Iran’s illicit procurement activities: Past, present and future
Ian J. Stewart & Nick Gillard
With Contributions from John Druce
About Project Alpha

Alpha was established in 2011 at King’s College London’s Centre for Science and Security Studies (CSSS) with government funding to improve the implementation of trade controls. Alpha conducts research to understand both illicit trade and the effectiveness of supply-side controls in countering such trade. This research forms the basis of Alpha’s outreach and capacity building activities.

Acknowledgements

This report draws upon an earlier paper written by Ian J. Stewart, ‘An Architecture for Controlling Nuclear-relevant Trade with Iran’, Project Alpha, 20 April 2015. Elements of it have been previously published in a World Export Control Review article by Ian J. Stewart, titled ‘The Iranian Nuclear Procurement Channel: the most complex part of the JCPOA?’ The research for this paper was undertaken with the kind support of the John D. and Catherine T. MacArthur Foundation under grant #100971.

Copyright 2015 King’s College London

The author of this report invites liberal use of the information provided in it for educational purposes, requiring only that the reproduced material clearly cite the source, using: ‘Ian J. Stewart and Nick Gillard, “Iran’s illicit procurement activities: Past, present and future”, Project Alpha, King’s College London, 24 July 2015’.
Executive Summary

The international sanctions regime on Iran’s nuclear programme has had both successes and limitations in constraining Iran’s technical capability. Underpinned by a series of UN Security Council resolutions, this sanctions regime is a core factor in Iran’s inability to expand its nuclear programme to the extent to which it aspires. Despite such sanctions, Iran has reached the point from a technical capability perspective at which it could build nuclear weapons if it decided to do so.

Iran has historically been – and remains – an importer of nuclear-related technology. The country has also undertaken an active foreign procurement programme for its UN-proscribed ballistic missile programme. Most of the critical inputs for Iran’s nuclear programme have been obtained from overseas. Moreover, Iran still relies on foreign supply chains to keep its proliferation-sensitive capabilities operational and expand its current capabilities. Iran’s domestic industries have made some efforts to indigenise production of sensitive nuclear- and missile-related materials and technologies, but to date, these efforts have met with only limited success.

The future trajectory of Iran’s nuclear-related procurement will be largely determined by the Joint Comprehensive Plan of Action (JCPOA), which includes specific provisions intended to prevent Iranian illicit procurement for its nuclear programme. One of the key measures envisaged by the JCPOA is the establishment of a dedicated procurement channel, operated by a Procurement Working Group for nuclear-relevant trade. It is through this dedicated channel that any legitimate procurement of such goods can take place. In implementing this procurement channel, a key challenge will be in ensuring that Iran can access nuclear-relevant goods for legitimate nuclear and legitimate non-nuclear end uses while also maintaining control over the trade in such goods. Another challenge is ensuring that Iran can fulfil and does fulfil its obligations not to procure nuclear-relevant goods outside of the channel.
# Contents

1. Introduction ............................................................................................................ 5

2. Iran’s nuclear infrastructure ....................................................................................... 7
   Iran’s uranium enrichment programme: crown jewels made with stolen gems .......... 9
   Scale of growth of Iran’s enrichment infrastructure .................................................. 10

3. Sustaining illicit programmes, from at home and from abroad .................................. 11
   Case study: Carbon fibre .......................................................................................... 12
   Case study: Aluminium alloys .................................................................................. 12
   Iran’s indigenous centrifuge-related manufacturing capabilities summarised ......... 13

4. Expanded, but delayed and constrained in key areas ............................................... 14

5. Further limitations in Iran’s technical capability ......................................................... 18

6. Iran’s procurement of prohibited items from abroad ................................................. 19

7. The geography of Iran’s illicit procurement ............................................................. 21
   Transshipment hubs: China and the UAE ................................................................. 23
   China as a procurement hotspot .............................................................................. 25
   The North Korean missile procurement channel .................................................... 26
   Expansion of trade and illicit procurement ............................................................... 27

