Technical Aspects of Multilateral Nuclear Agreements with Iran

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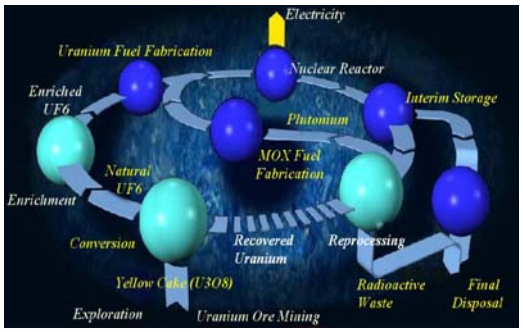
1. Overview of Iran's nuclear ambitions/capabilities

2. A Multinational Enrichment Facility in Iran
    1. Organization
    2. Cost estimates
    3. Preventing "Nationalization"

3. In the Short Term

Iran's Nuclear Fuel Cycle Facilities

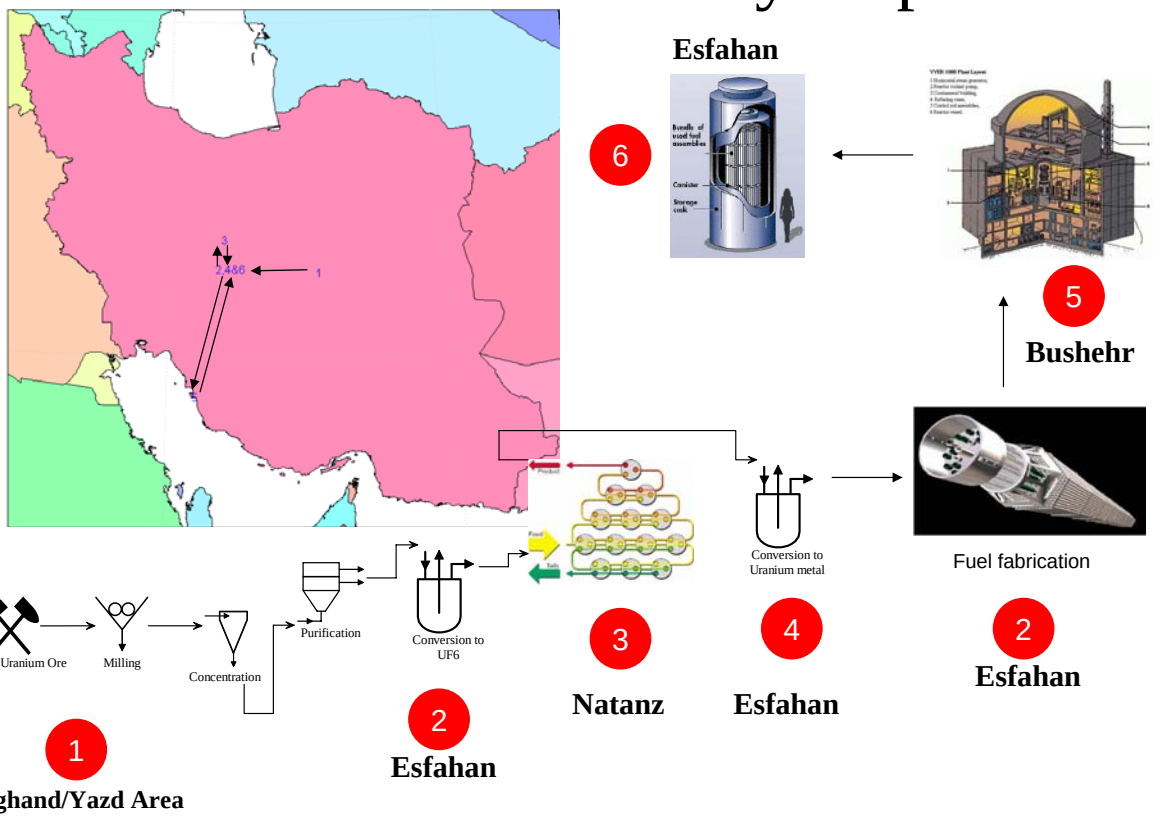
- ***Uranium Exploration: (1/3 of the country is under airborne exploration)***
- ***Mining: (2 anomalies are under operation in Saghand)***
- ***Yellow Cake Production: (YCP in Yazd and Bandar Abbas)***
- ***Uranium Conversion: (UCF in Esfahan)***
- ***Enrichment: (FEP in Natanz)***
- ***Fuel Fabrication: (FMP& ZPP in Esfahan)***



