

Nuclear Latency (NL) Dataset
Country Coding Sheets

REPUBLIC OF KOREA
COW COUNTRY CODE: 732

List of Country's Enrichment and Reprocessing (ENR) Facilities

1. KAERI (Laboratory for Quantum Optics at Korea Atomic Energy Research Institute)
2. Hot Cell Facility, (KAERI Facility)
3. Pyroprocessing Facility (KAERI)
4. Chemical Enrichment (KAERI)

Note: There was reportedly centrifuge-related research in South Korea in 2004.¹ We have found no clear evidence that South Korea attempted to enrich uranium with centrifuges (even though it may have had an interest in doing so), so we excluded these activities from the dataset.

Detailed Facility-Specific Information and Sources

1. KAERI (Laboratory for Quantum Optics at Korea Atomic Energy Research Institute)

- a. ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*

Enrichment, laser.

- b. Facility size (laboratory, pilot, commercial).*

Laboratory.

- c. Is the facility under construction or in operation? If under construction, list the construction years. If in operation, list the years of operation.*

Construction of the KAERI began in 1959.² Laser-related experiments took place from 1990 to 2000.

- d. Was the facility developed covertly? If so, identify years that facility was covert.*

The experiments were not declared to the IAEA until the 2000s, after South Korea ratified the Additional Protocol.

- e. Was the facility placed under IAEA safeguards? If so, identify the years that the facility was safeguarded.*

¹ Kemp, R. Scott. 2014. "The Nonproliferation Emperor Has No Clothes." *International Security* 38, no. 4: 45.

² ORNL report notes the experiments did not include the planning or building of facilities.

The existence of the experiment was reported to the IAEA in 2004. South Korea signed comprehensive safeguard agreements in 1975 and additional protocols in 2004.

- f. Was the facility placed under regional safeguards? If so, identify the years that the facility was under regional safeguards.*

No.

- g. Did the facility have a military purpose?*

Probably not, although South Korea's interest in laser technology dates back to the early 1980s – closer to the time when it sought nuclear weapons.

- h. Was the facility multinational? If so, identify the other countries that were involved.*

No.

- i. Was the facility built with foreign assistance? If so, list the supplier(s) and what they provided.*

Both the US and Russia provided assistance in laser technology. The US provided support in laser development and Russia supported AVLIS research. Mark Gorwitz notes that the AVLIS work at KAERI “has been a partial collaborative effort with the General Physics Institute, Moscow. Support has been in both the theoretical and experimental areas.” While it is unclear the degree of assistance provided by both the US and Russia, it appears Russia did provide technical assistance to KAERI's AVLIS efforts. General Physics Institute's assistance may not have been directed at uranium enrichment for weapons development, but it did assist in enrichment applications. While Pinkston states that Russia assisted with the enrichment of ytterbium, US-based scientists have stated that the type of assistance provided by Russia would not be able to produce bomb quantities of U235, but would provide the necessary quantities for testing prior to increasing production.

- j. Sources:*

El Baradei, Mohamed. 2004. “Introductory Statement to the Board of Governors.” Statement by the IAEA Director General to the Board of Governors, 13 September 2004. <http://www.iranwatch.org/library/international-organization/international-atomic-energy-agency-iaea/iaea-director-generals-statement/introductory-statement-director-general-4>. Accessed 06/29/2015.

Gorowitz, Mark. 1996. “The South Korean Laser Isotope Separation Experience.” Federation of American Scientists: <http://fas.org/nuke/guide/rok/sklis.pdf>. Accessed 19/08/2015.

- Hibbs, Mark. 2006. "IAEA, ROK Spar Over Safeguards on ACP Conversion Experiments." *Nuclear Fuel*. 31(1): 6.
- Hibbs, Mark. 2004. "77% U-235 Was Peak Enrichment Reported to IAEA by South Korea." *Nuclear Fuel*. 29(20): 7-27.
- Hibbs, Mark. 1994. "South Korea Must Reprocess if DPRK Has Weapons Program." *Nuclear Fuel*. 6: 6-7.
- Kang, Jungmin, Peter Hays, Li Bin, Tatsujiro Suzuki, and Richard Tanter. 2005. "South Korea's Nuclear Surprise." *Bulletin of the Atomic Scientists*. 61(1): 40-52.
- Kang, Jungmin, Tatsujiro Suzuki, and Peter Hayes. 2004. "South Korea's Nuclear Mis-Adventures." NAPSNet Special Reports. September 10, 2004. <http://nautilus.org/napsnet/napsnet-special-reports/south-koreas-nuclear-mis-adventures/>. Accessed 06/29/2015.
- Kang, Jungmin and H.A. Feiveson. 2001. "Viewpoint: South Korea's Shifting and Controversial Interest in Spent Fuel Reprocessing." *The Nonproliferation Review*. Spring: 70-78.
- Laughter, M.D. 2009. "Profile of World Uranium Enrichment Programs—2009." Oak Ridge National Laboratory
- Pinkston, Daniel. 2004. "South Korea Nuclear Experiments." James Martin Center for Nonproliferation Studies. <http://cns.miis.edu/stories/041109.htm#fnB14>. Accessed 06/29/2015.

