The North Korean Nuclear Crisis

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The confrontation between North Korea (Democratic Peoples Republic of Korea) and the International Atomic Energy Agency over North Korea's nuclear program presents a serious risk of war in Northeast Asia and poses an unprecedented test for the Nuclear Non Proliferation Treaty and the IAEA's system of inspections and audits called "safeguards." By withdrawing from the NPT and then suspending its withdrawal at the urging of the U.S., North Korea is claiming a "special status" that gives it the right to nuclear technology enjoyed by treaty parties, but not the obligation to open all its nuclear activities to IAEA inspectors. The crisis raises a number of important issues, including the effectiveness and enforceability of the NPT and IAEA safeguards, the proliferation risks of civilian use of weapon-usable nuclear materials (plutonium and highly enriched uranium), destabilizing interactions among nuclear programs using these materials in Northeast Asia, and potential consequences of conventional attacks on nuclear plants in North and South Korea that could amount to nuclear war conducted by conventional means. [M&GS 1994;1:164-175]

Introduction: Evolution of the Crisis

The nuclear research program of the Democratic Peoples Republic of Korea (DPRK) dates back to the ❧ 1950s, when the Korean government entered into nuclear cooperation agreements with the Soviet Union and China. In the mid-1960s, the DPRK received a small research reactor and critical assembly (a research tool used to sustain and study nuclear chain reactions) from the Soviet Union. At that time the DPRK was not a member of the Non-Proliferation Treaty (NPT). In 1977, the reactor and critical assembly were placed under limit-

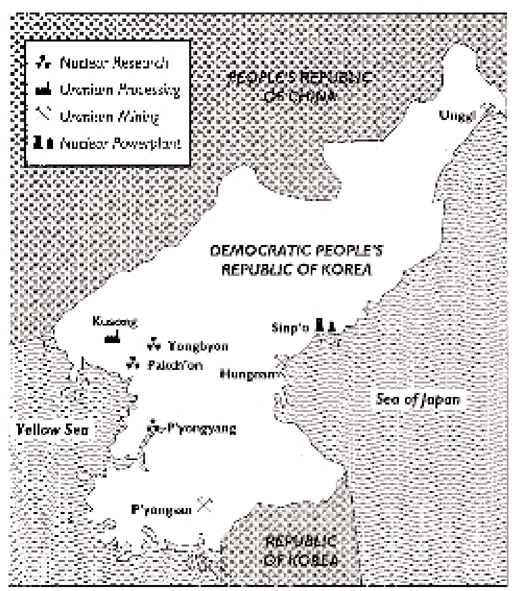

Figure 1. North Korean nuclear facilities (Adapted from Jane's Intelligence Review, February 1994.)

At the time of publication, PL was the president and SD the research director of the Nuclear Control Institute, a public-interest group concerned with nuclear proliferation.

Table 1. North Korea's Known Nuclear Infrastructure

	Type of Facility	Location	Operational	Declared Purpose	Source	Safeguards	Fissile Material/Fuel	Plutonium Prod. Capability
Critical Assembly	0.1 megawatts thermal (MWt) critical assembly	Yongbyon	Early 1960s	Isotope production	USSR	Limited, facility-specific, non-NPT safeguards agreement with IAEA concluded in 1977	??	
Research Reactor	8 MWt IRT-2000 research reactor (upgraded from 2 MWt)	Yongbyon	1967	Isotope production and scientific research	USSR; upgrade to 8 MWt used indigenous technology	Same as for critical assembly	Possibly highly enriched uranium containing 80% weapons-usable U-235	
Graphite Reactor 1	5 megawatts electric (MWe) gas graphite reactor (thermal power estimates vary from 20-50 MWt)	Yongbyon	1986[1]	Test atomic power plant[2]	Indigenous technology? Clone of UK Calder Hall reactor	Covered since 1992 by DPRK safeguards agreement with IAEA pursuant to NPT[3]	Metallic natural uranium	[4]
Graphite Reactor 2	50 MWe gas-graphite reactor (200 MWt)	Yongbyon	1995	Nuclear power program	Same as Graphite Reactor 1	n/a[5]	Metallic natural uranium	40 to 53 kg/year[6]
Graphite Reactor 3	200 MWe gas-graphite reactor (800 MWt)	Taechon	1996	Nuclear power program	Same as Graphite Reactor 1	n/a[5]	Metallic natural uranium	140 to 180 kg/year[7]
Radio-Chemistry Laboratory	Purex-type spent fuel reprocessing plant	Yongbyon	unknown[8]	Separation of plutonium for use in MOX fuel for nuclear power program; nuclear waste management	Indigenous technology?[9]	Covered since 1992 by DPRK safeguards agreement with IAEA pursuant to NPT[10]		200 kg/yr by late 1990s—enough for about 40 bombs
Fuel Fabrication Facility	Fuel fabrication facility	Yongbyon	1985-86 perhaps 1987	Fabrication of metallic natural uranium fuel for graphite reactors	Indigenous technology?	Covered since 1992 by DPRK safeguards agreement with IAEA pursuant to NPT[10]	200-300 metric tons per year, according to South Korean sources	

