THE NUCLEAR SHADOW OVER KARACHI

MAR 17 2014 BY PERVEZ HOODBHOY, ZIA MIAN AND A. H. NAYYAR

Illustration: Minhaj Ahmed Rafi

UNTESTED CHINESE NUCLEAR TECHNOLOGY COULD IMPERIL THE CITY OF 20 MILLION.

A debate has started about the wisdom of building two large Chinese-supplied nuclear reactors in Karachi. The fundamental concern is that the nearly 20 million people living in Karachi—about one out of every 10 Pakistanis—could be at risk from these reactors.

The two reactors, worth $4.8 billion apiece, are to be supplied on a turnkey basis by the Chinese National Nuclear Corp. A soft Chinese loan of $6.5 billion apparently proved irresistible to the cash-strapped Pakistani government. This brand of reactor, known as the ACP-1000, has not yet been built or tested anywhere. The Pakistan Atomic Energy Commission (PAEC), which will operate these reactors, insists the reactors will be safe.

But unlike Pakistan's officialdom, which is determined to rapidly expand nuclear power generation, some Chinese industry insiders are fearful of the nuclear rush in their own

country. With billions of dollars at stake, they suspect that money, schedules, and outsourcing to unqualified subcontractors may become more important than nuclear safety. The former vice-president of the China National Nuclear Corp. recently stated that, “Our state leaders have put a high priority on [nuclear safety] but companies executing projects do not seem to have the same level of understanding.” It is one of these Chinese companies that has designed and will build the Karachi reactors.

Nuclear supporters in Pakistan point to the International Atomic Energy Agency (IAEA) and highlight that it visits nuclear power plants and makes sure they are safe. But the fact is that after the Fukushima accident, while addressing his board of governors, and the world, on March 21, 2011, the director-general of the IAEA stated categorically that, “We are not a nuclear safety watchdog … responsibility for nuclear safety lies with our member states.”

Risky Business

Advocates for the Karachi reactors claim that the so-called K-2 and K-3 plants (each with a generation capacity of 1,100 megawatts) are based on a Chinese adaptation of a long-established reactor type but with added safety features. Although the reactor is still in the process of design, they expect it to work safely and well.

But will this first of a kind reactor actually behave as it should? According to IAEA sources, Pakistan has not requested a safety review of the ACP-1000 design even though it is committed to buying two reactors of this type. This is odd. Sensible people would not even buy a used car without driving it to see if everything works, and no airline would consider buying a new jetliner without extensive flight-testing. Nuclear reactors have systems far more intricate than those inside the most complex passenger aircraft. This is for good reason; the consequences of a reactor failure could be immeasurably worse than an airplane crash.

Unlike Pakistan, China exercises caution in nuclear matters. It has asked for assistance from the IAEA’s Design and Safety Assessment Review Service with the ACP-1000. It plans to build two such reactors in China, and subsequently hopes to get permits for exporting similar units to Europe and North America. However, the IAEA review will not be a detailed, independent, international technical assessment of this reactor’s safety. According to the IAEA, the Generic Reactor Safety Review requested by China and scheduled to begin this May, “is focused on checking the status of the documentation (completeness and comprehensiveness)” compared to IAEA-recommended standards. The IAEA is explicit that this review is not “intended … to constitute any kind of design certification.”

As an importer of nuclear technology, China is a more discerning buyer than Pakistan. Today, a debate rages in China over the purchase of new, so-far-untested American nuclear reactors. A former vice-president of the China National Nuclear Corp. has gone on record saying China should not buy the new untested American reactors because, “This is very advanced technology, but it has not been commercialized in a nuclear reactor anywhere, so it needs to be proven over time.”

On the other hand, China National Nuclear Corp. seems to have no qualms about selling its untested reactors to Pakistan. Indeed, K-2 and K-3 construction was initially supposed to be coincident with the construction of two prototypes of the ACP-1000 reactor design in China. But nuclear industry sources have suggested that China may now abandon these prototype reactors in favor of a different design. The final decision is yet to be taken. Should this happen, the Chinese reactors in Karachi may well be the only ones of their kind built anywhere.