8. The future of Iranian nuclear procurement ............................................................ 28

9. The JCPOA’s procurement channel ........................................................................... 29
   What is controlled under the JCPOA? ..................................................................... 30
   Role of the Procurement Working Group ................................................................. 32
   The role of the International Atomic Energy Agency ............................................... 33
   The role of industry and the private sector ............................................................... 33
   Iran’s role .................................................................................................................. 34
   Other States .............................................................................................................. 34

10. Monitoring illicit procurement .................................................................................. 35
    Broader issues .......................................................................................................... 35

11. Beyond Iran: preventing proliferation-related trade .................................................. 36
    Improving multilateral efforts ................................................................................... 37
    Improving national implementation ........................................................................ 39
    Improving implementation by companies and individuals .................................... 41

12. Conclusions ............................................................................................................ 43
1. Introduction

Iran’s nuclear and ballistic missile programmes have been and continue to be heavily dependent on imported technology and know-how. The elements of Iran’s nuclear programme which are prohibited by UN Security Council resolutions – Iran’s uranium enrichment and heavy water-related efforts – have relied on covertly acquired foreign assistance from their conception. After deciding to undertake a gas centrifuge programme in 1985, the Atomic Energy Organisation of Iran procured from the AQ Khan network designs and components for the Pakistani P-1 centrifuge, as well as designs for Pakistan’s more advanced P-2 model.1 Iran’s development of these centrifuges and an industrial-sized facility at Natanz with two cavernous underground halls to house them proceeded in secrecy. At the same time, after foreign suppliers rebuffed Iran’s attempts to buy a small plutonium production-capable research reactor, Iran began construction of a heavy water reactor and heavy water production facility at Arak using foreign design assistance.2 3

Indeed, most of Iran’s current nuclear infrastructure has been built with foreign help. The Bushehr Nuclear Power Plant was started by Germans and finished by Russians. The Tehran Research Reactor was built by the US. Iran’s heavy water production plant at Arak was commenced with Russian assistance, as was Iran’s uranium mine at Saghand, which was later completed with Chinese help.4 China helped develop Iran’s yellowcake production plant at Ardakan and provided designs for an industrial-scale uranium conversion facility and zirconium production plant, both of which Iran later completed itself.5 China also supplied Iran with a pilot-scale laser enrichment laboratory6 and 1.8 tonnes of natural uranium compounds in 1991.7 In the 1990s, China even built two small-scale research reactors at the Esfahan Nuclear Technology Centre, although these reactors lack proliferation utility.8

5 Ibid. 4.
6 Ibid. 4, 5.
Since the adoption of resolution 1737 in December 2006, measures such as another three Security Council resolutions,\(^9\) several decisions by the European Union Council, and unilateral sanctions measures by the US, Japan, Canada and others have sought to constrain Iran’s proliferation-related programmes. Despite these sanctions, Iran’s prohibited programmes have advanced. As Lieutenant General Stewart of the US Defense Intelligence Agency stated in February 2015, Iran ‘faces no insurmountable technical barriers to producing a nuclear weapon, making Iran’s political will the central issue.’\(^{10}\)

How have we come to this state of affairs, and how effective have sanctions been in constraining Iran’s nuclear and missile progress? Perhaps they have been more effective than some think. While Iran has still managed to progress its UN-prohibited nuclear activities, its progress has fallen far short of the goals it has set itself. Indeed, the sanctions regime is a core factor in Iran’s inability to expand its nuclear programme to the extent to which it aspires. Sanctions have provided legal grounds for multiple disruptions of illicit procurement activity, including through interdictions – some of them of extremely high value to Iran’s nuclear aspirations. Furthermore, sanctions have caused suppliers, state and private, to eschew sending critical items to Iran.