1. *Shut down for about 100 days in 1989 when at least a few damaged fuel rods (and possibly an entire core) were discharged.*
2. *No electric generating or transmission equipment installed until September 1992, just prior to third IAEA inspection.*
3. *Inspections interrupted by DPRK's temporary withdrawal from NPT in 1993. Safeguards agreement calls for IAEA inspectors on site only during refueling of reactors. Surveillance cameras and seals are in place between inspections. Most recent inspection began in May 1994.*
4. *David Albright at the Institute for Science and International Security (ISIS) estimated that the recently discharged core, if reprocessed, could provide 20 to 30 kilograms of plutonium—enough for about 4 to 6 bombs.*
5. *Nuclear material presumably not yet introduced into facility, so not yet subject to IAEA safeguards.*
6. *Albright calculated that this reactor, when completed, could produce 40 to 53 kilograms of plutonium per year—enough for 8 to 10 bombs. Defense Secretary William Perry recently stated that the reactor will produce enough plutonium for 10 to 12 bombs a year.*
7. *Albright calculated that this reactor could produce 140 to 180 kilograms of plutonium per year—enough for 28 to 36 bombs.*
8. *Facility will be completely operational in 1996. DPRK says plant has not yet been used, but blocked crucial elements of IAEA inspection in March 1994. IAEA saw some indications that plant may have been used. Second processing line may have been added since previous IAEA inspection in February 1993.*
9. *Based in part on Eurochemic blueprints for the Mol reprocessing facility in Belgium, published in IAEA technical reports.*
10. *Inspections interrupted by DPRK's temporary withdrawal from NPT in 1993. Most recent inspection May 1994.*

ed, facility-specific International Atomic Energy Agency (IAEA) safeguards that are applied to some imported nuclear facilities in non-NPT nations.

In the early 1980s, at Yongbyon, the DPRK constructed a 5 megawatt-electric (MWe), gas cooled, graphite moderated nuclear reactor, a clone of Great Britain's first reactor at Calder Hall that produced plutonium for Great Britain's nuclear weapons program. Fueled with natural uranium, the DPRK's reactor became operational in 1986 (see Figure 1, Table 1). Upon discovering that the DPRK was building this reactor, the U.S. pressured the Soviet Union to urge the DPRK to join the NPT. The DPRK joined the NPT in December 1985, perhaps persuaded by a Soviet offer of nuclear power reactors. These reactors were never constructed [1].

1987 NPT Violation Ignored

The NPT requires a member state to conclude a safeguards agreement with the IAEA within 18 months of becoming a party to the treaty. These safeguards agreements permit inspections of all plants containing fissile materials. The DPRK notified the IAEA 18 months after signing the NPT that it had been sent the wrong paperwork for the safeguards agreement -- that is, it received the form to be filled out for non-NPT safeguards rather than NPT safeguards. The IAEA responded by sending the DPRK the correct form and by giving the North Koreans another 18 months to complete it. Apparently under Chinese and Soviet pressure, neither the IAEA nor the Reagan or Bush administrations raised the matter of this clear violation of NPT obligations. Nor did they bring pressure on the DPRK to complete its inspections arrangement with the IAEA [2]. As a consequence, in 1989 the DPRK was able to shut down its 5 megawatt reactor at Yongbyon for about three months with no IAEA inspectors present. It is suspected of having then removed fuel containing enough plutonium for one or two bombs for its nuclear-weapons program. The DPRK did not enter into an NPT safeguards agreement with the IAEA until 1992, more than six years after joining the treaty.

In December 1991, North and South Korea signed a bilateral agreement prohibiting nuclear weapons, as well as uranium enrichment and plutonium reprocessing facilities, from the Korean peninsula. A month earlier, U.S. Secretary of State James Baker had urged that there be an agreement prohibiting acquisition of any weapons-usable nuclear materials (plutonium and highly-enriched uranium), as well as construction of facilities to produce them. But the materials-acquisition element was not included in the final bilateral agreement. This agreement is still not in effect, because negotiations on its implementation and verification became entangled with broader talks on North-South Korean relations and possible reunification, which remain dead locked.

The DPRK finally concluded its NPT safeguards agreement with the IAEA in early January 1992. That June the first inspections under this agreement commenced. At this time the DPRK admitted that it was constructing a large reprocessing plant, which it called a radiochemical laboratory, at Yongbyon, near its reactors. This plant was reportedly first detected by U.S. intelligence satellites in late 1988 or early 1989 [3]. Reprocessing chemically separates plutonium, a weapons-usable fissile material, from uranium and from fission products in spent nuclear reactor fuel.

The DPRK declared that it had removed a number of damaged fuel rods from its gas graphite reactor when it was shut down for about 100 days in 1989, and that these rods had been reprocessed in March 1990 to separate small amounts (gram quantities) of plutonium, samples of which were provided to the IAEA for analysis. The DPRK also admitted that in 1975, using Soviet-supplied "hot cells" (laboratory-scale reprocessing units), it had separated minute amounts of plutonium from uranium irradiated in its research reactor.