Instrumentation and control systems are another potential worry. For the prototype reactors planned for China, these systems will be supplied by the French nuclear company AREVA and the German industrial giant Siemens. A contract was signed in December 2013, but these European companies may not be allowed to sell the same systems for the Karachi reactors. If the Chinese nuclear industry has to produce such systems, they will be the first of a kind.

A troubling precedent suggests the need for caution.

In the 1990s, China designed and built a prototype nuclear reactor at Qinshan. An accident in 1998 due to a design flaw shut it down for a year. Initially the Chinese nuclear designers and operators could not understand or fix the problem, and had to contract a U.S. company for the repair work. One part of the reactor had to be redesigned. After this China did not build any more reactors of the Qinshan design for itself, but happily sold this type of reactor to Pakistan; four such reactors will eventually operate at Chashma. Pakistan was lucky that the reactor accident happened before the first Chashma plant went online. There was enough time for it to be redesigned to avoid the problem that led to the breakdown at Qinshan. But will Pakistan’s luck always hold?

Site and Sound

Reactor supporters are not worried about an earthquake or tsunami risk to the reactor site.

According to PAEC officials, the K-2 and K-3 site has been carefully studied and the IAEA is claimed as having approved the site. This is not as reassuring as it sounds.

At PAEC's request, the IAEA did indeed review, in 1998, a seismic study carried out at the Karachi Nuclear Power Plant (KANUPP), adjacent to the site of K-2 and K-3. But IAEA sources tell *Newsweek* that the IAEA has not specifically carried out an assessment for the new Karachi site.

From the documents made available for this piece, the PAEC seems to assume that the largest possible earthquake that might happen off the Makran Coast, shaking Karachi and unleashing a tsunami, would be an 8.3-magnitude event. This was the size of the 1945 Makran earthquake.

But new scientific research, published in 2013 by a team from Britain's National Oceanography Centre and Canada's Pacific Geoscience Centre, finds that the largest earthquake in the Makran area may, in fact, be a lot bigger than what the PAEC has assumed. The lead author of the study concludes: "Past assumptions may have significantly underestimated the earthquake and tsunami hazard in this region." The new research suggests the Makran area is capable of producing earthquakes as large as 9.2-magnitude ones. An earthquake of this size would be significantly larger than the 9-magnitude earthquake that hit Fukushima in March 2011. It would release over 20 times the energy of an 8.3-magnitude earthquake, assumed by the PAEC in its studies of the earthquake risk at the Karachi reactor site.

An earlier study, in 2007, of the earthquake risk to Karachi by a group of researchers from the United States and Pakistan looked at historical earthquakes over a period of more than 1,000 years and found the risk to be poorly understood. The study concluded that "Considering the number of known active [earthquake] faults that menace Karachi from almost every direction … it seems possible if not probable that hazard is higher than that assigned by recent national and global hazard maps."

Even in the 21st century, earthquakes remain notoriously unpredictable. Just a month before the Fukushima disaster, Japan's nuclear regulatory authority approved a request to run the nuclear plant there for another 10 years. This request had been supported by studies on the risk to the site from earthquakes and tsunamis. Everything looked okay. But, of course, it wasn't.

Fukushima was hit by a once-a-millennium event the nuclear industry's earthquake experts did not anticipate. The experts were clearly wrong about how big the biggest earthquake could be, where it could be, and the tsunami's strength. This was despite the fact that Japanese earthquake and tsunami researchers form a large and well-funded scientific community with the world's most advanced instruments and computer models, and have many hundreds of years of carefully collected earthquake and tsunami records to build on.

On the other hand, Pakistan has limited capability to monitor earthquake activity. In 2012, the National Seismic Monitoring & Tsunami Early Warning Center in Karachi complained that, "nearly half of the 62 seismometers working in the country are not transmitting real-time data to the national seismic-activity monitoring network." They had been disconnected for lack of money to pay the monthly connectivity cost of between Rs. 2,000 and Rs. 5,000 each.

Remember Chernobyl?