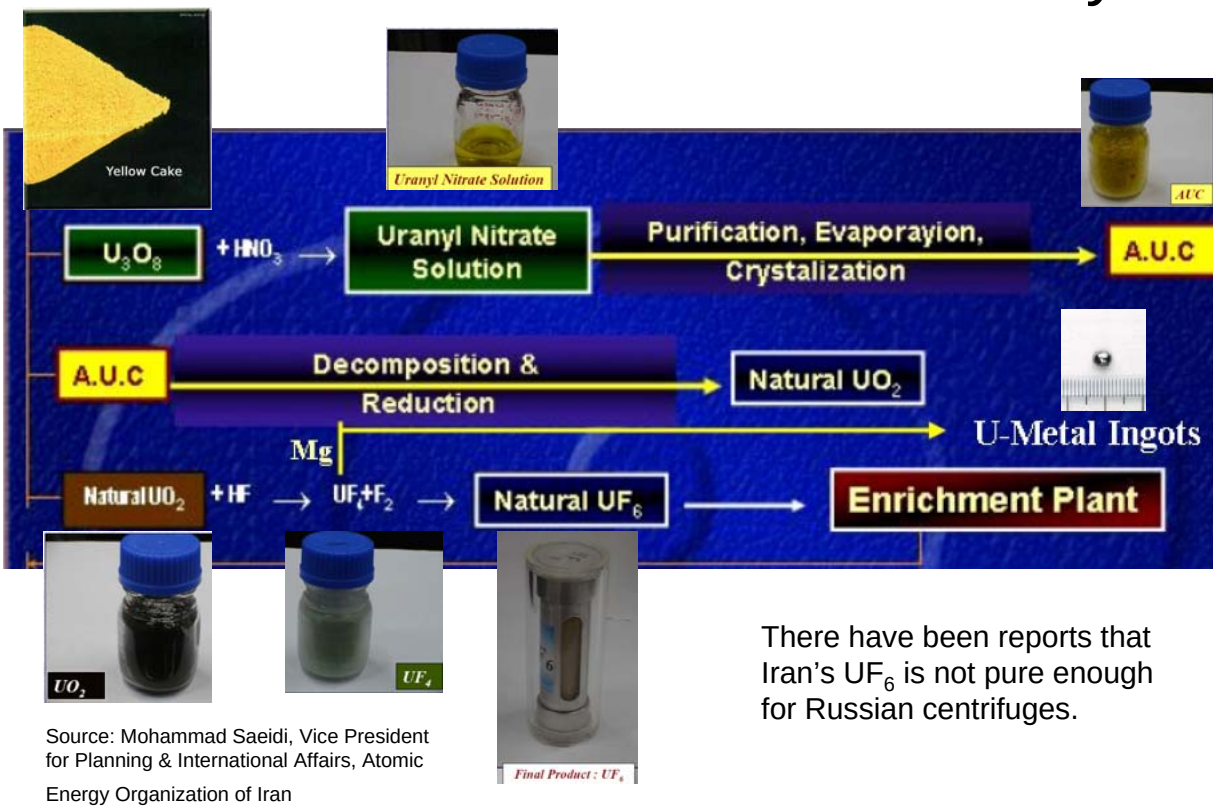
- ***Nuclear Reactors: (VVER-1000 in Bushehr, TRR in Tehran, Zero Power-Sub critical-MNSR in Esfahan and IR-40 in Arak)***
- ***Reprocessing: None***
- ***Waste Management: (Development of Generic Conceptual Design for a Near Surface Repository in the Country, and Incinerator, and Online Activities)***

Source: Mohammad Saeidi, Vice President for Planning & International Affairs, Atomic Energy Organization of Iran

Iranian uranium fuel cycle path



Iran's Uranium Conversion Facility



There have been reports that Iran's UF_6 is not pure enough for Russian centrifuges.