2. Hot Cell Facility, (KAERI Facility)

- a. *ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*

Reprocessing.

- b. *Facility size (laboratory, pilot, commercial).*

Laboratory.

- c. *Is the facility under construction or in operation? If under construction, list the construction years. If in operation, list the years of operation.*

The equipment and facilities required for the experiment were maintained within KAERI. An exact date of construction for the facility in which the experiment occurred is unknown. The facility separated plutonium in April and May of 1982.

- d. *Was the facility developed covertly? If so, identify years that facility was covert.*

Yes, South Korea informed the international community about the experiments in 1983, one year after the events.

- e. *Was the facility placed under IAEA safeguards? If so, identify the years that the facility was safeguarded.*

No, South Korea only stated that they had improperly used radiated fuel rods when reporting the incident a year after the experiments. It was only after investigation that the IAEA found traces of plutonium at the facility. The IAEA informed South Korea of the plutonium in 1998.

- f. *Was the facility placed under regional safeguards? If so, identify the years that the facility was under regional safeguards.*

No.

- g. *Did the facility have a military purpose?*

We do not have definitive evidence indicating that the reprocessing was part of a nuclear weapons program.

- h. *Was the facility multinational? If so, identify the other countries that were involved.*

No, the facility is not multinational.

- i. *Was the facility built with foreign assistance? If so, list the supplier(s) and what they provided.*

No evidence of foreign nuclear assistance found. South Korean's sought assistance from numerous countries and companies from the 1970's forward, but evidence of direct assistance on the separation procedure was not found. Evidence to confirm that the French or Canadian deals for reprocessing technologies actually occurred could not be found. The US intervened on several occasions to prevent the transfer of nuclear material production facilities. The separation experiments in the early 1980's used depleted uranium rods acquired from Germany and the TRIGA-III reactor. The assistance was indirect in this experiment.

- j. *Sources:*

Hibbs, Mark. 2004. "77% U-235 Was Peak Enrichment Reported to IAEA by South Korea." *Nuclear Fuel*. 29(20): 7-27.

Hibbs, Mark. 2004. "KAERI Report Documents Production of 200 Kilograms UF₄, DU Imports." *Nucleonics Week*. 45(44): 15-16.

Kang ,Jungmin, Peter Hays, Li Bin, Tatsujiro Suzuki, and Richard Tanter. 2005. "South Korea's Nuclear Surprise." *Bulletin of the Atomic Scientists*. 61(1): 40-52.

Pinkston, Daniel. 2004. "South Korea Nuclear Experiments." James Martin Center for Nonproliferation Studies. <http://cns.miis.edu/stories/041109.htm#fnB14>. Accessed 06/29/2015.

3. Pyroprocessing Facility (KAERI)

- a. *ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*

Reprocessing.

- b. *Facility size (laboratory, pilot, commercial).*

Laboratory (bench top).

- c. *Is the facility under construction or in operation? If under construction, list the construction years. If in operation, list the years of operation.*

Construction of the facility began in 1996. Work on pyroprocessing has been ongoing since 1997. The laboratory facility was delayed in 2006 but experiments were ongoing. Expanded hot experiments began in 2012.

- d. *Was the facility developed covertly? If so, identify years that facility was covert.*

No, the experimentation and development has largely been public.

- e. *Was the facility placed under IAEA safeguards? If so, identify the years that the facility was safeguarded.*

Yes, the facility is under IAEA safeguards. Safeguards are one of the sticking points in the potential pilot plant.

- f. *Was the facility placed under regional safeguards? If so, identify the years that the facility was under regional safeguards.*

No.

- g. *Did the facility have a military purpose?*

No.

- h. *Was the facility multinational? If so, identify the other countries that were involved.*

No.