Plutonium Diversions Suspected

In July 1992, the IAEA analyzed samples of separated plutonium provided by the DPRK, as well as samples of radioactive materials from the North Korean hot cells. Based on differing amounts of the radioactive isotope americium-241 (a decay product of plutonium) in the samples, the IAEA concluded that the DPRK must have reprocessed on at least three separate occasions in 1989, 1990, and 1991. The DPRK denied this charge [4].

In February 1993, during its sixth visit to the DPRK, the IAEA was refused permission to inspect two sites at the Yongbyon facility that inspectors had visited briefly in September 1992 and that were believed, reportedly on the basis of satellite photos provided by U.S. intelligence, to contain reprocessing waste not declared by the DPRK [5]. The DPRK denied that the sites contained nuclear waste and refused to permit inspection of the facilities on the grounds that they were military sites not related to the nuclear program. The IAEA was not satisfied with this explanation. On February 25, the IAEA Board of Governors formally demanded that the DPRK permit a "special inspection" -- that is, a visit to a site where the presence of undeclared or diverted fissile material is suspected.

In response, the DPRK announced on March 12 that it was withdrawing from the NPT, and gave three months notice as required by the treaty. The U.S. led a strenuous diplomatic effort to keep the DPRK in the treaty. On June 11, one day before the three-month notice period ended, the DPRK announced that it would "suspend" its withdrawal from the NPT "for as long as is necessary." The DPRK still refused, however, to permit special inspections of the suspected nuclear waste sites.

Throughout the summer of 1993 bilateral talks continued between the U.S. and the DPRK, and between North and South Korea, to attempt to resolve the inspection impasse. At one point, the DPRK indicated its willingness to abandon reprocessing and plutonium if the U.S. provided it with light water reactors, a technology somewhat more proliferation-resistant than the gas-graphite reactors. [Ed. note: At press time, the U.S. government announced it had reached just such a bilateral agreement with North Korea.]

The talks failed to make major progress. The U.S. insisted that the nuclear impasse be resolved prior to discussion of the broader U.S.-North Korea relationship. The DPRK demanded that nuclear questions be dealt with simultaneously, as one part of an overall "package deal" involving its demands for a permanent suspension of annual "Team Spirit" military exercises by the U.S. and South Korea and for formal diplomatic relations with the United States. Talks between the IAEA and the DPRK also continued without progress.

In early March 1994, an IAEA inspection team visited the DPRK, but was not permitted to take samples or radioactivity measurements from crucial portions of the Yongbyon reprocessing plant. These steps were needed to determine whether reprocessing had taken place since the last full inspection more than a year earlier (the DPRK claimed that it had not). Some seals also showed signs of tampering. In addition, the inspectors found evidence, but were unable to confirm, that the DPRK had begun construction of a second, undeclared reprocessing line at the facility near Yongbyon, potentially doubling its plutonium-separation capacity. As a result, the IAEA Secretariat informed the Board of Governors on March 16 that it could not verify non-diversion.

The U.S. threatened to call for UN Security Council approval of economic sanctions if the DPRK continued to resist inspections. The DPRK responded by accusing the U.S. of driving the situation to the brink of war, and warned that Seoul would be rendered "a sea of fire" if hostilities broke out. On March 31 the UN Security Council called upon the DPRK to permit full inspections. The call took the form of a non-binding appeal, rather than a resolution, for fear that China would veto stronger action. The DPRK rejected the appeal and said it would resume certain unspecified "peaceful nuclear activities" that it had suspended. IAEA inspectors were eventually allowed to return to Yongbyon and complete the inspection.

Defueling of Yongbyon Reactor Begins

On May 12, the DPRK announced it had begun defueling its 5 MWe reactor at Yongbyon, despite the fact that IAEA inspectors were still en route and not present to witness the procedure. On June 3 IAEA Director General Hans Blix announced that the DPRK had defueled so much of the reactor that it was no longer possible for inspectors to acquire the data they needed to determine the reactor's operating and fueling history. On June 8, the DPRK hinted it might agree to full inspections if the U.S. resumed negotiations. The U.S. rejected this offer and the State Department claimed that the DPRK had "crossed the point of no return" by unloading almost all the fuel from its gas-graphite reactor, thereby destroying evidence needed for the IAEA to deter mine how much plutonium-bearing fuel was unloaded in 1989.

On June 17 and 18, former President Jimmy Carter met with Kim Il Sung in Pyongyang to discuss the nuclear crisis. Carter stressed that he was traveling as a private citizen and did not represent the U.S. government, but still managed to extract an offer from Kim Il Sung to defer reprocessing and refueling of the 5 MWe reactor, in exchange for U.S. postponement of its campaign to impose sanctions on the DPRK and for renewal of bilateral talks with the United States. Though distressed by Carter's statement that the U.S. had already agreed to postpone sanctions, the Clinton administration's overall reaction to this offer was favor able and bilateral talks resumed in Geneva on July 8.

On the same day, the DPRK announced that Kim Il Sung had died of a heart attack. His successor, expected to be his son Kim Jong Il, was not immediately announced, prompting Western fears of a destabilizing crisis over succession and a possible military coup. As of this writing, these fears have not materialized, and Kim Jong Il appears to be the DPRK's next leader. Bilateral talks were suspended for Kim Il Sung's funeral and the DPRK's period of mourning, but resumed in Geneva the first week of August.