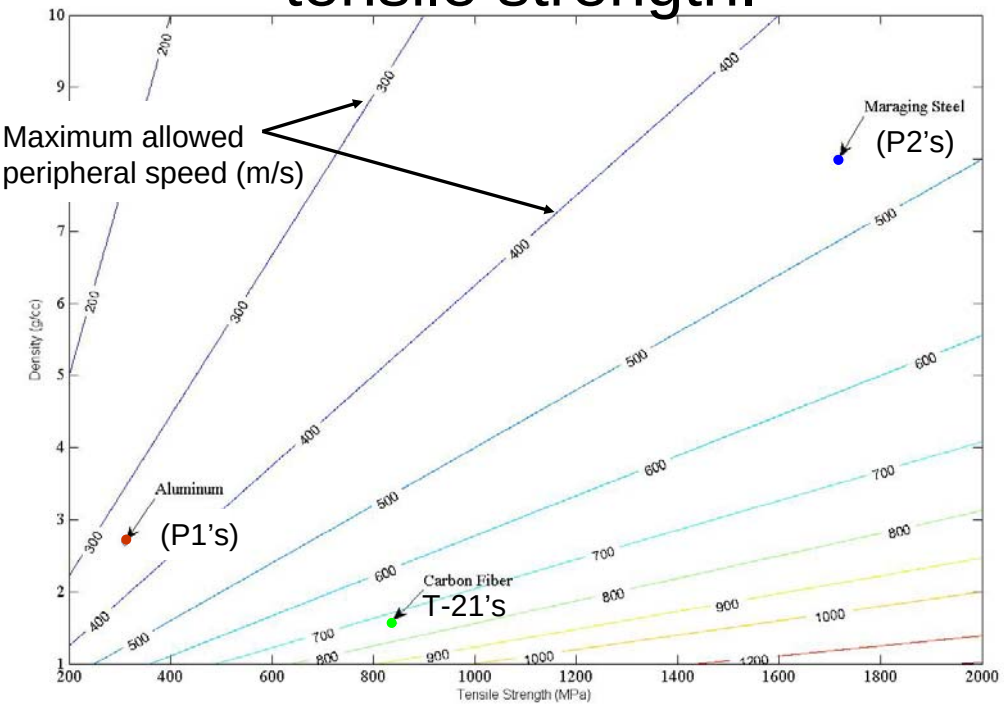
Source: Mohammad Saeidi, Vice President for Planning & International Affairs, Atomic Energy Organization of Iran