Analysing illicit procurement is inherently challenging. The use of sanctions evasion techniques have become commonplace, with such measures being used not only for nuclear- and missile-related procurement but also for alternative legitimate procurements. Iran has declared that it seeks to circumvent sanctions and export controls, with Iran’s president Hassan Rouhani stating that Iran is ‘proud’ to evade sanctions on the grounds that Iran considers these measures illegal.\(^{11}\) In order to evad control measures and foreign intelligence efforts, Iranian procurers for the nuclear programme hide their activities from authorities, which hinders analysis of much of their activities. Naturally, this could skew datasets. Additionally, sanctions evasion must be covert almost by definition, making it more difficult to identify specific cases. Still, with more than ten years of close public scrutiny of Iran’s nuclear procurement activity, there is now sufficient evidence available to draw conclusions about the foreign channels through which Iran has developed what it has in the nuclear domain. And because of the IAEA’s large body of reporting on Iran’s enrichment and heavy water-related activities – largely based on the close access provided under Iran’s safeguards agreement with the IAEA – there is a robust technical basis to assess the effect of sanctions on Iran’s nuclear programme.

---


Assessing the impact of sanctions on Iran’s ballistic missile programme is much more challenging. In comparison with Iran’s nuclear activities, there is no international inspection regime to measure Iran’s progress in developing and testing existing and new missile systems. This work is done within Iran’s Ministry of Defence and Armed Forces Logistics and Islamic Revolutionary Guards Corps, and the process is mostly kept opaque. Tehran’s occasional public releases of missile-related imagery do not permit as robust an assessment to be made as is possible regarding Iran’s nuclear progress. It is possible, however, to evaluate the nature of Iran’s missile-related procurement activities, which this paper seeks to accomplish. For the most part, these activities closely track procurement for Iran’s missile programme by geography and tradecraft.

Beyond these challenges, the Joint Comprehensive Plan of Action reached with Iran on 14 July 2015 offers an opportunity to ‘reset’ Iranian procurement behaviour. The JCPOA includes measures to monitor Iranian procurement of nuclear-relevant technologies. Importantly, as part of the agreement, the Iranian government has also committed that all procurement for its nuclear programme will go through the channel. In effect, if Iran was to conduct illicit procurement activities, it would be violating the terms of the agreement. Evidently, this raises important questions about how to ensure and monitor compliance. As there is apparently no expiry date on this procurement channel, these questions will endure for the indefinite future.

2. Iran’s nuclear infrastructure

Today, Iran has a complete nuclear fuel cycle encompassing uranium mining and processing, uranium conversion, uranium enrichment by gas centrifuge, nuclear fuel production, and light water and heavy water reactors. Despite sanctions and other efforts to slow Iran’s nuclear progress, these capabilities – largely based on foreign technology – are almost all operational (see table 1).
<table>
<thead>
<tr>
<th>Fuel cycle aspect</th>
<th>Relevant facilities</th>
<th>Year begun</th>
<th>Source of foreign assistance</th>
<th>Control status of exports to this facility</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uranium mining</td>
<td>Saghand</td>
<td>Approx. 1995</td>
<td>China, Russia</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Uranium mining and yellowcake production</td>
<td>Gachin (Gchine)</td>
<td>Approx. 2002</td>
<td>N/A</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Uranium processing and yellowcake production</td>
<td>Ardakan</td>
<td>Approx. 1990</td>
<td>China</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Uranium enrichment (centrifuge)</td>
<td>Natanz Uranium Enrichment Facility; Fordow Uranium Enrichment Facility</td>
<td>1987</td>
<td>AQ Khan network</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Uranium enrichment (laser)</td>
<td>Lashkar’Abad; Tehran Nuclear Research Centre</td>
<td>1975</td>
<td>China, Russia</td>
<td>Prohibited by UN sanctions</td>
<td>Suspended</td>
</tr>
<tr>
<td>Uranium conversion</td>
<td>Esfahan Uranium Conversion Facility</td>
<td>1990</td>
<td>China</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Fuel fabrication</td>
<td>Esfahan Fuel Manufacturing Plant</td>
<td>1990</td>
<td>China</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Light water reactor</td>
<td>Bushehr Nuclear Power Plant</td>
<td>1975</td>
<td>West Germany, Russia</td>
<td>Exempt from sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Heavy water reactor</td>
<td>Arak IR-40 Heavy Water Reactor</td>
<td>2004</td>
<td>Russia</td>
<td>Prohibited by UN sanctions</td>
<td>Incomplete</td>
</tr>
<tr>
<td>Heavy water production</td>
<td>Arak Heavy Water Production Plant</td>
<td>Mid-1990s</td>
<td>Russia</td>
<td>Prohibited by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Research reactor</td>
<td>Tehran Research Reactor</td>
<td>1960</td>
<td>US</td>
<td>Not specifically targeted by UN sanctions</td>
<td>Online</td>
</tr>
<tr>
<td>Research reactor</td>
<td>Esfahan Miniature Neutron Source Reactor, Zero-Power Reactor, open tank subcritical reactor and graphite-moderated subcritical reactor</td>
<td>1992</td>
<td>China, France</td>
<td>Not specifically targeted by UN sanctions</td>
<td>Online</td>
</tr>
</tbody>
</table>

