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Technical Note: Annual Future Low-Enriched Uranium Fuel Requirements for the Tehran Research Reactor

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The annual LEU requirement of the Tehran Research Reactor is estimated by making assumptions about the reactor's operating power, its annual operating capacity, and the fuel's burnup, or irradiation level before spent fuel discharge. A fundamental constant in this calculation is that about 1.25 grams of uranium-235 is consumed (fissioned or converted into uranium 236) per megawatt-thermal-day.

The reactor has a rated power of 5 megawatts-thermal (MW-th), although it has been operating at 3 MW-th, partly because of a lack of fuel. Iran bought 116 kg of LEU (19.75% enriched) from Argentina in the late 1980s (see Timeline) and started to fuel the reactor with this fuel in about 1993. No other country has since been willing to supply additional fuel until the October 1 announcement following the historic meeting in Geneva betweeen the P5+1 and Iran. For this calculation, a power of 5 MW-th is assumed during future operations.

The capacity is taken as the reactor operating at full-power 40-80 percent of the year. Eighty percent is probably too high, but serves as an upper bound on annual fuel requirements and forty percent is near or lower than actual operational experience.

The fuel burnup is taken as 50 percent, which is typical for this type of research reactor fuel.

Estimates:

1) The annual uranium 235 consumption is:
   5 MW-th x 365 days/year x (0.4 to 0.8) x 1.25 grams/MW-th-days = 0.91 to 1.82 kg per year.
2) The amount of uranium-235 in the fresh fuel required annually is the amount consumed divided by the fuel's burnup, or 1.82 to 3.64 kg of uranium 235 per year.
3) Since the fuel is 19.75 percent enriched, the estimated annual fuel requirement is 9.2 to 18.4 kg LEU (uranium mass) per year. If the reactor operated only at 3 MW-th, it would require only 5.5 to 11 kg of LEU (uranium mass) per year.

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At this lower power level, the Argentine-supplied fuel would last 10-20 years. Since the Argentine fuel is expected to run out during the next few years, Iran has likely been operating the reactor near 3 MW-th and the lower operating capacity factor of 40 percent since 1993.

4) If Iran provides 1,200 kg of LEU (3.5 %) hexafluoride, as reported in the media, Russia could produce about 120 kilograms of 19.75 LEU (uranium mass) can be made, assuming a tails assay of 0.71 percent (natural uranium).[1] This quantity of 19.75% LEU would correspond to roughly 6-13 years worth of fuel at an operating power of 5 MW-th and a capacity factor between 40 and 80 percent, assuming some minimal losses in fuel fabrication. If the TRR remains at 3 MW-th, then this would be sufficient fuel for 11 to 21 years of operation.

[1] If 0.3 percent tails assay were used, then about total LEU production would increase by about 14 kg. If the tails stock is natural uranium, it could be sold on the international market.