly. Thus challenging acceptance of nuclear power. Although that acceptance differs from country to country and depends on various factors such as geography, history, and environment. The protestors raised various concerns about nuclear power. The main concerns were losing means of livelihood, land/water rights, culture, natural beauty,[7] waste management, nuclear safety, etc.[8]

People expressed concerns over the environmental impact of nuclear energy also, which adversely affected the construction and operation of nuclear reactors. People raised serious concerns related to NPPs and believed that the construction and operation of nuclear plants impacts terrestrial environment by activities such as, loss of trees, noise, dust, emission of biocides etc.[9] Another important concern raised, relates to the ecological impact of the waste discharged in the form of thermal effluents which effects the habitat in ecosystem— terrestrial and aquatic. The accidental release of the radioactivity in the surrounding environment is the most serious concern related to nuclear power in India, as large scale exposure to radioactive material can pose serious health risks. In order to address the public concerns regarding the nuclear accidents the government passed the Nuclear Liability Act 2010 which specifies procedure for the compensation of the victims of nuclear accidents.[10]

Nuclear Safety:

In India nuclear safety is a major issue as most of the people consider nuclear energy as unsafe. In the aftermath of Fukushima nuclear accident, the use of civilian nuclear energy has led to several debates on nuclear safety in India The incident brought public attention to the issue of nuclear

[7] Monamie Bhadra, "Fighting Nuclear Energy , Fighting for India's Democracy," *Science as Culture* 22, no. 2 (2013): 238–46.
[8] Patil, "Public Concerns over Nuclear Energy in India," 75.
[9] Balachandran.et.al, "Environmental Impacts of Nuclear Power Plants in India," 119–26.
[10] P. Sarkar, "The Civil Liability For Nuclear Damage Act 2010: A Comparative Study" (KIIT University, 2017).

safety. Nuclear accidents have created strong public awareness about potential hazards of nuclear accidents and importance of nuclear safety. According to the U.S Atomic Act, nuclear safety is defined as,

> "The status and the ability of nuclear installation or transport equipment and operating personnel thereof to prevent uncontrolled development of fission chain reaction or unauthorized release of radioactive substances or ionizing radiation into the working environment or the environment, and to mitigate consequences of incidents and accidents at nuclear installations or consequences of events upon shipment of radioactive material".[11]

India promotes high safety standards in all types of civilian nuclear activities, including nuclear power production, medical research and waste storage. But Fukushima nuclear incident raised doubts over the safety of nuclear power plants (NPPs) all over the globe including India, leading to safety evaluation of nuclear power plants by NPCIL as most of the nuclear plants lie in coastal areas and are vulnerable to tsunami.[12] According to Durgesh Rai,

> "Most of our nuclear plants in India are in weak seismic zones but lie in coastal areas. Their structure is earthquake-resistant but they have not been tested against tsunami. The entire coastal region is believed to be vulnerable to tsunami,".[13]

Although, India has a respectable nuclear safety record, but government of India since Fukushima has not inspired public confidence over the use of nuclear energy. According to a report prepared by NPCIL post Fukushima, the safety features of Indian NPPs are designed for earthquake with return period of 10,000 years.[14] The report further says, effects of natural external

[11] U.S. Nuclear Regulatory Commission, 'Nuclear Regulatory Legislation´ (2011), <http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr0980/v1/sr0980v1.pdf#page=13>, accessed 26 June 2019.
[12] K.D Kapur, "Post-Fukushima Global Nuclear Scenario," in *India's Nuclear Energy Programme : Challenges, Prospects and Public Concerns*, ed. Kapil Patil ; Arvind Gupta, K.D. Kapur, G. Balachandran, First (New Delhi: Pentagon Press, 2014), 10–18.
[13] **"**How Vulnerable Are India's Nuclear Power Plants to Disaster," Down to Earthh, accessed November 24, 2019, https://www.downtoearth.org.in/news/how-vulnerable-are-indias-nuclear-power-plants-to-disaster-33202.
[14] "Safety Evaluation Of Indian Nuclear Power Plants Post Fukushima Incident," *Nuclear Power Corporation of India Limited*, 2011, 5-6.

events such as earthquake, cyclone, storm surge and Tsunami events are the considerations in siting requirements of Indian NPPs along with many others lie vicinity of water resources, availability of heat sink, etc.