North Korea's Nuclear Program: The Reasons for Concern

There are three primary reasons for concern about the DPRK's nuclear program. The first relates to the DPRK's continued defiance of IAEA safeguards, its March 1993 withdrawal from the NPT (which, although suspended, was never renounced entirely), and its subsequent withdrawal from the IAEA. The DPRK now claims a "unique status" under the NPT as a nation that has withdrawn and then suspended that withdrawal. The DPRK claims its unique status allows it to accept some IAEA inspections and safeguards while rejecting others. Such unique status is neither claimed nor recognized by any other nation [6].

Second, the DPRK's history of military aggression and terrorism, its enormous conventional military capability, and its record as a major exporter of missiles and other conventional arms to the Middle East all provide a context that makes its nuclear ambitions particularly threatening.

Third, the DPRK's choices of technologies for its nuclear program make no economic or technical sense for a nuclear power program, but are perfectly logical for a nuclear weapons production effort. Natural uranium-fueled reactors similar to the

DPRK's were the technology of choice for weapons-grade plutonium production in each of the five declared nuclear weapons states [7]. Moreover, the DPRK's Yongbyon reactor, operational since 1986, was not connected to electrical generators or power transmission lines until 1992, just prior to the third IAEA inspection [8].

Most significant, a civilian nuclear power program on the small scale of the DPRK's would have no sensible use for a large plutonium reprocessing plant such as that at Yongbyon. The DPRK's justifications for this plant (future development of breeder reactors and waste management) ring hollow, but are legitimized under the terms of the NPT and IAEA safeguards [9]. They also parallel those of Japan, whose extensive plutonium program has the approval of the United States (although it should be stressed that Japan accepts full IAEA safeguards, while the DPRK does not). This inconsistency in U.S. policy further complicates non-proliferation diplomacy with the DPRK.

Several other developments suggest that the DPRK seeks to acquire a nuclear weapons capability. In December 1992 a planeload of 36 Russian scientists was stopped by Russian authorities on the runway in Moscow, just before taking off for Pyongyang. According to security analyst Andrew Mack, "although the Sunday Times report referred to 'nuclear' scientists, Russian Security Minister Vicktor Barranikov later stated that the scientists had in fact been hired "to build missile complexes capable of delivering nuclear warheads'" [10]. There have also been unconfirmed reports that 56 kilograms of plutonium may have been smuggled out of the former Soviet Union to North Korea [11]. In the last few years U.S. intelligence satellites have detected more than 70 pits in the sand banks of the Kuryong River near the Yongbyon nuclear facility, suggesting evidence of testing of the non-nuclear elements of the triggering package for an implosion-type nuclear weapon. It is unclear, however, why the DPRK would choose to conduct such tests in the open and near a nuclear research facility, where they would be bound to generate suspicion [8].

Plutonium and Nuclear Weapons

Plutonium is one of two fissile materials, the other being highly enriched uranium (HEU), either one of which can comprise the essential ingredient for a nuclear weapon. When compressed into a critical mass, these radioactive materials fuel the fast chain reaction that produces a nuclear explosion. As little as four kilograms of plutonium, an amount about the size of an orange, is enough to produce a nuclear explosion [12].

Plutonium is not found in nature, but is produced in nuclear reactors when neutrons freed by the controlled chain reaction collide with and are absorbed by atoms of uranium-238 to create plutonium-239. When used (or "spent") uranium fuel is removed from a nuclear reactor, it can be chemically processed to separate out the plutonium, which can then be used as fuel for nuclear reactors or for nuclear bombs. The IAEA is concerned that some or all of the fuel previously removed by the DPRK from its gas-graphite reactor at Yongbyon might have been diverted from safeguards and reprocessed to separate plutonium for use in nuclear weapons [13].

The IAEA analyzed plutonium samples provided by the DPRK. By analyzing the radioactive isotopes present in this plutonium, as well as samples from the hot cells (process stages of the Yongbyon reprocessing plant) where this plutonium had been separated from spent fuel, the IAEA was able to estimate when the reprocessing took place. The DPRK claims it reprocessed only a few damaged fuel rods in 1989. The IAEA's isotopic analysis indicated that reprocessing had to have occurred on at least three separate occasions in 1989, 1990, and 1991, at the Yongbyon facility [14]. This led the IAEA to suspect that the DPRK may have removed more fuel in 1989 than it had declared, reprocessed it, and hidden the separated plutonium and reprocessing waste from the IAEA.

Suspicion that the DPRK was hiding undeclared reprocessing waste triggered the IAEA's insistence on special inspections at two sites in 1993. This request was refused in March 1993, which marked the beginning of the crisis that led to the DPRK's withdrawal from the NPT.

In early 1992, the Soviet press quoted a KGB document reporting that the DPRK had already manufactured two nuclear-weapon triggering devices [15]. U.S. intelligence believes that the DPRK may already have separated enough plutonium for at least one bomb [16]. The largest estimate is from Dr. Taewoo Kim, president of the Institute for Peace Strategy in South Korea, who contends that the DPRK might possess enough separated plutonium for up to 14 bombs [17]. In July 1994 a defector who claimed to be the son-in-law of the DPRK's prime minister alleged that North Korea had constructed five nuclear warheads and was working on an additional five, as well as the technology to mount the warheads on ballistic missile delivery systems [18,19]. South Korea and the IAEA later rejected the defector's story as not being credible.

