

DEPARTMENT OF NUCLEAR SCIENCE AND ENGINEERING
Doctoral Oral Examinations (S'15)

Nuclear Security and Policy

Mandatory Question

1/22/15 DRAFT

The Fukushima accident has disrupted Japan's plans for the nuclear fuel cycle. A key issue concerns whether to reprocess spent fuel from Japan's reactors at the Rokkasho-Mura reprocessing plant. In this question you are asked to explore this topic. (The plant is scheduled to begin operating this year.)

- a. A recent estimate of the capital cost of the Rokkasho-Mura plant is \$25B (in today's dollars.) The capacity of the plant is 800 metric tons of spent fuel per year. How would you estimate the unit cost of reprocessing at the plant (in dollars per kg of spent fuel)?
- b. Other Japanese fuel cycle costs (or cost estimates) are listed below. On the basis of these data, as well as any additional assumptions you choose to make, do you think it would be economically sensible for Japan to reprocess its fuel?
- c. Japanese researchers have been developing new technology for recovering uranium from seawater. Discuss an appropriate target cost for such a process (in dollars per kg of uranium).
- d. How likely is it that the developers of this process could hold the technology proprietary? What would be the implications for nuclear non-proliferation efforts if uranium from seawater technology became widely available around the world?

Japanese nuclear fuel cycle costs (in today's dollars)

Cost of natural uranium (yellowcake + conversion) = \$120 per kg of U.

Total cost of low-enriched UO_2 fuel assemblies (enriched to 4.5% in U-235) = \$4000/kgU in the fuel (note: the total cost includes yellowcake, conversion, enrichment, and fuel fabrication costs)

Estimated total cost of interim storage and direct disposal of spent uranium fuel = \$700/kg U in the fuel

Assume that 6kg HM of UO_2 fuel would have to be reprocessed to obtain the plutonium needed to produce 1 kg HM of MOX fuel equivalent in energy output to 1 kg of 4.5% enriched UO_2 fuel.

MOX fuel fabrication cost = \$3200/kg HM

Estimated total cost of interim storage and direct disposal of spent MOX fuel = \$700/kg HM in the fuel