However, there are still public doubts over the safety of nuclear power plants and there is a need of a relevant policy to clear them. The Integrated Regulatory Review Service (IRRS) submitted a draft report to India's Atomic Energy Regulatory Board (AERB) on 27 March 2015, reviewing the country's legal and regulatory regime for safety of Nuclear Power Plants (NPPs) and safety practices and policies at plants across the country. The report recommended that India's AERB should "Promulgate a national policy and strategy for safety, and a radioactive waste".[15]

Cyber Attacks and Growing Cyber Security Risks:

Nuclear power plants are vulnerable to cyber-attacks, which pose a mounting threat to nuclear facilities and materials. Cyber threat includes data breaches, computer viruses and Denial of Service (DoS) attacks and is mounted by means of cyber space. The common methods used in cyber-attacks are malware, phishing, spear phishing, Trojans, man in the middle (MitM), ransomware, etc.[16] Cyberattacks are growing day by day and are becoming increasingly more sophisticated with the passage of time. Various incidents in different parts of the world have demonstrated the vulnerability of nuclear establishments to cyber threats and the need of cyber security (See Table 1). According to the International Atomic Energy Agency (IAEA), nuclear security is "the prevention of, detection of, and response to, criminal or intentional unauthorized acts involving or directed at nuclear material, other radioactive material, associated facilities, or associated activities."[17] Cyber-attacks are carried out by foreign governments, groups hostile to the government of a given State, or individuals motivated by greed, hatred or curiosity and by

[15] IAEA, March 2015. IAEA *Mission Concludes Peer Review of India's Nuclear Regulatory Framework*, available at https://www.iaea.org/newscenter/pressreleases/iaea-mission-concludes-peer-review-indiasnuclear-regulatory-framework. accessed on September 20, 2020.

[16] "What Are Cyber Threats: How They Affect You and What to Do About Them," Prey Nation, 2018, https://preyproject.com/blog/en/what-are-cyber-threats-how-they-affect-you-what-to-do-about-them/. Last accessed on November 24, 2019.

[17] "Nuclear Security Series Glossary," *International Atomic Energy Agency*, Version 1.3, (November 2015), https://www.iaea.org/sites/default/files/18/08/nuclear-security-series-glossary-v1-3. pdf Cited in Pulkit Mohan, "Ensuring Cyber Security in India's Nuclear Systems," *Observer Research Foundation*, 2020.

citizens of a state.[18] In 2018, the Trump administration accused Russia of conducting a series of cyberattacks aimed at U.S. from 2015 through 2017.[19] Similarly, South Korea's nuclear facility also came under cyberattacks in 2014. Cyber-attacks have operational, economic, and reputational costs to the country.

Table 1: Incidents of cyber-attacks on nuclear systems

Country & Attack Site	Year	Type of Cyber Attack	Components Affected
United States **Davis-Besse Nuclear Power Plant**	2003	Slammer computer worm	Compromised the safety control system for over four hours
Iran **Natanz uranium enrichment plan**	2010	Stuxnet computer worm	Plant's computer software and nuclear centrifuges were infected and damaged
United States **Hanford Nuclear Site**	2015	Hacking	Two Chinese hackers were indicted in 2020; believed to have targeted the site to gain information about individuals involved in the development of the atomic bomb during the Cold War
Germany **Gundremmingen nuclear power plant**	2016	W32.Ramnit and Conficker viruses	Viruses infected the computer systems and USB drives; did not pose a direct threat to plant's operating systems.

Source: https://www.orfonline.org/research/ensuring-cyber-security-in-indias-nuclear-systems/

The Indian Context

India has been no alien to cyberattacks. A security threat report issued by security software company Symantec in 2018 placed India amongst the top five nations that are facing targeted attacks and cyber threats.[20] According to a report submitted to India's National Security Council Secretariat (NSCS) in 2018, 'an unprecedented 35 percent of cyberattacks against the country were

[18] Thomas Shea;Sandro Gaycken;Maurizio Martellini, "Cyber Security for Nuclear Power Plants," in *Cyber Security: Deterrence and IT Protection for Critical Infrastructures*, ed. Maurizio Martellini (Springer, 2013), 25–27.
[19] Nicole Perlroth and David E. Sanger, "Cyberattacks Put Russian Fingers on the Switch at Power Plants, U.S. Says," *The New York Times*, March 18, 2018.
[20] Mohan, "Ensuring Cyber Security in India's Nuclear Systems."

attributed to China'.[21] Although the physical security of the nuclear power plants has been upgraded worldwide and are designed to withstand natural disaster like earthquake of low intensity, but a potentially more challenging cyber threat is endangering them. Cyber security at the nuclear facilities is receiving increased attention but they are still vulnerable to cyberattacks.

