Toward a Final Settlement of the Iran Nuclear Crisis

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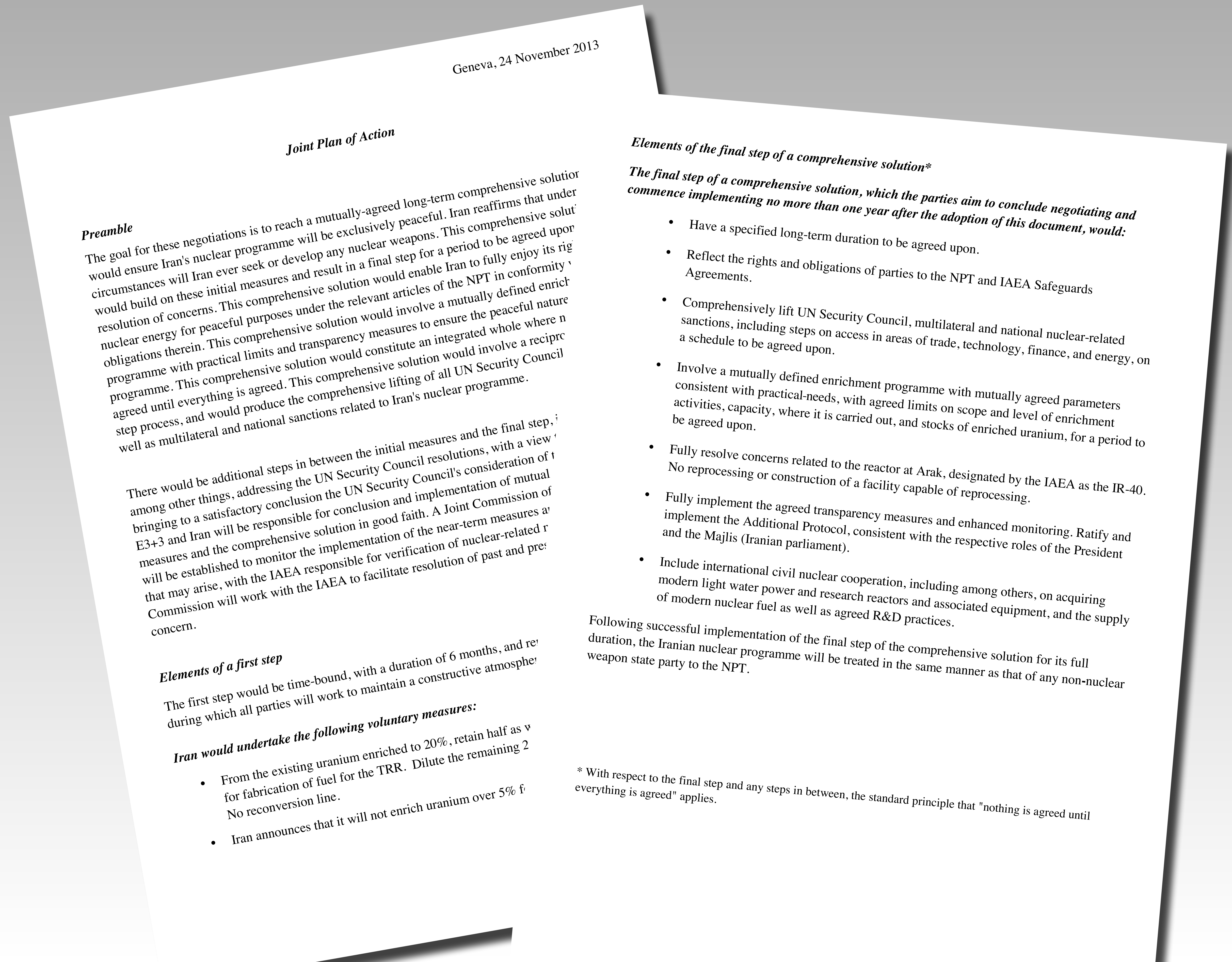
Revision 3x


Geneva, 24 November 2013

Joint Plan of Action

Preamble

The goal for these negotiations is to reach a mutually-agreed long-term comprehensive solutior
would ensure Iran's nuclear programme will be exclusively peaceful. Iran reaffirms that under
circumstances will Iran ever seek or develop any nuclear weapons. This comprehensive solut
would build on these initial measures and result in a final step for a period to be agreed upor
resolution of concerns. This comprehensive solution would enable Iran to fully enjoy its rig
nuclear energy for peaceful purposes under the relevant articles of the NPT in conformity
obligations therein. This comprehensive solution would involve a mutually defined enrich
programme with practical limits and transparency measures to ensure the peaceful nature
programme. This comprehensive solution would constitute an integrated whole where n
agreed until everything is agreed. This comprehensive solution would involve a recipro
step process, and would produce the comprehensive lifting of all UN Security Council
well as multilateral and national sanctions related to Iran's nuclear programme.

