

NUCLEAR WEAPONS

Iran's Trouble With Molybdenum May Give Diplomacy a Second Chance

Defying the West, Iran this week vowed to resume R&D on uranium enrichment and other sensitive elements of a nuclear program alleged to include weapons research. But U.S. officials and analysts believe it will take months for Iran to solve a key technical challenge in purifying uranium isotopes—unless it gets outside help.

Iran's decision has endangered talks with three European countries on a diplomatic solution to the crisis and has exasperated officials at the International Atomic Energy Agency

bulk purchases of materials such as zirconium, which can be used in fuel rods or warheads.

Western scrutiny of late has focused on R&D at the Esfahan Nuclear Technology Center's Uranium Conversion Facility (UCF). At this complex, Iran intends to convert milled uranium ore, or yellowcake, into uranium hexafluoride (UF_6), potentially to be separated into isotopes by centrifuges at a giant facility under construction in Natanz. Iran had suspended R&D at Natanz in 2004; Iranian officials began removing IAEA seals there on



All that glitters ... Technical troubles at the Uranium Conversion Facility near Esfahan may buy negotiators time to persuade Iran to accept constraints on its nuclear program.

(IAEA) in Vienna, Austria, which is responsible for verifying that Iran's nuclear program is peaceful. The move also jeopardizes a Russian proposal to allow Iran to carry out uranium enrichment on Russian soil. The world is "running out of patience with Iran," IAEA director Mohamed ElBaradei said to the U.K.-based Sky News on 9 January.

Iran claims that its nuclear program is strictly for producing energy. To that end, it insists on exercising its right under the Nuclear Non-Proliferation Treaty to transform uranium ore, predominantly containing uranium-238, into fuel enriched in the rarer, fissile isotope uranium-235.

The United States and some European nations argue, however, that Iran's peaceful program is a cover for weapons development. Western officials point out that Iran kept most elements of its nuclear effort secret for more than a decade until they were exposed by an exile group in 2002. Also cited as evidence of Iran's intent are

10 January, in the presence of IAEA inspectors.

As a prelude to enrichment, Iran announced last May that it had converted 37 tons of yellowcake into uranium tetrafluoride (UF_4), a solid. This was a big step. Creating purified UF_6 , which can be fed as a gas into centrifuges for isotope separation, would be a much bigger one. According to an official at the U.S. State Department, Iran has struggled to convert UF_4 into UF_6 , a dangerous process involving highly toxic and corrosive fluorine gas. The official also claims that Iranian UF_4 is tainted with large amounts of molybdenum and other heavy metals. These oxyfluoride impurities in UF_6 "might condense" and thereby "risk blockages" of valves and piping, an IAEA specialist told *Science*.

Reducing impurities to allow production of uranium fuel for peaceful uses, containing a few percent U-235, should not be a huge challenge, according to experts. But more sophisticated equipment is required to reduce impu-

rities enough to make highly enriched uranium, containing 20% or more U-235. Only a handful of countries can do it. For a weapons effort, filtering out molybdenum "is a fairly significant problem," says nuclear nonproliferation expert Rose Gottemoeller, director of the Carnegie Endowment for International Peace's Moscow office.

The key question, some Western analysts say, is whether Iran can get help to make clean UF_6 . During the early 1990s, China offered to share its uranium-enriching skill with Iran by building the UCF but abandoned the project in 1998 under pressure from the U.S. government. China probably has not passed forbidden knowledge to Iran, which is believed to have constructed the UCF based on Chinese blueprints, experts judge. Supporting this assessment are comments by Mohamed Saeedi, deputy chief of Iran's Atomic Energy Organization. In the Iranian newspaper *Kayhan* last April, Saeedi described a visit to Beijing in 1998 during which Iranian officials sought to persuade China to follow through with construction of the UCF. They were rebuffed. The Chinese, Saeedi said, "told us that ... we would only make some headway in the primary stages and encounter difficulties in the next high-tech stages of the project, just as they did ... [before] the Russians came to their assistance."

U.S. officials are worried that China's tutor—Russia—could solve the impurities problem for Iran. "It's not in Russia's interest to fix that problem," argues Gottemoeller, noting that Russia's goal is to remain the long-term supplier of fuel to Iran's nuclear power program. But some fear that if Iran were to agree to Russia's proposal to conduct enrichment on Russian soil—negotiations on this proposal are set to resume next month—it could learn enough indirectly to overcome the UF_6 obstacle. At a minimum, some argue, Iran would need access to "imported technology" that countries have vowed to place off-limits, according to the 29 August 2005 issue of *NuclearFuel*, an industry newsletter.

If Iran solves the molybdenum problem, that would raise another concern: It could trade such knowledge to North Korea. Last month, a South Korean official told *Science* that intelligence indicates Iran may have assisted North Korea's alleged uranium-enrichment program in exchange for technical help with ballistic missiles. (Officially, South Korea maintains a studied ambivalence about whether North Korea's enrichment program exists; see p. 170.)

IAEA is unaware of such evidence: "We do not have any leads to act on, nor have our investigations turned up any such connection," says an agency spokesperson, Melissa Fleming. Even without airtight evidence, observers say, these scenarios are worrisome enough to justify a redoubled diplomatic effort to reach an agreement with Iran.

—RICHARD STONE

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