In the recent times, India's Kudankulam Nuclear Power Plant (KKPP) in Tamil Nadu came under cyberattack in September, 2019, breaching its administrative network without causing any critical damage. The Nuclear Power Cooperation of India Limited (NPCIL) initially denying the attack stated, "Any cyberattack on the Nuclear Power Plant Control System is not possible." The KKNPP site director further stating that "the totally isolated network of KKNPP could not be accessed by any outside network from any part of the globe. Hence there was no question of it being hacked."[22] The NPCIL finally confirmed cyberattack in October and cyber security experts suggested that the malware (DTRACK virus) used for data extraction is linked to the North Korea backed Lazarus Group.[23] According to the NPCIL statement, "the malware attack on KKNPP was noticed September 4, by the CERT-In (Indian Computer Emergency Response Team), which is the national agency for responding to cybersecurity incidents".[24] The virus scanning website, VirusTotal has indicated theft of large amount of data from the administrative network of the power plant.[25]

The Kudankulam cyberattack revealed India's outdated cyber-defenses and exposed vulnerability of nuclear sector to cyber espionage, despite having a cyber security policy. The Kudankulam cyberattack is a wakeup call for India about its vulnerable cyber defenses critical infrastructures and nuclear facilities. It needs to mount an active defense and pursue transformation necessary to get ahead of the cyber threat. It is also essential to strengthen systems against cyber threats using preventive access tools such as "firewalls, anti-virus programs, air gaps and

[21] By Elizabeth Radziszewski and Brendan Hanson, "India's Response to China's Cyber Attacks," *The Diplomat*, July 2019.
[22] "An Indian Nuclear Power Plant Suffered a Cyberattack. Here's What You Need to Know.," *The Washington Post*, November 4, 2019.
[23] "India Confirms Cyber Attack on Nuclear Power Plant.," *Financial Times*, October 31, 2019.
[24] "An Indian Nuclear Power Plant Suffered a Cyberattack. Here's What You Need to Know."
[25] Ibid

unidirectional gateways."[26] It needs to take lessons from countries like United Kingdom (UK), United States (US) and Japan, who have nurtured an advanced cyber-security systems and mechanisms. Indian policy makers also need to engage in multilateral dialogues to help develop appropriate international regulatory norms, frameworks and institutions for cyber and nuclear security.

The Evolving Threat of Nuclear Terrorism and India:

Nuclear terrorism is possibly the least understood danger/threat emanating from nuclear weapons, as no terrorist group has developed, deployed or obtained nuclear weapons till date. In the recent years the threat of nuclear terrorism has been assessed by statesmen, academics and intelligence analysts. Leaders, heads of the state or government from various countries have recognised the threat of nuclear terrorism. The threat is real, urgent and commands action.[27] According to Yukiya Amano, the former Director General of the International Atomic Energy Agency (IAEA), "the threat of nuclear terrorism is real, and the global nuclear security system needs to be strengthened in order to counter that threat."[28] Since the beginning of the twenty first century, the probability of non-state actors acquiring and using Chemical, Biological, Radiological and Nuclear (CBRN) weapons against the susceptible non-combatants has remained a worrying threat. The making of nuclear bomb is difficult but is within the capabilities of a technically sophisticated terrorist groups.[29] According to the former United Nations Secretary General Ban-Ki Moon, "Nuclear terrorism is one of the most serious threats of our time. Even one such attack could inflict mass casualties and create immense suffering and unwanted change in the world forever. This prospect should compel all of

[26] Mohan, "Ensuring Cyber Security in India's Nuclear Systems."
[27] Matthew Bunn, Martin B. Malin, Nickolas Roth, and William H. Tobey, *Preventing Nuclear Terrorism: Continuous Improvement or Dangerous Decline?* (Cambridge, MA: Project on Managing the Atom, Belfer Center for Science and International Affairs, Harvard Kennedy School, March 2016), 34.
[28] Anthony Chibarirwe, "IAEA Chief Warns of the Threat of Nuclear Terrorism," *theTrumpet.com*, July 7, 2013, https://www.thetrumpet.com/article/10787.19.0.0/world/terrorism/iaea-chief-warns-of-threat-of-nuclear-terrorism (accessed August 26, 2020) also cited in Tobey, 34.
[29] Matthew Bunn and Anthony Wier, "Terrorist Nuclear Weapon Construction: How Difficult?" *Annals of the American Academy of Political and Social Science*, Vol. 607, September 2006, pp. 133–149

us to act to prevent such a catastrophe."[30] Similarly a report on nuclear terrorism prepared by the US and the Russian experts in 2011 summarized the threat in following words:

> "Nuclear terrorism is a real and urgent threat. Urgent actions are required to reduce the risk. The risk is driven by the rise of terrorists who seek to inflict unlimited damage, many of whom have sought justification for their plans in radical interpretations of Islam; by increased availability of weapons-usable materials; and by globalization, which makes it easier to move people, technologies, and materials across the world."[31]

Any terrorist activity involving potential use of nuclear materials to perpetrate damage in the pursuit of political ends is called as nuclear terrorism.[32] It may take different ways and forms, such as theft, unauthorized access, smuggling and sabotage; leading to lethal and enormous consequences. The present scholarship on the issue of nuclear terrorism is divided into two schools of thought. One school of thought presents the alarmist view while the other presents a complacent view on nuclear terrorism.