There would be additional steps in between the initial measures and the final step,
among other things, addressing the UN Security Council resolutions, with a view
bringing to a satisfactory conclusion the UN Security Council's consideration of
E3+3 and Iran will be responsible for conclusion and implementation of mutual
measures and the comprehensive solution in good faith. A Joint Commission of
will be established to monitor the implementation of the near-term measures a
that may arise, with the IAEA responsible for verification of nuclear-related r
Commission will work with the IAEA to facilitate resolution of past and pre
concern.

Elements of a first step

The first step would be time-bound, with a duration of 6 months, and re
during which all parties will work to maintain a constructive atmosphe

Iran would undertake the following voluntary measures:

- From the existing uranium enriched to 20%, retain half as w
for fabrication of fuel for the TRR. Dilute the remaining 2
No reconversion line.
- Iran announces that it will not enrich uranium over 5% f

Elements of the final step of a comprehensive solution*

The final step of a comprehensive solution, which the parties aim to conclude negotiating and commence implementing no more than one year after the adoption of this document, would:

- Have a specified long-term duration to be agreed upon.
- Reflect the rights and obligations of parties to the NPT and IAEA Safeguards Agreements.
- Comprehensively lift UN Security Council, multilateral and national nuclear-related sanctions, including steps on access in areas of trade, technology, finance, and energy, on a schedule to be agreed upon.
- Involve a mutually defined enrichment programme with mutually agreed parameters consistent with practical-needs, with agreed limits on scope and level of enrichment activities, capacity, where it is carried out, and stocks of enriched uranium, for a period to be agreed upon.
- Fully resolve concerns related to the reactor at Arak, designated by the IAEA as the IR-40. No reprocessing or construction of a facility capable of reprocessing.
- Fully implement the agreed transparency measures and enhanced monitoring. Ratify and implement the Additional Protocol, consistent with the respective roles of the President and the Majlis (Iranian parliament).
- Include international civil nuclear cooperation, including among others, on acquiring modern light water power and research reactors and associated equipment, and the supply of modern nuclear fuel as well as agreed R&D practices.

Following successful implementation of the final step of the comprehensive solution for its full duration, the Iranian nuclear programme will be treated in the same manner as that of any non-nuclear weapon state party to the NPT.

* With respect to the final step and any steps in between, the standard principle that "nothing is agreed until everything is agreed" applies.

Elements of the Final Step of a Comprehensive Solution

in the Joint Plan of Action

Elements of a Final Settlement

Two main elements in the JPA define the architecture of Iran’s nuclear program

They are (to a large extent) technical in nature

- *Involve a mutually defined enrichment program with mutually agreed parameters consistent with practical needs, with agreed limits on scope and level of enrichment activities, capacity, where it is carried out, and stocks of enriched uranium, for a period to be agreed upon.*

- *Fully resolve concerns related to the reactor at Arak, designated by the IAEA as the IR-40. No reprocessing or construction of a facility capable of reprocessing.*

What Are We Concerned About?

Defining Breakout

Significant Quantity

25 kg of uranium-235 in highly enriched uranium (> 20% U-235, typically > 90% U-235)
Material can be produced in enrichment plants

8 kg of plutonium (essentially any composition)
Material is produced during routing reactor operation but has to be separated from spent fuel

Iran's Main Options

Breakout using (declared) enrichment facility to produce weapon-grade uranium

(Breakout using undeclared enrichment facility)

Breakout using irradiated fuel from Arak (IR-40) heavy water reactor to separate plutonium

Plutonium Production

(recovered from irradiated Arak reactor fuel)


Iran's Arak (IR-40) Heavy Water Reactor
Source: Wikipedia; User: Nanking2012

Proliferation Concerns

and Basic Strategy to Address them

Reactor is fueled with natural uranium which maximizes plutonium buildup in the core

About 9 kg per year; after five years, about 50 kg available (in spent fuel pool and core)

