

Bavaria bucks ban

By Alexander Glaser

THE MAIN TECHNICAL BARRIER preventing the proliferation of nuclear weapons is the difficulty of acquiring the necessary plutonium or highly enriched uranium (HEU). While most recent attention has focused on plutonium disposition, the ongoing use of HEU in civilian research reactors makes safeguarding and controlling these fissile materials difficult. If the German government grants the last partial license allowing the Forschungsreaktor München-II (FRM-II) research reactor in Munich to begin operating, international efforts to end the civilian use of HEU will suffer a serious setback.

The bulk of HEU is held by the world's militaries. But approximately 20 tons (it takes 10–20 kilograms to build a nuclear bomb) are in the civilian sector, where it fuels research reactors used for scientific, industrial, or medical applications.

Inside the FRM-II reactor building.

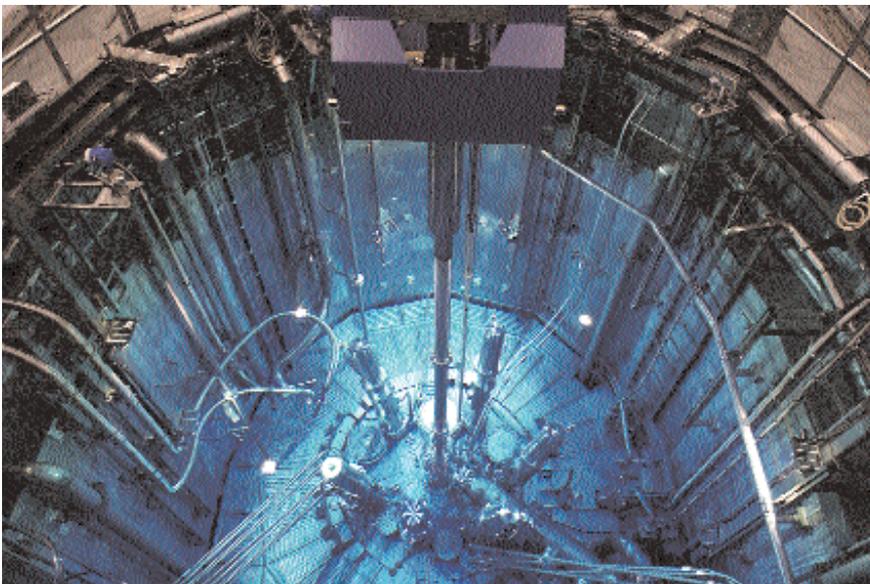


PHOTO CREDIT HERE

Handling, transporting, and storing this uranium—in unirradiated and irradiated form—provides opportunities for diversion or theft by both state and non-state actors.

Almost 20 cases of illicit trafficking in fissile material, and of HEU in particular, have been confirmed since the 1990s. Since the September 11 attacks, HEU has become of particular concern because it is easier to handle than plutonium. It can also be used in the simplest type of nuclear bomb—the so-called gun-type design used in the bomb dropped on Hiroshima—which may be attractive to low-tech proliferators.

Converting research reactors

From a technical point of view, HEU enriched to 90–93 percent uranium 235 is an obvious fuel for research reactors. It allows for the most compact core designs and the highest

neutron fluxes. For the same reason, it is also usable in nuclear weapons.

Replacing HEU with low-enriched uranium (LEU)—by definition uranium enriched to less than 20 percent—is an effective way to make the nuclear fuel cycle more proliferation resistant. Uranium enriched below 20 percent is considered unusable in a nuclear weapon.

In light of these facts, in 1980, at the milestone International Nuclear Fuel Cycle Evaluation Conference, the International Atomic Energy Agency (IAEA) first recommended converting research reactors to low-enriched fuel. Actions based on this recommendation were later instituted by the Reduced Enrichment for Research and Test Reactors (RERTR) program. Initiated by the United States, the program today receives broad international support.

Converting reactors is one of the main objectives of the reduced enrichment program. At least 34 of 71 operational research reactors (with outputs of at least 1 megawatt), in 19 countries that use or formerly used HEU fuel, have been fully converted, are in the process of conversion, or are scheduled for either conversion or shutdown.

Most of the remaining HEU-fueled facilities are located in Russia and the United States. For some of these facilities, a suitable low-enriched fuel is not yet available. In a few cases, operators are opposing or trying to postpone conversion, usually in order to avoid re-licensing procedures or minor performance losses. In Russia, in spite of declared support for the program, action is marginal due to economic con-

straints. Some HEU-fueled reactors, many of 1950s and early 1960s vintage, will simply die out without being converted.

Another important component of the program is building momentum for the development of advanced, high-density LEU fuels. The next generation of these fuels is expected to be approved within five years and allow for conversion of all existing reactors. The promise of these advanced fuels has until now discouraged the construction of new HEU-fueled reactors.

Since 1980 more than 20 LEU-fueled research reactor projects have been initiated, and all the research reactor projects currently being built or planned are based on low-enriched fuel. The only exception is Germany's FRM-II research reactor, which would have an annual demand of more than 40 kilograms of HEU fuel. If started as planned, it would be the first HEU-fueled reactor to begin operating in more than a decade. In an affront against the nonproliferation and reactor conversion communities, the reactor will use the high-density fuel originally developed for converting reactors to less highly enriched uranium.