The technical community widely accepts the premise that the principal obstacle to building nuclear weapons today is obtaining the essential nuclear material -- separated plutonium or highly enriched uranium. A nation with a nuclear infrastructure such as the DPRK is assumed to be able to build at least World War II-type nuclear weapons, although not necessarily more advanced designs that could be delivered by missiles.

What Might the DPRK be Hiding?

The IAEA wants to conduct special inspections at two sites near the Yongbyon facility. The DPRK refuses even to discuss the possibility of such inspections. The IAEA also had hoped to take random samples from some 300 of the 8,000 fuel rods removed from the gas graphite reactor at Yongbyon. This is important so that the IAEA can determine how much plutonium is contained in the spent fuel. Sampling could also assist the IAEA in deter mining how long the fuel was in the reactor, which would help determine whether an entire core (or a partial one) was removed during the 1989 shutdown. The IAEA has stated, however, that any chance to answer that question was lost when the DPRK defueled the reactor without setting aside fuel rods specified by the Agency [20]. The DPRK will not allow the IAEA to take samples from the fuel rods which remain under IAEA safeguards at the moment. Moreover, there is now no way to determine where the fuel rods were located inside the reactor before they were removed -- information important for interpreting amounts of plutonium found in the spent fuel.

Despite its threatened withdrawal from the NPT and its actual withdrawal from the IAEA, so far the DPRK has allowed IAEA inspectors to remain [21] and as long as they do, it should be possible to confirm that no additional fuel is being removed to the reprocessing plant for extraction of weapons-usable plutonium. If these inspections continue, the effect will be to "cap" at least this element of the DPRK's suspected nuclear weapons program.

In addition to plutonium, nuclear bombs can be made from highly enriched uranium (HEU). HEU for weapons usually consists of 90% or more U-235, the isotope that sustains the chain reaction in both nuclear reactors and nuclear bombs. Because natural uranium contains less than 1% U-235, an expensive, technically complex process known as enrichment is required to separate the U-235 from the most abundant isotope, U-238. Most of the undeclared nuclear facilities discovered in Iraq after the Gulf War were part of a large-scale uranium enrichment program.

No such facilities are publicly known to exist in the DPRK. But unconfirmed South Korean reports indicate that a uranium enrichment facility was established in the mid-1980s near Pyongsan, about 95 kilometers southeast of Pyongyang (Fig 1) [8]. These reports do not indicate either the capacity or enrichment technology of such a plant, but if confirmed the DPRK could possess an unsafeguarded source of weapons-usable material in addition to its reprocessing plant. The DPRK's expertise in tunneling technology also raises the possibility that it could build additional reactors and reprocessing plants, as well as enrichment facilities, underground, without these facilities being detected by either the IAEA or Western intelligence [23].

Potential Nuclear Consequences of a Conventional Korean War

A conventional war on the Korean peninsula could have major nuclear consequences in the form of radioactive releases if reactors and other nuclear plants were targeted and destroyed. This danger is not widely recognized, but is known to be a major factor inhibiting a more aggressive U.S. response to the DPRK's defiance of inter national nuclear inspections and other NPT obligations. The DPRK's reactors presumably could be bombed in a way to collapse upon themselves and cause minimal radioactive releases -- as was the case when allied forces destroyed Iraq's research reactors during the Gulf War. (The DPRK has two larger power reactors under construction, but like the unfinished Iraqi reactor destroyed by Israel in 1981, they would not give off radioactive releases if bombed.) The Yongbyon reprocessing plant conceivably could be bombed in a way to minimize releases if no spent fuel is present in the plant and if high-level reprocessing waste tanks are not hit. Such a "benign" or "surgical" strike, however, may not be possible in practice.

In South Korea there are nine large operating nuclear power reactors located 125 to 250 miles from the North Korean border [23], any one of which, if destroyed in an attack, could cause Chernobyl-type effects. These reactors are clustered as many as four to a site. Thus, the toxic effects could be compounded if more than one were destroyed in an attack.

Reactors, despite their massive size, are vulnerable to conventional explosions -- including truck bombs. The U.S. Nuclear Regulatory Commission (NRC) recently ordered nuclear utilities to build barriers against truck-bomb attack, as the result of two events last year -- the truck-bombing of the World Trade Center and a security penetration at the remaining nuclear power plant at Three Mile Island by an intruder who crashed his car into the turbine building of the plant [24]. Although a reactor cannot explode like a nuclear weapon, a large conventional explosion could destroy a reactor's redundant safety systems, cutting off water that cools the core and causing the radioactive fuel to melt down. There could be similar consequences if a plant were "decapitated" by destroying its control room.

A military attack against a reactor could break open the containment dome and cause maximum dispersal of the radioactive poisons in the core. Such a catastrophic release could affect 2,000 to 5,000 square miles and cause hundreds of thousands of excess deaths over subsequent years in densely populated countries such as South Korea and Japan. Although early fatalities are probable, most deaths would likely be caused by late cancers. Over time there could also be severe genetic effects [25].