Iran says that it wants to use the reactor for medical isotope production

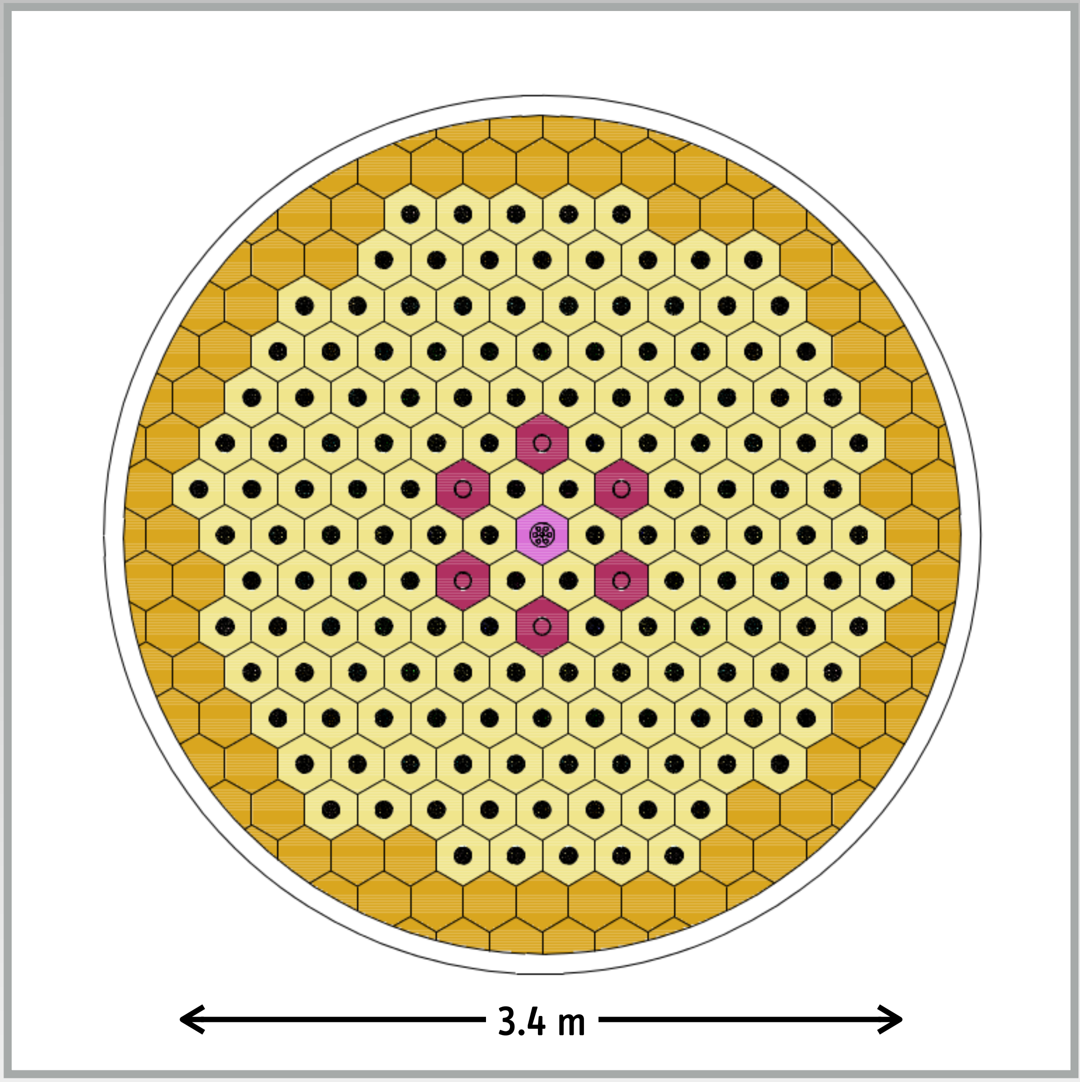
Plutonium production in a research reactor is largely determined by fuel enrichment and power level