Iran's centrifuge pilot plant

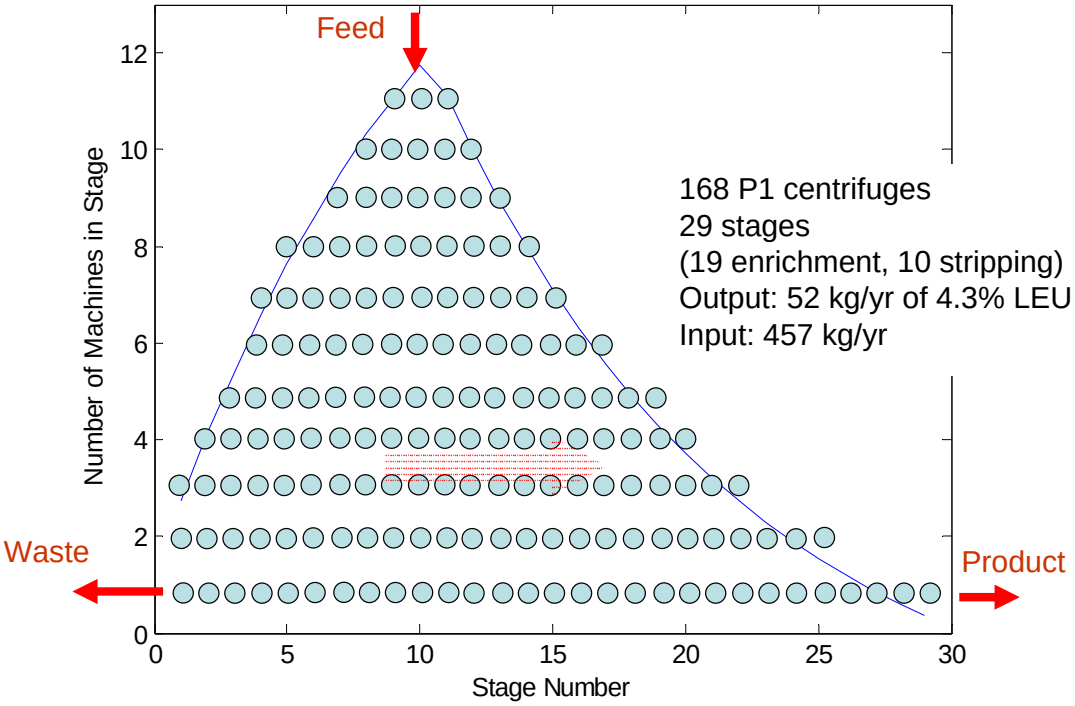
Testing plans:

1. Test single P1 centrifuge with "nuclear material" (UF_6)
2. Test a "cascade" of 10 P1's with UF6.
3. Test 19 P1s in a cascade.
4. Run a cascade of 168 P1s.

Centrifuge velocity for density and tensile strength.



Estimation of what the Iranian cascade might look like:



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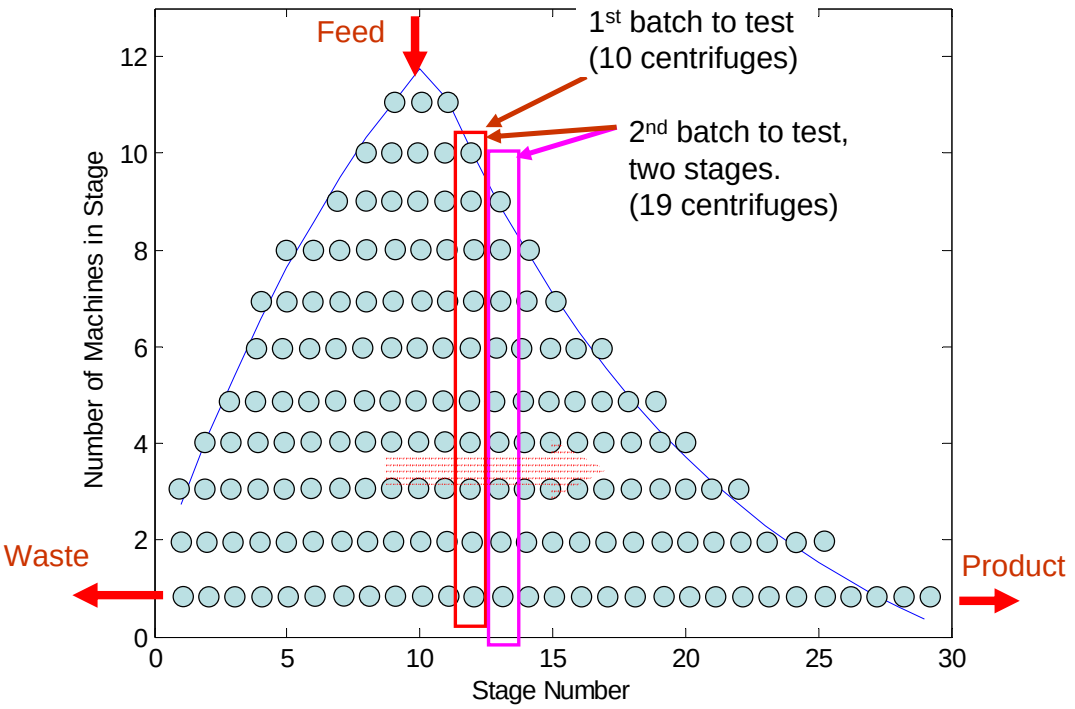
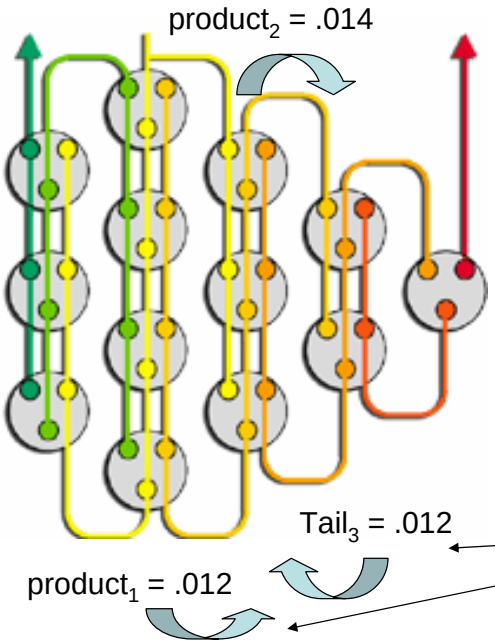