The DPRK's Scud B missile has a range of 175 miles; the Scud C's range is 375 miles. The No-dong-1 missile, now under development and test-fired last year into the Sea of Japan, has a range of at least 625 miles and two other missiles are under development with ranges exceeding 1,200 miles [26]. All these missiles are notoriously inaccurate and might not come close enough to a reactor to severely damage it with a conventional warhead. Reactors in South Korea and Japan, however, are within easy range of North Korean aircraft, and South Korea's reactors would be vulnerable to North Korean artillery and commando attack in a war. South Korea's reactors deliver a total of 7,600 megawatts of electrical power (MWe) and range in size from 650 to 950 MWe each (see Figure 2). Six of them are 950 MWe [23]. The core of a 1,000 megawatt reactor contains some 5 million curies of strontium-90 and 6 million curies of cesium-137 -- two of the deadliest and longest-lived radioactive poisons. By comparison, a 20-kiloton, Hiroshima-scale bomb gives off 2,200 curies of strontium-90 and 3,200 curies of cesium-137. Expressed another way, the strontium and cesium contained in the core of a single 1,000 megawatt nuclear power reactor is equivalent to the strontium and cesium fallout created by 70 to 90 megatons of nuclear explosions, or 350-450 nuclear weapons, each with a yield of 200 kilotons [27].

In addition to strontium and cesium, nuclear reactors produce large amounts of plutonium -- the deadliest radioactive element. The Nagasaki bomb contained about 6 kilograms of plutonium (about 13 pounds), of which only about 1 kilogram was consumed by fission, leaving 5 kilograms dispersed in the fallout. By comparison, a 1,000-megawatt reactor contains about 500 kilograms of plutonium in its core. Thus, a nuclear power reactor contains plutonium comparable to what would be dispersed by 100 fission weapons [27]. A few micrograms of plutonium, about the size of a pollen grain, can cause cancer if inhaled and caught in the lung or if absorbed elsewhere in the body after being ingested or passing through a cut or wound.

Even if war on the Korean peninsula were known to be imminent, South Korea (which is dependent on nuclear power for 40% of its electricity) could not shut down its reactors fast enough to prevent major releases in the event of an attack. The "residual heat" in the core of an operating reactor is so great that a 1,000-megawatt reactor would have to be shut down for several weeks for the heat to dissipate sufficiently to avoid a meltdown in case of attack. An attack could also cause cooling water to drain from the spent-fuel storage pond on the plant site, and there could be additional releases from melted fuel.

Thus, the possible nuclear consequences of a conventional war should be a major factor in considering any action that could provoke a war on the Korean peninsula.

The Role of South Korean and Japanese Nuclear Programs in the Crisis

The North Korean nuclear crisis is perpetuated by a regional triangle of misperception and mistrust. Each of the three regional actors (Japan, the DPRK, and South Korea) suspects the other two of harboring military intentions for plutonium. Each actor could become less willing to forego its own plutonium option and, thus, reinforce the fears of the other two.

The DPRK has repeatedly accused Japan of pursuing nuclear weapons through its plutonium program. The accusation was first made by the DPRK at an IAEA Board of Governors meeting in the fall of 1991 [28]. The DPRK has pointed to Japan's surplus of plutonium as indications of a bomb program. The DPRK's Korean Central Broadcasting network reported last year that "if the plutonium Japan has brought in is for peaceful use, as the Japanese ruling circles claim, the quantity they stockpile is too large, and they need not bring it in such secrecy, hiding it from people's eyes. Japan is scheming to stockpile enormous quantities of plutonium to produce nuclear weapons massively at any time it chooses " [29]. The DPRK's government-controlled press also cited Japan's fast breeder reactor program (which in fact pro duces weapons-grade plutonium) and sea shipments of plutonium from Europe as proof that "the danger of Japan's nuclear armament presents itself as a thing of the present-day reality, not of a distant future" [30].

To some extent this is propaganda to divert attention from and to justify the DPRK's own plutonium efforts. Nonetheless, some of the DPRK's fear of a nuclear-armed Japan could well be genuine, given Japan's close alliance with the U.S. and the historical enmity between Japan and Korea. At any rate, the DPRK has used Japan's plutonium program to justify its own and has closely linked a halt in Japan's plutonium program to the resolution of the nuclear impasse on the Korean peninsula.

The DPRK has challenged the nonproliferation bona fides of South Korea as well. Earlier this year, a North Korean Foreign Ministry memorandum accused South Korea of "stockpiling of plutonium through the PHWR [pressurized heavy water reactor] and completion of a system for the full-scale nuclear weapons development....It follows that the PHWR operating in South Korea since 1983 has by now produced potential plutonium enough to manufacture over 370 atomic bombs" [31]. This claim ignores the important distinction between weapons-usable, separated plutonium and plutonium that remains inaccessible for direct use in weapons so long as it is contained in spent fuel, but it does demonstrate the complex interaction of regional nuclear programs.