The September 11, 2001 attacks by Al-Qaida demonstrated that the present day terrorism has no limits or constraints. The attacks led to the belief that terrorists can use any means to inflict maximum possible carnage to meet their ends and nothing is off the table.[33] Similarly, the terrorist attacks on Indian Parliament in 2001, Mumbai Attacks in 2008 and recent Pulwama attack clearly show that terrorists can strike anywhere, raising serious security concerns. The rising terrorism activities raised greater concerns regarding nuclear terrorism, thus challenging nuclear security.[34]

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[30] Ban-Ki Moon, "Secretary General Welcomes Swift Entry Into Force of Nuclear Terrorism Convention, Calls on All States to Ratify Without Delay" (New York: United Nations, June 13, 2007), http://www.un.org/press/en/2007/sgsm11040.doc.html (accessed July 17, 2020).

[31] Tobey, "Preventing Nuclear Terrorism: Continuous Imrovement or Dangerous Decline?," 43.

[32] Nuclear terrorism is defined as, "Acts of violence and destruction performed by non-state actors where the means applied are nuclear explosive devices – or threats of such actions – with the purpose of inflicting destruction, creating a condition of fear, getting attention, blackmailing, installing instability, and to affect an audience beyond the victim(s) directly targeted. nuclear terrorism is one of the most challenging threats to international security". "Nuclear Security Series Glossary Version 1.3 (November 2015)," 2015, 18, https://www-ns.iaea.org/downloads/security/nuclear-security-series-glossary-v1-3.pdf. Last October 08,2020).

[33] Paul J. Smith, *The Terrorism Ahead: Confronting Transnational Violence in the Twenty-first Century*, ME Sharpe, New York, 2008, p. 104.

[34] Nuclear security relates to theft, sabotage, unauthorized access and illegal transfer or other malicious acts involving nuclear material and other radioactive substances and associated facilities; it involves nuclear

The threat perception about terrorists acquiring nuclear technology increased when there were revelations that Al-Qaida is desirous of acquiring nuclear/radiological materials and weapons. The emergence of terrorist groups like ISIS makes the threat of nuclear terrorism more serious. Although their intentions to nuclear terrorism remained more unclear but The *New York Times Magazine* reported in 2015 that, "IS was actively seeking to purchase "red mercury"—a mythical material believed by some to be useful in nuclear weapons, which has been the center of countless nuclear smuggling scams—over a period of more than a year."[35] The rise of terrorist groups like IS clearly raises the threat of nuclear terrorism but the full magnitude of the increase in threat is uncertain.

There are also multiple cases in which plutonium or highly enriched uranium (HEU) have been stolen. International Agency Energy Agency (IAEA) Incident and Trafficking Database (ITDB) reports also deliberates on attempts of theft of nuclear material in the following words:

> "In 2018, 253 incidents were reported to the ITDB by 49 States indicating that unauthorized activities and events involving nuclear and other radioactive material, including incidents of trafficking and malicious use, continue to occur. As of 31 December 2018, the ITDB contained a total of 3497 confirmed incidents reported by participating States since 1993".[36]

India is home to a host of secessionist movements, saboteur and radical extremist groups ranging from Naxalites in the "red corridor' to secessionist movements in Kashmir and Punjab. The secessionist movements are supported by radical terrorist groups such as Jaish-e-Mohammed (JeM), Hizbul Mujahideen (HM) and Lashkar-e-Toiba (LeT) in Kashmir. Besides, there is also a rise in the Hindu extremist groups such as Rashtriya Swayamsevak Sangh (RSS), Bajrang Dal,

safety issues and physical protection form an important part of it. See D. Schriefer., "Nuclear Security - An Overview," *Nuclear Fuel Cycle Science and Engineering*, 2012, available https://www.sciencedirect.com/topics/engineering/nuclear-security. accessed on 10/09/2019,.