Higher enrichment of fuel = less plutonium

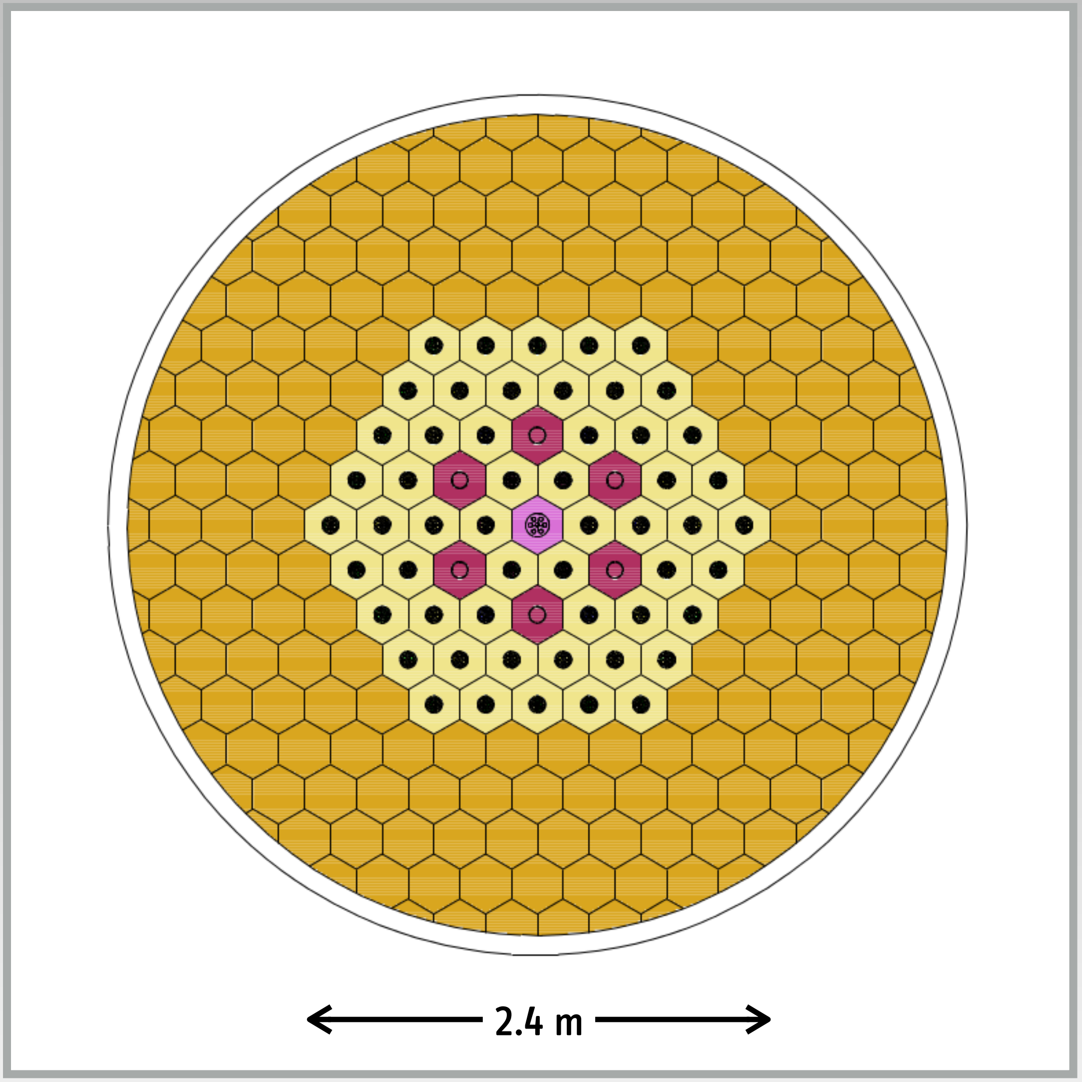
Lower power of reactor = less plutonium

The Modified Core is More Compact

It uses 5%-enriched fuel and operates at a much lower power level



Original core
(40 MW with natural uranium fuel)