The vulnerability of nuclear reactors to lax attitudes about safety and a lack of experience by operators became catastrophically evident in the 1986 Chernobyl disaster. An IAEA investigation and report determined that "a poor level of safety culture" and the "lack of feedback of operating experience and the inadequacy of communication between designers, engineers, manufacturers, constructors, operators and regulators … were critical factors in the events leading up to the Chernobyl accident."

How vulnerable is Pakistan to the kind of human and institutional factors that led to the Chernobyl accident? Pakistanis are often willing to accept high levels of risk and place low priority to safety. The approach to problems in the general public is often unscientific; many are satisfied to place their faith in God as protector. Would these broadly shared social attitudes be reflected in how nuclear power plant operators handle problems?

A further concern is how well the Pakistani operators will understand and manage the new Chinese reactors. The operators, who will be from the PAEC, are likely to have less-than-complete knowledge of the imported nuclear plants because there was no real local input into the design or manufacture of key components and software.

Along with natural disasters and operator error, in Pakistan there is the need to worry about the risk of deliberate sabotage or terrorist attacks on nuclear reactors. Although PAEC officials dismiss the possibility—and one hopes they are right—the problem needs to be taken seriously.

Well-organized and well-armed religious terrorists, often with insider help, have successfully attacked even tightly guarded military institutions. The list includes places that would expect to be attacked in wartime and so should have been heavily defended—including the Pakistan Army's General Headquarters, the Navy's Mehran base, and the Air Force's Kamra base. If security forces cannot protect their own bases, it is hard to see how they could successfully defend a nuclear power plant.

Coping with Catastrophe

Accepting that a nuclear accident is unlikely, the question is how well could state machinery respond just in case one happened? Better than with natural disasters or industrial disasters? How well has Pakistan done in tackling them?

The 2010 floods—which left a fifth of Pakistan inundated and over 10 million people affected—were notable for the lack of urgent response from the president and prime minister. The National Disaster Management Authority responded sluggishly. The downstream population received little warning. With the state nowhere visible in many places, Pakistan's ubiquitous, armed jihadist groups substituted for it and played a major part in relief efforts.

Poor state control and monitoring also leads to frequent industrial accidents in Pakistan. These are underreported but often devastating. In 2012, a fire in one factory killed 300 people, but those responsible for ignoring safety standards have never been punished. In a nuclear accident, those affected could be in the millions but, again, those responsible may never be brought to task.

To be fair, the PAEC accepts that there can be a catastrophic nuclear accident and could require evacuation of Karachi's population. This is why they have prepared an emergency plan just in case something terrible happens. According to a press briefing given by the project manager of the new Karachi reactors, there is an evacuation plan for people living out to 15 kilometers from the site and the "Pakistan Army, provincial and national disaster management authorities and local administration and traffic police are in the loop in case of emergency evacuation."

But the choice of 15 kilometers for the emergency evacuation is arbitrary. The nature of the accident will determine how much radioactivity is released, and the wind will decide how fast and in which direction this radioactivity will go. The initial exclusion zone around the Chernobyl nuclear power plant after its accident was 30 kilometers and even today no one is permitted to live within this distance of the site. Similarly, at Fukushima, people within 30 kilometers were evacuated. Today, almost three years later, the area within 20 kilometers of the reactor is still defined as an evacuation zone, with people not allowed to live there.

The discipline of Fukushima's residents during their evacuation was exemplary. But a similar attempt in Karachi would likely result in unmanageable chaos. Roads would be jammed, and emergency personnel and law enforcers would be rendered immobile or might prefer to save themselves and take flight. In a city sharply divided between haves and have-nots, and with large sections run by criminal mafias, looting would be such a strong possibility that many would risk losing all they have—and hence refuse evacuation.

If the PAEC has a credible emergency evacuation plan, then it should hold public meetings across Karachi and explain its strategy. The citizens of Karachi should have the right to decide for themselves how well this plan deals with the challenge of their safe and speedy evacuation in case of a nuclear accident.

Unfortunately, there is evidence that nuclear evacuation plans have not been dealt with seriously in Pakistan. In its survey of the Karachi reactor site, the PAEC assumed that about 8 million people live within about 30 kilometers of the site as of 2011 and only 12 million people live within about 50 kilometers of the site. But it is obvious even to the casual

observer that all of Karachi falls within this distance of the reactor site and Karachi has a lot more than 12 million people living in it. The real population of Karachi may be closer to 20 million.