[35] C.J. Chivers, "The Doomsday Scam," *New York Times Magazine*, November 19, 2015, http://www.nytimes.com/2015/11/22/magazine/the-doomsday-scam.html? _r=0 (accessed September 5, 2020).

[36] "IAEA INCIDENT AND TRAFFICKING DATABASE (ITDB)," in IAEA, 2018 *Fact Sheet*.p 2-3 For details see full report available at https://www.iaea.org/sites/default/files/19/04/itdb-factsheet-2019.pdf

Vishwa Hind Parishad (VHP) that have the potential to ignite a communal conflict.[37] There is also emergence new separatist jihadi organisation like Ansar Gazwat-ul-Hind (AGH) and Islamic State Jammu and Kashmir (ISJK). These new separatist groups share a common ideology with Al-Qaida and IS, thus making nuclear terrorism threat real. The terror groups operating in India make the nuclear terrorism threat latent. Reshmi Kazi, a leading nuclear terrorism expert believes that, "The apprehension of nuclear terrorism is further strengthened with the reported incidents of smuggling of fissile material in India and in the subcontinent. Since 1993, nine trafficking cases involving uranium ore and LEU have been recorded in India, one in Bangladesh, and another in Pakistan."[38] She argues that the proliferation of the fissile material deserves attention as nuclear terrorism is gaining ground in South Asia.[39] Further the infamous black market which was started by Dr Abdul Qadeer Khan further raises the fear of illegal transfer or nuclear technology sold out to the terrorists .[40] Adrian levy and Catherine Scott-Clark argue that:

> Pakistan continues to sell nuclear weapons technology (to clients known and unknown) even as Musharraf denies it—which means either that the sales are being carried out with Musharraf's secret blessing, or that he did not know. . .[41]

Although, it is an established fact that nuclear establishments in India have high level in-built safety mechanism and security measures, making them relatively less vulnerable to sabotage, but there have been cases where terrorists have penetrated through high level security zones. And there have also been instances where natural uranium was stolen from the nuclear research centers.[42] Nuclear terrorism poses a high- consequence probability, therefore there is no room for complacency when it comes to the protection of nuclear establishments in India. The primary

[37] F. Hassan, "Tackling Nuclear Terrorism in South Asia," Prism 5, no. 1 (1998): 81–100.
[38] Reshmi Kazi, "The Danger of Nuclear Terrorism: The Indian Case," *Strategic Analysis* 33, no. 4 (2009): 498–515.
[39] Ibid
[40] Ibid
[41] Adrian Levy and Catherine Scott-Clark, *Deception: Pakistan, the United States, and the Secret Trade in Nuclear Weapons*, Penguin Books, New Delhi, 2007, p. 448. Cited in Kazi, "The Danger of Nuclear Terrorism: The Indian Case."
[42] For instance, in July 1998, the Central Bureau of Investigation recovered over 8 kilograms of natural uranium stolen from the Indira Gandhi Centre for Atomic Research (IGCAR) in Chennai. See "Uranium Racket Unearthed," *Indian Express*, July 23, 2002 Also see Hasan-Askari Rizvi. Basrur, Rajesh M, "Nuclear Terrorism and South Asia," *Cooperative Monitoring Center Occasional Paper* SAND98-050, no. 25 (2003): 65–67.

challenge before the policy makers is to secure the nuclear facilities from the terrorists and secure fissile materials against such acts.

Conclusion:

The Fukushima nuclear accident resulted in mixed trends with regard to nuclear energy. The accident revitalized anti-nuclear moments and dwarfed the projected growth of nuclear energy all around the world including India. Various European countries, like Germany decided to completely phase out nuclear energy from its energy basket. People started to raise concerns about safety against radioactive materials. India made significant progress in its indigenous nuclear energy program and incorporated best safety measures which are at par with international level in its reactor design. The negative public perception about the nuclear power has severely affected India's nuclear ambitions. India needs to follow a well-coordinated risk management and effective communication efforts to ensure wider public participation in nuclear projects. Besides, India being home to a host of secessionist movements, saboteur and radical extremist groups, makes its nuclear facilities prone to terrorist attacks. In the Post-Fukushima nuclear accident period India's nuclear programme has become vulnerable to cyber threat and nuclear terrorism, as there have been attempts of cyberattack by hackers belonging to different countries. And, India's muted response to cyberattacks shows that it is struggling to modernize its cyber security policies and needs to increase its focus on cyber security. Since nuclear terrorism is an unpredictable reality, India needs to develop an attribution capability similar to the nuclear attribution programme developed by the US Department of Defense. It also needs to develop and implement robust sabotage resistance safety systems to reduce the threat.