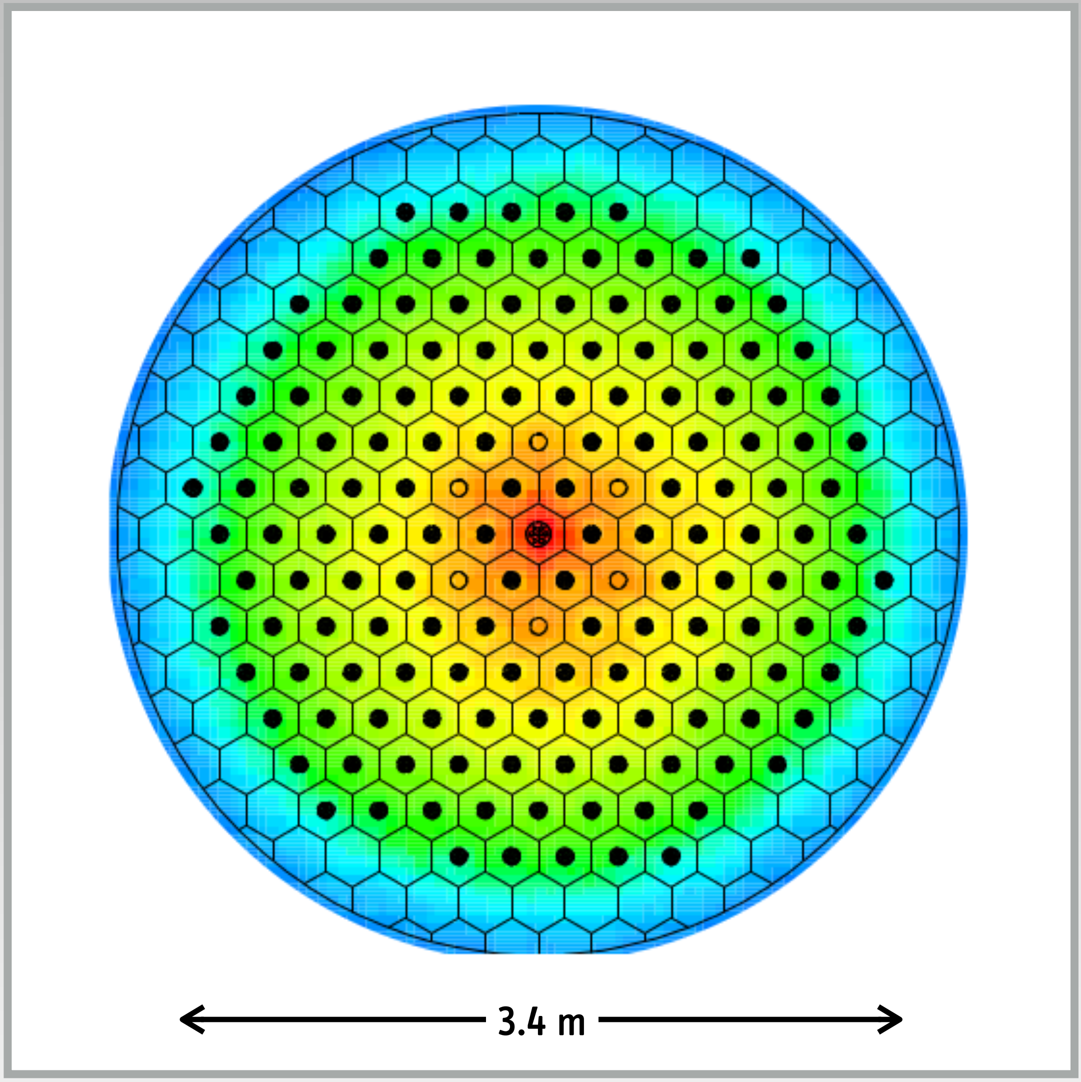


Modified core
(10 MW with 5%-enriched fuel)

A. Ahmad, F. von Hippel, A. Glaser, and Z. Mian, “A Win-Win Solution For Iran’s Arak Reactor,” *Arms Control Today*, April 2014

The Modified Core is More Compact

It has a much higher neutron flux, which compensates for usability



Original core

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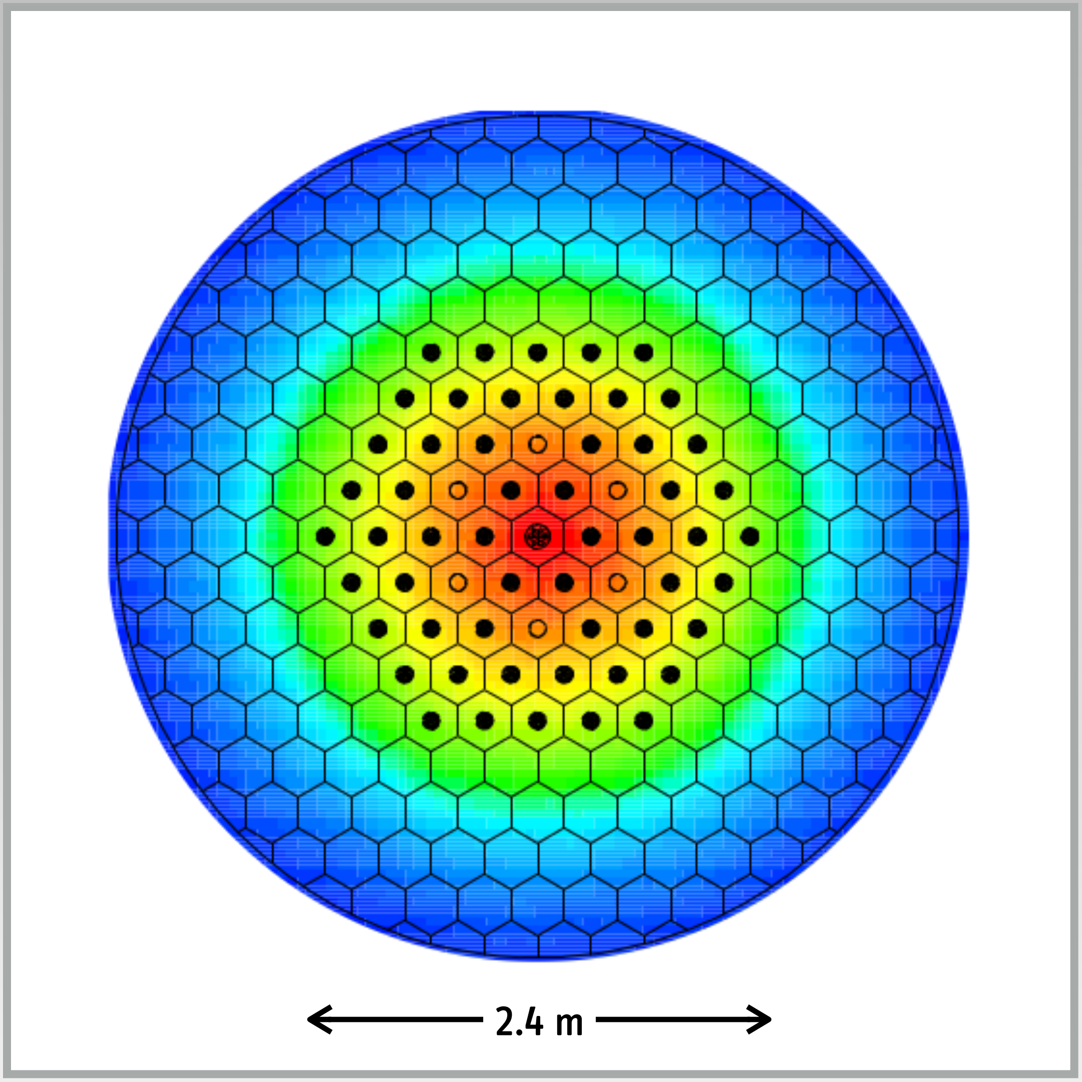