In an ideal cascade the “tails” of one stage is feed back to the stage before

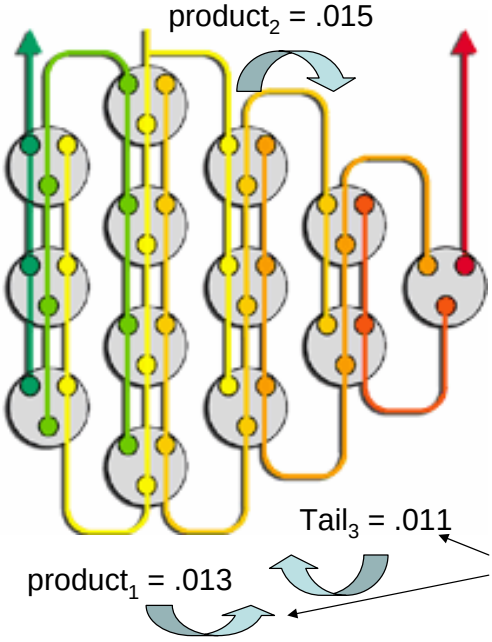
For instance:



Both are feed into the 2nd stage. They should have the same concentration.

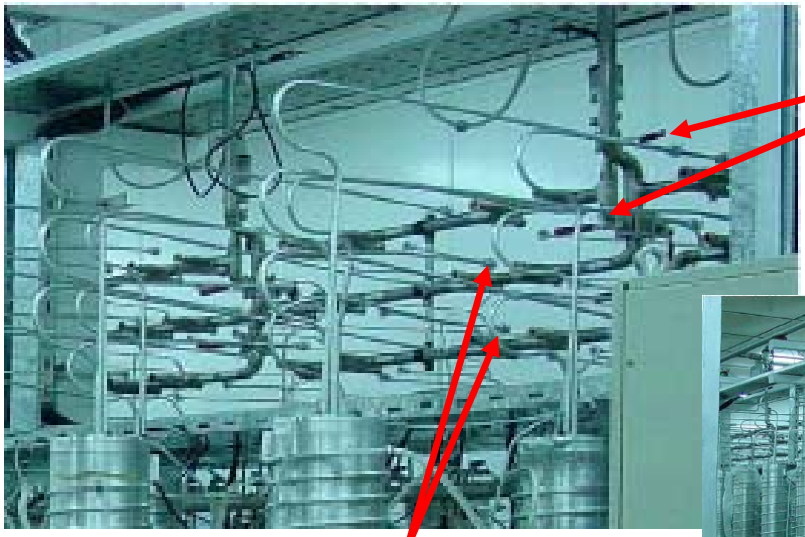
Such a “small” cascade (only 168 machines) effectively reduces the cascades separative power by ~30%

For instance:



Some of the separative power of the 1st stage is “wasted” by mixing with lower concentrations from the 3rd stage.