- i. *Was the facility built with foreign assistance? If so, list the supplier(s) and what they provided.*

Yes. KAERI has been developing pyroprocessing techniques since 1997. Since 2005 the US has provided funding, expertise, and technical assistance to South Korea's pyroprocessing projects. Funding for the joint pyroprocessing projects has been provided by the US DOE through the International Nuclear Energy Research Initiative. In 2005 with US assistance, the Republic of Korea built a laboratory scale Advanced Spent Fuel Conditioning Process Facility (ACPF) inside KAERI's Irradiated Material Examination Facility, which Lyman and von Hippel say should be considered a laboratory scale reprocessing facility. More recently South Korea has been developing more advanced pyroprocessing facilities, though it is unclear if the US continues to provide assistance on these projects.

- j. *Sources:*

Hibbs, Mark and Daniel Horner. 2006. "Hot Operation of Korean ACPF will be Delayed Several Years." *Nuclear Fuels*. 31(18): 8.

Kang, Jungmin, Peter Hays, Li Bin, Tatsujiro Suzuki, and Richard Tanter. 2005. "South Korea's Nuclear Surprise." *Bulletin of the Atomic Scientists*. 61(1): 40-52.

Lee, Hansoo, Geun-Il Park, Jae-Won Lee, Kweon-Ho Kang, Jin-Mok Hur, Jeong-Guk Kim, Seungwoo Paek, In-Tae Kim and Il-Je Cho. 2013. "Current Status of Pyroprocessing Development at KAERI." *Science and Technology of Nuclear Installations*. 2013:11. <http://dx.doi.org/10.1155/2013/343492>. Accessed 06/29/2015.

Song, Kee-Chan, Hansoo Lee, Jin-Mok Hur, Jeong-Guk Kim, Do-Hee Ahn, Yung-Zun Cho. 2010. "Status of Pyroprocessing Technology Development in Korea." Korea Atomic Energy Research Institute. <http://www.kns.org/jknsfile/v42/JK0420131.pdf>. Accessed 06/29/2015.

4. Chemical Enrichment (KAERI)

- a. *ENR type (diffusion, centrifuge, EMIS, chemical and ion exchange, aerodynamic isotope separation, reprocessing).*

Enrichment, chemical.

- b. *Facility size (laboratory, pilot, commercial).*

Laboratory (bench top).

- c. *Is the facility under construction or in operation? If under construction, list the construction years. If in operation, list the years of operation.*

The movement toward chemical enrichment probably began in 1972 following reports on the Atomic Fuel Development Plan. The facility operated from 1979 to 1981.³ The equipment of the facility was dismantled in 1983.

- d. *Was the facility developed covertly? If so, identify years that facility was covert.*

The experiments were not disclosed to the IAEA until 2004. Kang et al. state specialists were aware of the chemical enrichment by 1984. Korean scientists published results from the experiments in 1981 but did not report it to the IAEA. This is an ambiguous case, but we code the facility as operating covertly due to the lack of reporting to the Agency in a timely fashion.

- e. *Was the facility placed under IAEA safeguards? If so, identify the years that the facility was safeguarded.*

No.

- f. *Was the facility placed under regional safeguards? If so, identify the years that the facility was under regional safeguards.*

No.

- g. *Did the facility have a military purpose?*

It does not appear that the experiments were part of a weapons program but South Korea did pursue nuclear weapons in the 1970s under Park Chung Hee.

- h. *Was the facility multinational? If so, identify the other countries that were involved.*

No.

- i. *Was the facility built with foreign assistance? If so, list the supplier(s) and what they provided.*

No evidence of foreign assistance found. The South Korean government has said chemical enrichment experiments took place without the knowledge and authorization of the central government.

- j. *Sources:*

Blanc, Alexis. 2008. "Nuclear Proliferation: A Historical Overview." Institute of Defense

³ The operational date is from Blanc and Roberts 2008.

Analyses. <http://www.dtic.mil/cgi-bin/GetTRDoc?AD=ADA482642>. Accessed 06/29/2015.

Hibbs, Mark. 1994. "South Korea Must Reprocess if DPRK Has Weapons Program." *Nuclear Fuel*. 6: 6-7.

Kang ,Jungmin, Peter Hays, Li Bin, Tatsujiro Suzuki, and Richard Tanter. 2005. "South Korea's Nuclear Surprise." *Bulletin of the Atomic Scientists*. 61(1): 40-52.

Meyer, Stephen M. 1984. *The Dynamics of Nuclear Proliferation*. Chicago, IL: The University of Chicago Press. 172

Pinkston, Daniel. 2004. "South Korea Nuclear Experiments." James Martin Center for Nonproliferation Studies. <http://cns.miis.edu/stories/041109.htm#fnB14>. Accessed 06/29/2015.

Spector, Leonard S. 1984. *Nuclear Proliferation Today*. Cambridge, MA: Ballinger Publishing.