The origins of FRM-II

The FRM-II project began in the early 1980s when the Technical University of Munich first contemplated upgrading its older FRM reactor. In the project's early stages, reactor designers suggested at several conferences on reduced enrichment that they were seriously considering the use of low-enriched fuel.

By the late 1980s the decision was made to build a new reactor instead of upgrading the old one, and the designers clearly shifted to the use of HEU fuel. When the licensing procedures began, the first critical voices regarding the HEU concept were heard in the German public and the scientific community. The RERTR program also intervened, and in

1995, before construction began, Argonne National Laboratory proposed an alternative LEU-based core concept.

At the same time, the United States violated its own policy by planning to build the HEU-fueled Advanced Neutron Source research reactor. This apparently led the Technical University of Munich to expect that a supply of HEU fuel would come from the United States against its declared policy adopted in 1992. But those hopes evaporated in 1995 when the Clinton administration, citing nonproliferation concerns, canceled the Advanced Neutron Source project and ruled out supplying HEU fuel for the FRM-II.

With the supply issue unresolved, Russia offered to provide the required HEU. In June 1998, only a few months before the German national elections, an agreement with Russia was signed allowing the transfer of more than 1 metric ton of HEU for fuel fabrication.

After the elections, expectations in the arms control community were high when the new Socialist-Green coalition expressed explicit nonproliferation concerns about the reactor in its joint statement. Early the next year, the government established an expert commission to study the issue, which established that conversion to LEU before startup would be technically feasible and the most responsible solution. The main conversion strategies cited by the commission were taken up again by Argonne, which had found that converting the reactor would result in a performance loss of less than 15 percent.

But the commission's report made no recommendations, and the German government took no immediate action. Additional costs and a low level of public interest eventually led the government to avoid confronting the state of Bavaria and the University of Munich.

Although construction continues at the FRM-II site, on February 1 the Federal Environment Ministry, which is supervising the licensing

procedure, issued a press release indicating that start-up of the facility is currently being delayed due to a series of deficiencies in the documentation, mostly related to reactor safety and fuel disposition. Even a preliminary license is not expected before May 2002.

How low is low?

On October 25, 2001, the German and Bavarian governments signed an agreement on the FRM-II reactor. Two preconditions set by Bavaria stipulated that no modification could be done to the core structure, and that a performance loss of more than 5 percent could not be tolerated. Argonne had pointed out earlier that conversion to LEU fuel would be impossible under these conditions.

While the reactor will start operation with fuel enriched to the design value of 93 percent, the compromise agreement states that by December 2010 enrichment will be reduced to 50 percent. While this number may seem satisfactory mathematically, from a nonproliferation perspective it is not.

Why? Uranium's critical mass greatly increases only as enrichment values near 20 percent, so uranium enriched to 50 percent has a critical mass less than three times higher than uranium enriched to 93 percent. This means that uranium enriched to 50 percent is still weapons-usable. Even beyond this technical argument, for political reasons the internationally agreed on enrichment limit of 20 percent cannot be arbitrarily shifted or redefined.

Consequences

The FRM-II facility will require more HEU fuel than any other research reactor in a non-nuclear weapon state. When some of the remaining facilities in Europe and the United States are converted, as planned, the FRM-II reactor could become the world's

major user of HEU fuel.

Operating the FRM-II will require periodic shipments of fresh fuel elements, each of which will involve significant quantities of HEU. After a few years of operation, several hundred kilograms of irradiated fuel with residual enrichment beyond 88 percent will have accumulated in intermediate storage, which may also represent a proliferation risk.

The case of the FRM-II has already damaged the international nonproliferation regime in other ways. It has diverted attention from other HEU-fueled reactors in Europe and the United States. It might encourage construction of HEU-fueled reactors elsewhere. And it may have the unexpected consequence of defining a new “conversion” standard of 50 percent.

Lessons learned

Considering its few, non-binding leverage points, the reduced enrichment program has been remarkably successful. But in light of FRM-II, how can similar events that under-

mine nonproliferation efforts be prevented in the future?

First, it is important to note that only a few countries—mainly the United States and Russia—export research reactor technology and provide enriched uranium for research reactor fuel. Since these countries also operate older HEU-fueled research reactors, their future behavior will be decisive. Following the U.S. example, countries should not provide HEU to foreign markets when alternative fuels are available. Having a declared nonproliferation policy would discourage reactor designers from contemplating HEU in the first place.

For the sake of credibility, supplier countries should convert their own remaining facilities to LEU as soon as possible. It is unlikely that excessive “unidirectional” pressure will prove successful in the long run. In fact, it is crucial that policymakers, reactor designers, and users of research reactors in the scientific community all recognize the benefits of LEU-based designs.

While the IAEA is now seriously concerned about the threat of nuclear terrorism, its focus is primarily on physically protecting nuclear materials and installations. However, it is crucial that facilities incorporate proliferation-resistant features in the first place. If the IAEA took a more active role on this issue, it could have a positive impact on member states and significantly support the RERTR program.

The FRM-II case highlights the vulnerability of conversion activities. But this case should be seen for what it is: an anachronistic project that unnecessarily and deliberately weakens the achievements of a successful international effort to increase the proliferation resistance of the nuclear fuel cycle. ✱

Alexander Glaser, a physicist, is a Social Science Research Council dissertation fellow at MIT's Security Studies Program, and a member of the Interdisciplinary Research Group in Science, Technology, and Security at Darmstadt University of Technology in Germany.