Modified core

(10 MW with 5%-enriched fuel)

A. Ahmad and A. Glaser, "A Conversion Proposal for Iran's IR-40 Reactor with Reduced Plutonium Production," Working Paper, in preparation

Comparing the Original and the Modified Arak Reactor

	Current design (40 MW, natural uranium fuel)	Proposed Modification (10 MW, 5%-enriched fuel)
Plutonium production	24 grams per day	1.1 grams per day
Pu-239 fraction (at end of life)	76%	71%
Cycle length	350 days	300 days

Annual plutonium production in modified core is 400–420 g (down from almost 9 kg)

A. Ahmad, F. von Hippel, A. Glaser, and Z. Mian, "A Win-Win Solution For Iran's Arak Reactor," *Arms Control Today*, April 2014

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Summary

Proposed Compromise for Iran’s Arak Reactor

Proposed Modification Would Significantly Reduce Plutonium Production in the Reactor

400 grams of plutonium per year

Even after several years of operation, not a significant quantity onsite

Plutonium remains in spent fuel; no reprocessing (as already agreed in Joint Plan of Action)

Spent fuel could be shipped to third country after 5-year cooling period

As we will see, plutonium route becomes much less “attractive” for breakout than uranium enrichment route

(At this point not worth pushing much further)

Has A Compromise on the Arak Reactor Already Been Reached?

"The issue of heavy water reactor … has been virtually resolved," state television quoted Salehi as saying. "Iran has offered a proposal to … redesign the heart of the Arak facility and these six countries have agreed to that."

Iran state TV says dispute over Arak nuclear plant 'virtually resolved,' *The Guardian,* April 19, 2014
www.theguardian.com/world/2014/apr/19/iran-arak-nuclear-plant

Uranium Enrichment

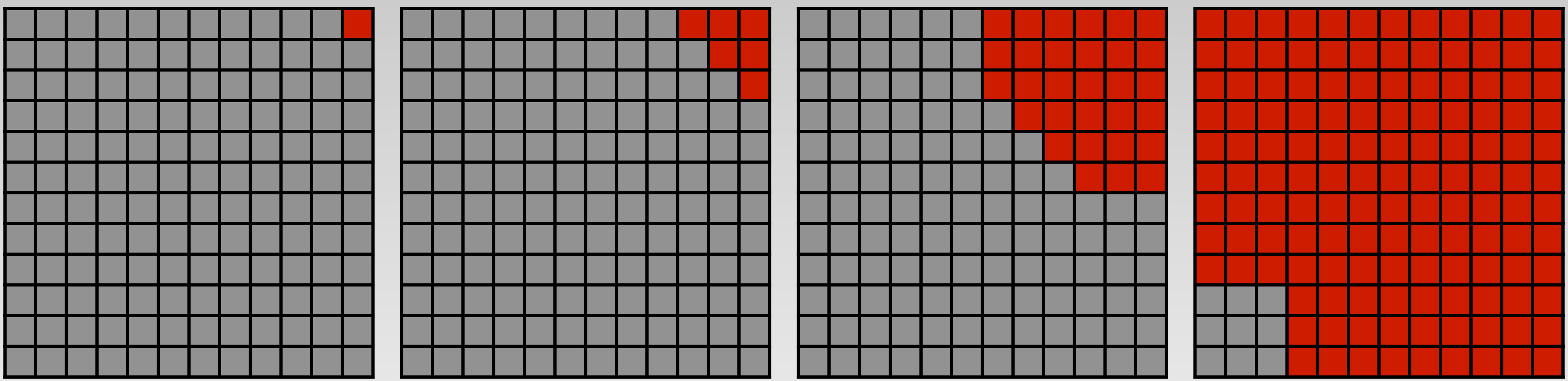

200 meters
Fuel
Enrichment
Plant
(FEP)
(FEP)
The Natanz Site in Iran (2007)