Is it safe to build a reactor so close to so many people? The United States has a hundred nuclear reactors, more than any other country in the world. U.S. Nuclear Regulatory Commission guidelines require that a reactor should be located so that there are not more than 500 people per square mile in any direction up to a distance of 20 miles (about 30 kilometers) of the site. These guidelines clearly say that, “A reactor should not be located at a site whose population density is well in excess of the above value.”

By the PAEC’s own counting, there are 8 million people within 20 miles of the site, a population density of 6,450 people per square mile—more than 10 times the population density considered acceptable by the U.S. Nuclear Regulatory Commission. The PAEC and the disaster management authorities need to explain how, if needed, they will carry out an emergency evacuation. How many people will have to be evacuated in case of an accident? How will so many people be moved so quickly and to where? How will they provide them shelter, food and water, hygiene and medicine, and for how long?

The experience from Fukushima and Chernobyl shows nuclear-accident evacuations can last for years and even decades. What would be the long-term economic consequences of a nuclear accident in Karachi? Just a few miles from the site of the new reactors is a very large concentration of industries. What would happen to all these businesses? If Karachi Port Trust and Port Qasim Authority have to be shut for weeks, months, possibly years, because of radioactive contamination, what would happen to all the industries and people across the country that depend on the imports and exports passing through these ports? If the PAEC knows the answers, they should make them public.

Visit Opacity

It is hard to get official answers to questions about anything nuclear in Pakistan. Citing national security reasons, opaqueness underlies all nuclear projects, civilian and military. The authorities strictly control regulatory mechanisms. Unlike in advanced countries, there is no public input on matters pertaining to nuclear plant location and safety, or disposition of nuclear waste. Citizens raising questions about nuclear safety are frequently labeled agents of foreign powers.

Nuclear authorities have a history of dismissing local concerns regarding public safety. Poor and powerless village communities around the Baghalchur area of Dera Ghazi Khan have reported health effects from uranium mining operations. Questions were asked in the National Assembly about the “serious hazard posed to the health and survival of residents of central Punjab by the shocking levels of toxic uranium waste being dumped in Baghalchur by government agencies” and why “PAEC refuses to answer.” The villagers mustered the courage to go to court and demand compensation. PAEC refused to give an answer in open court. Eventually, under pressure, the villagers withdrew their court cases.

Today, the PAEC claims that in its 40 years of operations the KANUPP reactor has never discharged a significant amount of radiation to Karachi’s environment. There is no independent means of saying whether this is true or false. Individuals not belonging to the PAEC, or the Pakistan Nuclear Regulatory Agency, are forbidden from attempting to monitor radiation levels near any nuclear facility.

The siting process for the new Karachi reactors has revealed a new reason for withholding vital information from the public and denying them any role in decision-making. The Environmental Impact Assessment for K-2 and K-3 was treated strictly as a formal requirement, empty of any real meaning. In late 2013, it was pushed through the Sindh Environmental Protection Agency (SEPA) surreptitiously and without a public hearing. The PAEC official in charge of the new Karachi reactor project told the press that, “We requested SEPA not to hold a public hearing because of international politics.” The rights of Karachi’s citizens were less important than the potential questions that might embarrass China’s nuclear industry.

Coming Soon

So far, mostly lawmakers and citizens connected with the city have raised concern about the Karachi reactors. But other Pakistanis may soon have to start worrying about the risks and consequences of nuclear accidents.

The two reactors planned for Karachi are the first step of a recently announced plan to build 32 nuclear power plants generating 40,000 megawatts at eight sites across Pakistan. Each site would have four plants of 1,100 megawatts each. There are reports that the government is discussing with China a deal to build three reactors at Muzaffargarh, near Multan, and one or more reactors at Ahmadpur East, near Bahawalpur; as many as six sites for reactors have been identified.

The drive for such a massive and rapid expansion of nuclear power comes from the PAEC. It is a powerful institution with tens of thousands of employees and a budget that in the financial year 2012-2013 was a whooping Rs. 39.2 billion. PAEC's clout owes to the role it played in the nuclear-weapons program, and this clout remains although the imported plants are under international safeguards and thus cannot contribute to bomb-making.