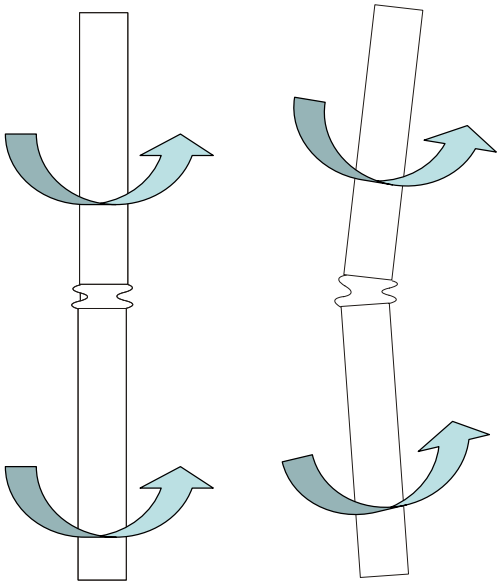
Points to note about Iran's Centrifuge plant (circa 15 Jan 05)



This is a pilot plant and as could be expected, is built to be highly flexible.

Source: Mohammad Saeidi, Vice President for Planning & International Affairs, Atomic Energy Organization of Iran

P2 centrifuges are made of maraging steel with a bellows in the middle to handle "resonances."



The IAEA has been told that Iran cannot manufacture maraging steel bellows and so has produced shorter rotors.

Analysis of Iran's Fuel Cycle Facilities

Conversion facility ⇨ Enrichment facility ⇨ Fuel fabrication facility

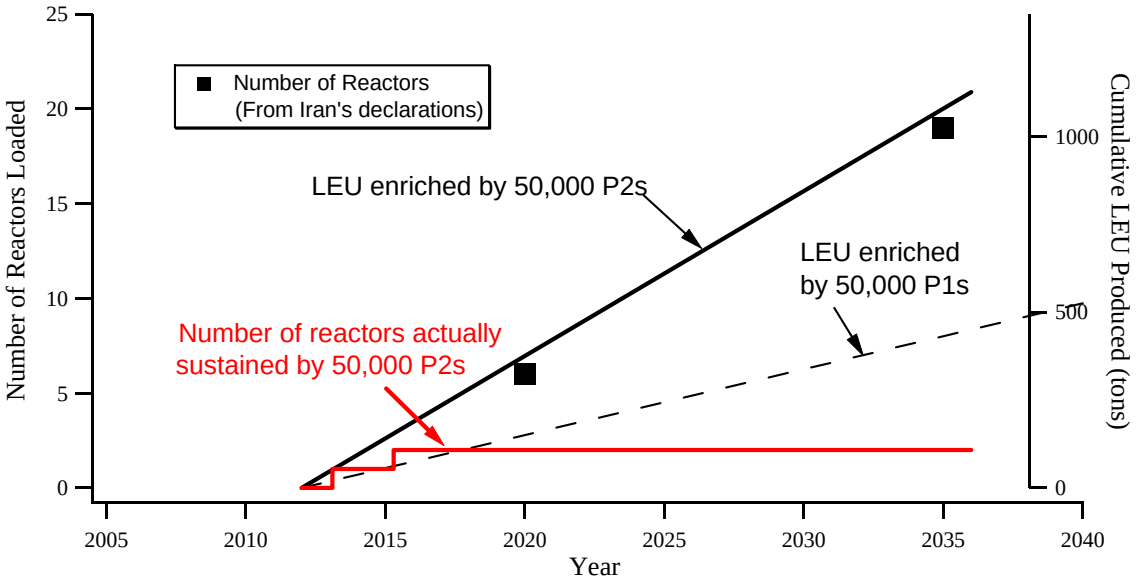
Output: 200 tons UF_6

50,000 P1s:
Capacity: 100,000 SWU-kg/yr
➔ 17 tons U at 4.3%
(20 tons UO_2)
➔ 1 reactor refueling.
required input: 239 tons UF6
➔ matches conversion facility
80% duty cycle.

