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Critique of Recent *Bulletin of Atomic Scientists* article on the Fordow Enrichment Plant

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An analysis published November 24 in the *Bulletin of Atomic Scientists* by Ivan Oelrich and Ivanka Barzashka, "A Technical Evaluation of the Fordow Fuel Enrichment Plant" concludes that the Fordow enrichment facility is "neither ideal for commercial nor for military purposes." Oelrich and Barzashka argue that not only is the facility ill-suited for the production of reactor fuel, it is also too small for enriching uranium for weapons. This latter argument appears to rest primarily on an assertion that 3,000 IR-1 centrifuges, the type and the number that Iran has declared will be deployed at Fordow, would need roughly one year to produce enough weapons-grade uranium using low enriched uranium as feed, or four years to produce enough weapons-grade uranium for one bomb starting with natural uranium. The authors provide no further explanation or technical justification in the article for their estimates. Nonetheless, these estimates of time, however, are far too long, under a range of reasonable assumptions about future operation of IR-1 and more advanced centrifuges at the Fordow site.

ISIS's assessment is that using 3,000 IR-1 centrifuges, and starting with natural uranium, Iran could produce enough weapons-grade uranium for one bomb in roughly one year. With the use of low enriched uranium, the facility could make weapons-grade uranium significantly faster. This one-year estimate is similar to what the U.S. government estimated when it revealed the Fordow site on September 25, 2009.

Taking conservatively an average enrichment output per machine of 0.6-0.7 separative work unit (swu) per year, which is undoubtedly too low, 3,000 centrifuges would produce approximately 12-14 kilograms of weapons grade uranium within one year after starting with natural uranium.[1] This amount is almost enough for one crude nuclear weapon.[2]

[1] This estimate of producing weapons-grade uranium assumes a tails assay of 0.5 percent. This value is higher than Iran uses at the Natanz facility, but it is reasonable if enrichment capacity is in short supply and uranium is plentiful, as is the case with Iran with regard to nuclear weapons production. In addition, this approach is consistent with other country's practice in producing their initial highly enriched uranium for nuclear weapons.

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There would certainly be inefficiencies in IR-1 centrifuge operation, but the above case is based on the overall experience of the IR-1 centrifuges to date at the Natanz Fuel Enrichment Plant. It is derived from an average enrichment output over nine months in 2009. But the number of centrifuges used in the derivation is from IAEA safeguards reports and exceeds the quantity of those centrifuges that are actually enriching. This number includes IR-1 machines stated in IAEA safeguards reports to be enriching that are in fact not being used or are broken. Thus, the value is likely too low. For example, from June to October 2009, daily average enrichment output stayed constant at 2.75 kilograms of low enriched uranium hexafluoride per day, while the number of centrifuges enriching dropped from about 4,920 to 3,936. A significant fraction of these roughly 4,000 machines are likely also not enriching or are broken, particularly in the older cascades. In addition, the performance of the IR-1 centrifuges, or perhaps at least the newer cascades, has improved, which is to be expected as Iran gains more experience.

Achieving an enrichment output of about 1.0-1.5 swu/year, where the upper bound is close to Iran's stated goal, is reasonable for new IR-1 centrifuge cascades slated for installation at the Fordow facility. At this level the Fordow site could produce approximately 20-30 kilograms of weapon-grade uranium per year, again starting with natural uranium. With further improvements in the IR-1 centrifuge, Iran could achieve even higher enrichment outputs; the theoretical maximum for IR-1 centrifuges is 3 swu per year. In addition, Iran has stated its intention to install more advanced centrifuges at this site, boosting enrichment output further.

In a U.S. government background briefing on the Fordow facility, the officials stated that this facility is the right size to produce enough weapons-grade uranium for a "bomb or two a year." This facility would give Iran "an option of producing weapons-grade uranium without the international community knowing about it." This assessment is unlikely to assume a break-out scenario using low enriched uranium (LEU), since few believe such a diversion would go undetected as long as the International Atomic Energy Agency (IAEA) remains at Natanz. It probably assumes a baseline 3,000 centrifuges starting with natural uranium. The actual amount of weapon-grade uranium produced will depend on the type and performance of the centrifuges.

The authors also argue that if Iran wanted to break-out utilizing its stock of LEU at Natanz, it would be more likely to enrich at Natanz rather than at Fordow. They appear to assume that any break-out scenario utilizing the LEU stock at Natanz would be dependent upon the break-out activities not being discovered. Instead, Iran would likely have built into any break-out scenario involving the stock of LEU the assumption that, regardless of where the enrichment took place, its activities would be discovered. In order to deal with this, having a covert enrichment plant that intelligence agencies did not know about would be very beneficial for Iran in case military strikes were imminent. Furthermore, if Iran broke-out and intelligence agencies secretly knew about a covert enrichment plant, an enrichment plant built deep inside a mountain, such as the Fordow

[2] Little information is available about the amount of weapons-grade uranium Iran would choose for its nuclear weapons. Values range from 15-25 kilograms of weapons-grade uranium depending on the design considered. Up to 20 percent more is usually assumed to be needed to account of losses in fabrication.

site, would be well positioned to withstand an aerial attack (though its tunnel entrances would likely be bombed), whereas the Natanz facility, despite being buried, would likely be destroyed.

In summary, the authors appear to assume that the Fordow plant would perform more poorly than Natanz does currently. These assumptions appear too one-sided and unrealistic. It is important to make clear the assumptions on which timetables are projected, and not to be biased one way or the other in making them, in particular as they concern Iran's potential for producing weapons-usable fissile material.