South Korea, in turn, has expressed grave concerns about the North's plutonium program. South Korea, acutely aware that it could be the first target of any North Korean nuclear weapons, has steadfastly insisted that the North abandon reprocessing. Less widely publicized are South Korean fears of Japan's plutonium program. An official in the South Korean Ministry of Foreign Affairs stated in December that "his government is keenly suspicious of Japanese defense policies and Tokyo's accumulation of plutonium stockpiles" [32].

Japan is greatly concerned about the North Korean program, having gone so far as to hint at Japanese withdrawal from the NPT if the North gets the bomb. Kabun Moto, at the time Japanese Foreign Minister, stated in July 1993 that "there is a clause in the NPT allowing withdrawal from the treaty. If North Korea develops nuclear weapons and that becomes a threat to Japan...if it comes down to a crunch, possessing the will that 'we can do it' is important" [33]. Japanese officials and nuclear industrialists have also

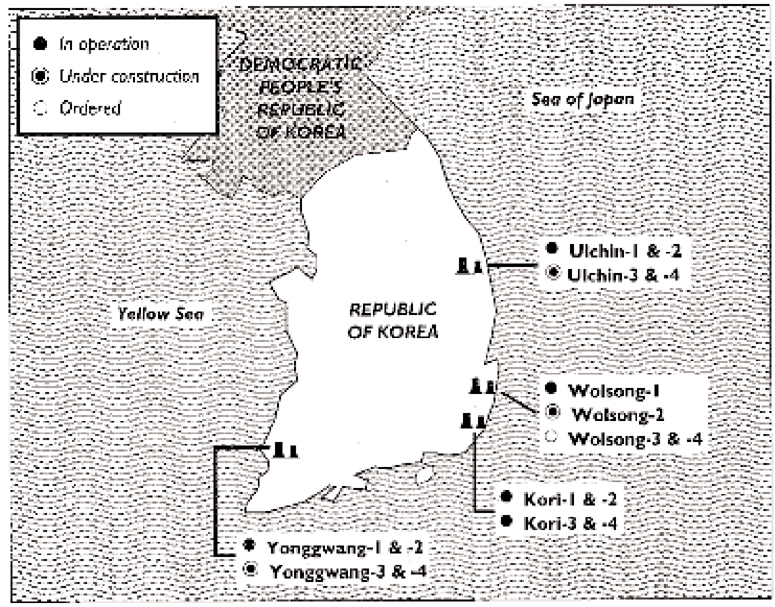

Figure 2. South Korean nuclear power plants (Source: Korean Electrical Power Company)

made it clear in direct communications with the Nuclear Control Institute that they would not favor South Korea's acquiring plutonium because of proliferation risks.

Clinton Administration Plutonium Policy and North Korea

U.S. policy on the use of plutonium has remained essentially the same under the Reagan, Bush, and Clinton administrations: the DPRK and South Korea must renounce all plutonium, but Japan can acquire as much as it wants from U.S.-supplied nuclear fuel. This discriminatory approach was reiterated by President Clinton, whose nonproliferation policy states, "The United States does not encourage the civil use of plutonium and, accordingly, does not itself engage in plutonium reprocessing for either nuclear power or nuclear explosive purposes. The United States, however, will maintain its existing commitments regarding the use of plutonium in civil nuclear programs in Western Europe and Japan" 1341. (At the same time, U.S. Energy Secretary Hazel O'Leary has launched an initiative to explore alternatives to reprocessing and has expressed her opposition to reprocessing and plutonium fuel cycles.)

The U.S. has insisted that the DPRK give up its reprocessing plant and all plutonium ambitions. South Korean efforts to acquire reprocessing plants, plutonium separation technology, and related technology have also been quashed by firm U.S. diplomacy. U.S. plutonium policy toward Japan is governed by the 1988 revision of the U.S.-Japanese nuclear cooperation agreement that gave Japan advance approval to reprocess as much U.S.-origin spent fuel as it wants over a 30-year period [35]. The previous agreement, which was not due to expire until 2003, empowered the U.S. to decide each Japanese request for reprocessing and plutonium use on a case-by-case basis.

In November 1991, while the North-South Korean bilateral denuclearization agreement was being negotiated, then-U.S. Secretary of State James Baker made clear that prohibiting fuel cycle facilities was not sufficient, and "the only firm assurance against a nuclear arms race in the Korean peninsula would be a credible agreement by both Seoul and Pyongyang to abstain from the production or acquisition of any weapons-grade nuclear material" [emphasis supplied] [36]. It is significant that the North South agreement included a ban on production but not on acquisition of plutonium -- thus presumably leaving South Korea free to seek reprocessing services and delivery of separated plutonium from the U.K. or France, as Japan has done.

The present U.S. discriminatory policy may not prove diplomatically sustainable. Japan and South Korea are democratic governments, they are NPT members with full-scope safeguards, and they have defense treaties with the U.S. and large-scale nuclear power programs. The U.S. State Department must explain to South Korea why it trusts Tokyo, but not Seoul, with plutonium. U.S. policy suggests that NPT membership and IAEA safeguards compliance are the ultimate solution to the Northeast Asian proliferation problem. Absent the elimination of civil plutonium, however, this approach can only serve to codify the problem with an NPT/ IAEA stamp of approval.