16
17
www.President.ir

Enriched Uranium

(visually)

HEU
(weapon-usable)



Natural uranium
0.7% U-235

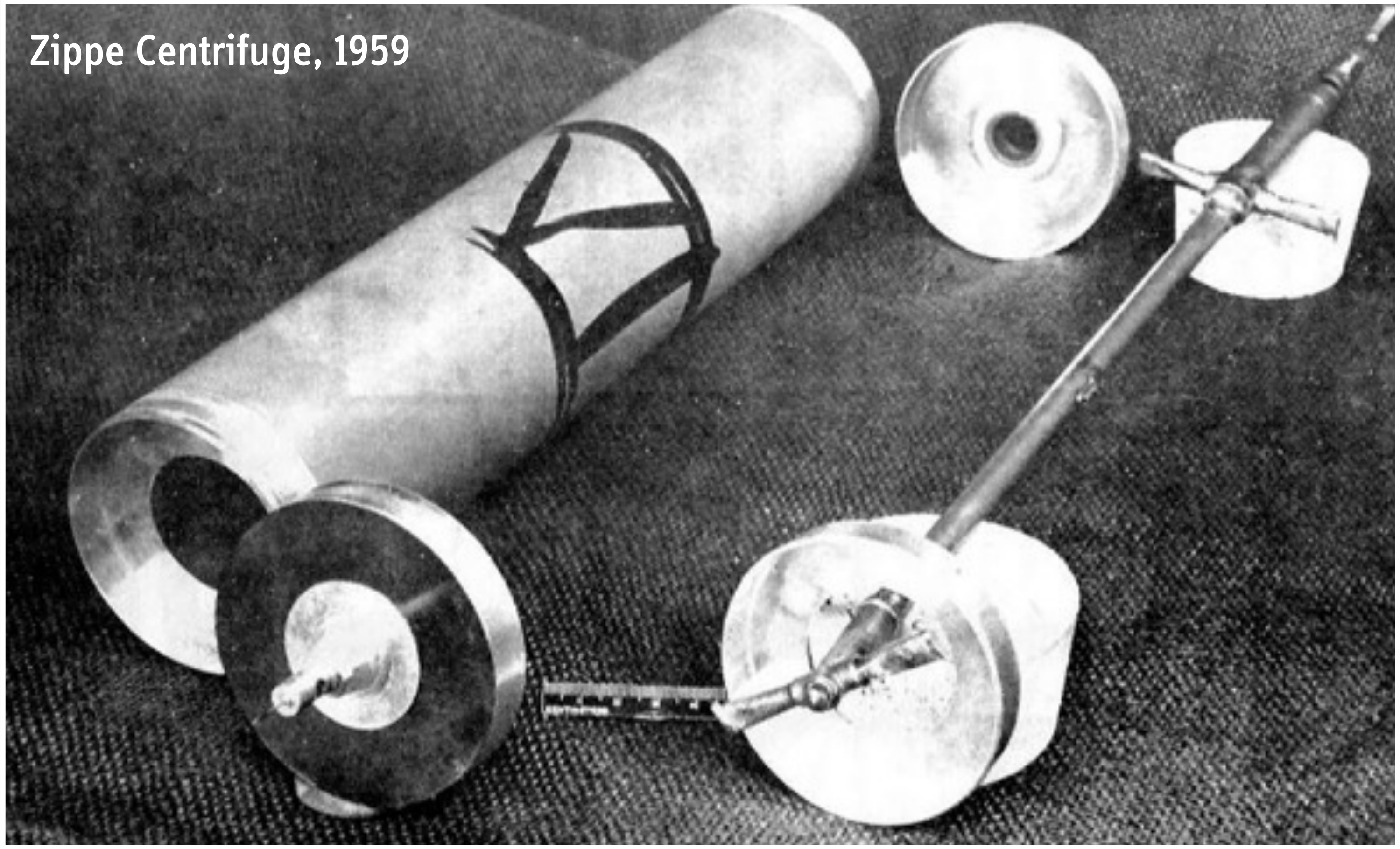
Low-enriched uranium
typically 3-5%,
but less than 20% U-235