Capacity 30 tons

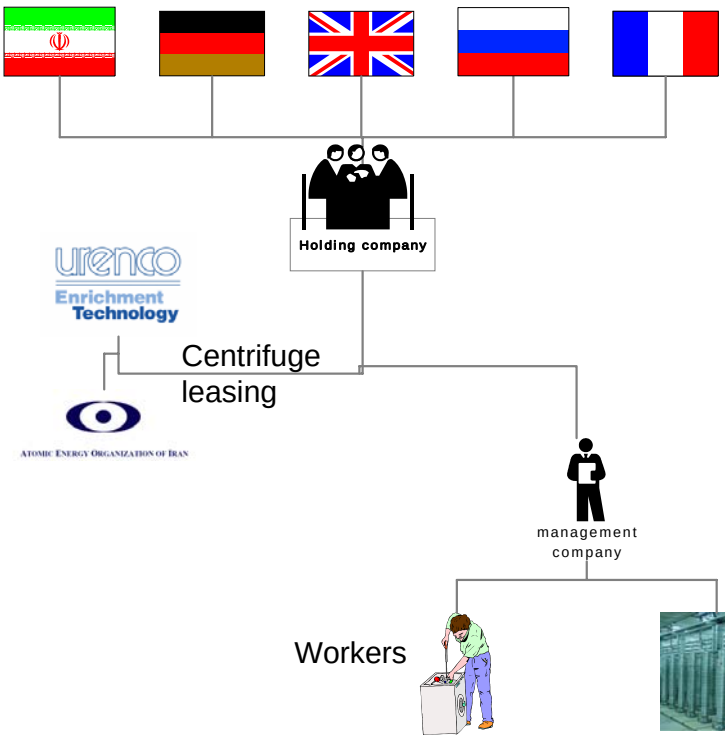
(unclear if this is an overcapacity or counts the steel matrix.)

But how capable are they of sustaining them?



A Joint Enrichment Facility in Iran

Organizational Chart for Joint Venture



The JV Centrifuge plant:

~168 P1 Centrifuges

50,000 T-21 centrifuges

5 Million SWU-kg/yr ➔ support 42 reactors.

We estimate that the facility will employ about 230 people:

Managers

Accountants

Technicians

Employees will come from each of the partner countries. There will be employees from each country present 24/7.

Times and Costs:

The T-21 centrifuge has not gone into mass production yet, however, we estimate from LES and George Besse II the costs associated with this facility:

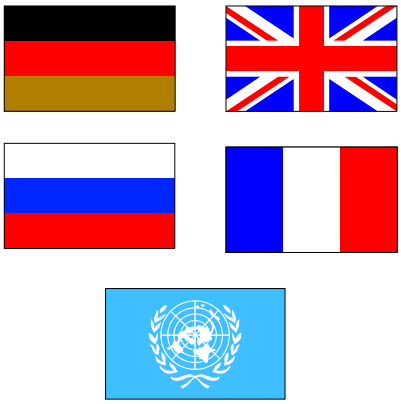
$1.9 billion to **$2.8 billion**, depending on how much extra it might cost to build a high tech facility in a developing country.

Again from George Besse II, we estimate that the entire facility might take 7 years to build.

But it could be made in stages, with the first taking as little as 18 months.

Preventing “Nationalization”

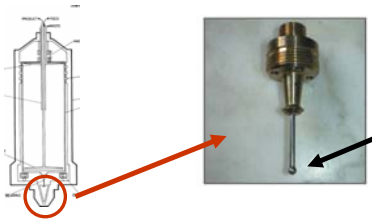
Political Barriers:



Technical Barriers:

Cascades will be setup as inflexibly as possible to prevent them from being quickly rearranged for producing HEU.

“Self-destruct” mechanisms



The bearing has very complex and difficult “groves”