Possible Solutions to the Crisis

Currently, the IAEA is insisting upon sampling and analysis of the spent fuel removed from the DPRK's gas-graphite reactor at Yongbyon, a policy that amounts to an attempt to "roll back" the suspected DPRK nuclear weapons program [37].

The DPRK refuses to allow this sampling, presumably because it would definitively prove that the DPRK had diverted fuel in 1989 and, therefore, had presumably reprocessed and separated more weapons-usable plutonium than declared. A new crisis could then arise over efforts to force the DPRK to confirm the existence of this plutonium (and thus destroy any weapons made with it) and give it up or at least place the plutonium under safeguards. Given the North Korean regime's apparent fear that the U.S. wants to destroy it, it is unlikely to give up any nuclear deterrent it has or has led us to believe it has.

One possible alternative to rollback would be to "cap" the DPRK nuclear program at current levels by conceding for the moment the one or two bombs the DPRK might now have, while pressing for continuation of IAEA safeguards on the fuel now being removed from the 5 MWe reactor at Yongbyon. The North Koreans apparently object not to the IAEA's monitoring of the fuel rods to ensure they remain at the reactor site, but only to the assaying of some of the rods to determine whether plutonium was previously diverted from the plant. The U.S. and other nations could provide technology to ensure safe storage of this fuel without reprocessing. This approach could avoid a showdown that might precipitate a war with severe nuclear consequences, even if nuclear weapons were not used (see above). This approach, however, would concede the DPRK's violation of the NPT.

Another approach to capping the North Korean nuclear program would be to let the DPRK out of the NPT, to press for a Security Council resolution condemning the DPRK and prohibiting any assistance to it that could be applied to its nuclear program, and to insist upon IAEA non-NPT safeguards on the fuel.

The advantage of this approach is that it refuses to accept the DPRK's exploitation of the benefits of being neither in nor out of the treaty. With the NPT up for extension next year, the treaty will be severely undermined if the situation with the DPRK is essentially the same at that time as it is today -- a treaty party in clear violation of the NPT. At a meeting of the Atlantic Council in Washington, DC on July 22, 1994, Dr. Bruno Pellaud, deputy director general and head of the safeguards division at IAEA, stated that although nobody wants to force the DPRK out of the NPT, IAEA may be getting to the point that it needs to declare it cannot implement safeguards in North Korea. DPRK's formal departure from the treaty, he said, would at least clarify its noncompliance status [20]. It may be better to deal with the DPRK as a non NPT nation and seek to cap its program, as we are attempting to do with such other non-NPT states as India, Israel and Pakistan.

This approach would have the disadvantage of ending full-scope safeguards on the DPRK nuclear program. Yet those safeguards are currently more honored in the breach than in the observance, with the DPRK claiming the right to choose what safeguards it will permit. The principal difficulty in letting the DPRK out of the NPT is the signal it might send to potential renegade NPT states such as Iran and Libya that they can gain all the diplomatic and technical benefits of NPT membership, complete their nuclear weapons program, and then drop out of the treaty without penalty. This undesirable effect could be countered, however, by making clear to such NPT parties that initial violations of the NPT will no longer be tolerated and overlooked, as was the case with the DPRK's failure to make good on NPT safeguards commitments in 1987.

Finally, the U.S. should not succumb to pressure from the DPRK to transfer a light-water reactor (LWR). The U.S. has offered to help North Korea acquire two LWRs if Pyongyang halts reprocessing, seals off its reprocessing plant, and halts construction of two additional graphite-moderated reactors [38]. U.S. officials assert that trading the DPRK an LWR for an agreement to shut down its gas-graphite reactors and reprocessing plant would enhance non proliferation, both by reducing the amount of plutonium produced in the DPRK's reactors and by making the DPRK dependent upon foreign sources of low-enriched uranium fuel [39]. It is true that an LWR produces less plutonium per unit of uranium fuel than a gas-graphite reactor. The difference, however, is marginal from a nonproliferation perspective: typical LWR spent fuel still contains about 10 kilograms of plutonium in every metric ton of spent fuel. At this rate, a large (1000-MWe) LWR produces about 260 kilograms of plutonium annually, enough to make 30 to 60 nuclear bombs if the fuel were reprocessed. Moreover, the DPRK might well tolerate dependence on foreign sources of enriched uranium fuel just long enough to build up a substantial stockpile of spent fuel for subsequent reprocessing, or to develop uranium enrichment capability, or both.

Transfer of an LWR to the DPRK could have a devastating effect on the nonproliferation regime, by sending a clear message that noncompliance with the NPT will not only be tolerated but rewarded. Instead, the U.S. should offer to transfer clean-coal combustion and energy efficiency technologies to the DPRK. Whether accepted or not, such an offer would put to the test the DPRK's claim that it seeks nuclear power solely for electricity generation [40].

The stakes have never been higher for nuclear nonproliferation, and it remains to be seen whether U.S. diplomacy and international institutions can meet the challenge. The broader lessons -- the inherent threat to world order from plutonium and HEU fuels and the need to overhaul the NPT and IAEA regimes to prohibit use of these exceedingly dangerous materials -- must not be forgotten once the current crisis has passed. ❧

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