Highly enriched uranium
20% U-235 and above

Weapon-grade uranium
more than 90% U-235

Uranium
U-235
U-238

Why Centrifuges Are Different



Characteristics of centrifuge technology relevant to nuclear proliferation

Clandestine Option and Rapid Breakout

The Current Situation

18,000 first-generation centrifuges in Natanz and Fordow

About 10,000 operating IR-1's

In addition: 7000 non-operating IR-1's and 1000 non-operating IR-2m's

Iran also has small number of next-generation prototype machines

Interim measures taken by Iran as Part of the Joint Plant of Action

Cap the number of operating centrifuges to those operating as of 20 January 2014

Not enrich uranium above 5 percent uranium-235

Dilute the stockpile of uranium that it has enriched to almost 20 percent

Defining Iran’s “Practical Needs”

Iran’s current demand for uranium enrichment is already met

(even for optimistic plans for future research reactors)

Fuel supply agreement for the Bushehr power reactor expires in 2021

Iran is “not interested” in renewing this agreement with Russia

By 2021, Iran wants to supply fuel for Bushehr domestically
This would require a ten-fold increase in enrichment capacity (up to 100,000 SWU/yr)

Huge gap between current demand and Iran’s future plans

How to define “practical needs”? How to bridge the gap between now and 2021?

An Evolutionary (Two-Step) Approach

based on A. Glaser, Z. Mian, H. Mousavian, and F. von Hippel "An Evolutionary Approach to a Possible Compromise on Iran's Centrifuge Program," Working Paper, forthcoming in Arms Control Today (July 2014)

An Evolutionary Approach: Step 1

Phase out existing IR-1 centrifuges in favor of IR-2m centrifuges

IR-1 is a low-performance (and unreliable) machine

It is not a viable candidate for a future commercial-size enrichment plant
(Iran has recognized the logic of replacing the IR-1 with more advanced machines)

Iran currently has one advanced machine available

IR-2m, about 5x more efficient

Iran could phase out the existing IR-1's an replace them with IR-2m's
but it would agree to keep the total installed enrichment capacity constant

This could mean reducing the number of operating centrifuges from 10,000 machines eventually to about 2,000 machines (less than 10,000 SWU/yr)

An Evolutionary Approach: Step 2

Develop, test, manufacture, and store next-generation centrifuges

Iran Has Several Advanced Centrifuge Types Under Development

Reportedly, their performance is 5–10 times higher than the performance of the IR-1

These machines (IR-4, IR-5, IR-6, IR-8) are not ready for deployment

Research, Development, and Testing of Centrifuges

Iran could field-test next-generation centrifuges as needed in its R&D facility

Manufacturing and Storage

After a testing period (2-4 years), Iran could begin to manufacture centrifuge components and store them under IAEA supervision

Key components requiring monitoring would be the centrifuge rotors and casings

Next-Generation Iranian Centrifuges

on display at Technology Exhibition, Tehran, February 2014

An Evolutionary Approach: Step 2

Develop, test, manufacture, and <u>store</u> next-generation centrifuges

Iran's net enrichment capacity would <u>not</u> increase between now and 2021

This is consistent with Iran's "practical needs"

The breakout time would remain on the order of 6–12 months

How much of a concern would be an inventory of components equivalent to 10,000–15,000 advanced machines?

Components would be under IAEA monitoring and removal would be immediately detected

It would then take 6–9 months to assemble and balance the centrifuges

Breakout time would not be shorter than it already is today (6–12 months)

Summary

Proposed Compromise for Iran's Enrichment Program

Short term (next 2–4 years)

Phase out first generation IR-1 centrifuges and transition to IR-2m

Enrichment capacity remains constant (at an agreed level) to meet Iran's practical needs as the total number of machines decreases (from 10,000 to about 2000)

Medium term (next 4–7 years)

Iran would be allowed to manufacture components for next-generation centrifuges at a rate that is consistent with its future plans

(i.e., provide fuel for Bushehr once the fuel-supply agreement with Russia runs out in 2021)

Toward a Long-Term Solution

Toward a Long-Term Solution

Designing a Multilateral Regime for Enrichment in the Middle East

P5+1 and some of Iran's neighbors would remain concerned because Iran's program to develop advanced centrifuges could exacerbate the proliferation risk in the longer run

Possible Action Items of a Final Agreement

P5+1 and Iran could agree as part of the final settlement to embark immediately on designing a regime, under which there will be effective multinational arrangements for enrichment in the Middle East

Establish a "working committee on multilateralization" of Iran's enrichment program and set a deadline for agreement well before 2021

A. Glaser, Z. Mian, H. Mousavian, and F. von Hippel "An Evolutionary Approach to a Possible Compromise on Iran's Centrifuge Program," Working Paper, forthcoming in Arms Control Today (July 2014)