If the Karachi reactors go ahead, the nuclear shadow will spread across the country and will be here to stay for a very long time. The new reactors will take at least six years to build, and are claimed to have operational lifetimes of at least 60 years. This means the Karachi reactors will be around at least until 2080—unless there is an accident. Long after today's nuclear decision-makers are a distant memory, children in Karachi and at the other planned sites will have to rely on the safety of Chinese technology and good luck.

There are the alternatives. The *World Nuclear Industry Status Report 2013* found that China, Germany, and Japan—three of the world's top four economies—today generate more energy from renewable sources than from nuclear power. In 2012, China and India generated more power from wind than from their nuclear plants. Just last year, India installed 2,500 megawatts of wind power and has plans for expansion. China plans to increase its wind-power capacity from 75,000 megawatts today to a staggering 200,000 megawatts by 2020. In the U.S., which has 100 nuclear power plants, a recent government report found that within four years electricity from wind would be cheaper than nuclear power. Some 13,000 megawatts of wind power plants were installed in the U.S. last year alone. The global addition to wind power in 2013 was over 40,000 megawatts.

There is a great expansion underway also in using solar energy. India, which has over 2,000 megawatts of solar power, announced in February a plan to build a 4,000-megawatt solar plant in the Rajasthan desert. This is equivalent to four large nuclear reactors. The $4.4-billion plant will take seven years to build. The cost of electricity from solar power in India has fallen by more than half in just the past three years, and it is expected to become even cheaper.

Environment friendly and safe renewable energy sources are being rapidly adopted on a large scale into the world's energy economy for good reason. They can be built quickly, can be expanded incrementally, and do not require vast commitments of capital for long periods of time. They are also competitive in terms of electricity cost.

There is no need for a technological breakthrough. In 2012, the U.S. National Renewable Electricity Laboratory found that renewables could provide over three quarters of U.S. electricity generation by 2050, "using technologies that are commercially available today, while meeting electricity demand in every hour of the year in every region of the country."

What has Pakistan done about using its abundant wind power and solar energy resources? The government's Alternative Energy Development Board has officially estimated that 50,000 megawatts of wind power is available in just the Keti Bandar-Gharo area alone. The total capacity of existing windmills there is a mere 100 megawatts.

If Pakistan is going to rely on China to solve its energy problems, then why not import wind turbines and production technology from China? China, after all, is now designing and building its own windmills. Unlike enormously complex nuclear power plants, wind turbines and solar thermal plants could be manufactured locally and offer an important stimulus for the national economy. Turnkey nuclear plants require that nearly everything, including skilled labor, be imported.

Similarly, Pakistan could learn from and cooperate with India in wind and solar power. Pakistan, for example, could explore building a large solar plant in Thar. Pakistan could also make much better use of the electricity it already produces. The National Power Policy, 2013, admits that Pakistan has a "limited and crumbling transmission system" and that this "terribly inefficient power transmission and distribution system … currently records losses of 23-25 percent." This means that about a quarter of all electricity produced is lost (and/or stolen) on its way from power plants to the final consumers.

On top of transmission and distribution losses is the fact that the machines and appliances in common use in Pakistani factories, offices and homes are not energy efficient and so consume more energy than they should. The National Power Policy claims that, “a conservation program based upon energy-saver lighting is already underway with a potential of saving 1,000 megawatts if all 50 million consumers were to be converted to florescent bulbs.” This says, in effect, that simply by switching the country to more efficient light bulbs, enough electricity could be saved to do without one of the new Karachi nuclear reactors.

Pakistan can take the path of developing safe, clean, renewable energy. It can focus on energy efficiency and conservation on a large and sustained scale. For the time being, it has chosen instead to massively expand its generation capacity from nuclear power plants. The siting of large and unproven nuclear reactors so close to Karachi carries great and unnecessary risks that could prove very costly—economically and in terms of lives. Fortunately, there is still time to reconsider them.

From March 22, 2014, issue of Newsweek Pakistan. The authors are physicists with an interest in nuclear issues.