Despite almost all of these facilities having origins with foreign suppliers, the provision of foreign assistance to them has been prohibited since Security Council resolution 1737 in 2006 – with the exception of the Bushehr power plant, of which Russia obtained a carve-
out. Indeed, Iran has had no formal arrangements with foreign government suppliers for any significant aspect of its nuclear programme since the mid-1990s. This means that in order to ensure their continuing operation or expansion, all of Iran’s nuclear facilities must rely on either domestically-made inputs or goods obtained from abroad.

Iran’s uranium enrichment programme: crown jewels made with stolen gems

Iran’s uranium enrichment programme, belatedly declared to the IAEA in 2002 after years of covert development, provides a good example of how Iran has relied on illicit procurement to build its nuclear capability and still relies on those practices for sustainment.

According to statements made to the IAEA by officials from the Atomic Energy Organisation of Iran (AEOI), Tehran decided to proceed with a centrifuge programme in 1985, with Pakistani-origin drawings and components of the URENCO-derived P-1 centrifuge received via the AQ Khan network in 1987. Further contacts between the AEOI and members of the Khan network continued into the 1990s with Iran receiving additional P-1 centrifuge components, and later designs for the more advanced P-2 centrifuge. The AEOI’s development and production of these centrifuges continued, initially at a small facility in Tehran, before construction of an industrial-scale enrichment facility was commenced in secret at Natanz. In 2002, Iranian dissidents exposed the facility, which was only then opened to IAEA inspection.

Despite the covert origins of Iran’s gas centrifuge uranium enrichment programme, there is now ample information in the public domain about its history and development. In addition to extensive information provided by Iran to the IAEA and published by the IAEA Board of Governors, Iran has released several dozen photographs and videos taken inside the Natanz uranium enrichment facility. These images show not just Iran’s centrifuges, cascades and other facility information, but (perhaps inadvertently) Western-origin supporting equipment. Still more information related to Iran’s centrifuge programme has also come to light through analysis of the Stuxnet malware, which appears to have

---


15 Even prior to the revelation of the Natanz facility in 2002, there were strong indicators in the public domain regarding Iran’s clandestine centrifuge activity. See, e.g., Andrew Koch and Jeanette Wolf, ‘Iran’s nuclear procurement program: how close to the bomb?’ The Nonproliferation Review, fall 1997, pp. 123-135.
been specifically configured to degrade Iran’s centrifuge programme. As such, the centrifuge programme makes for an ideal example with which to examine in-depth Iran’s illicit procurement efforts and the effect of sanctions.

**Scale of growth of Iran’s enrichment infrastructure**

By several measures, it is clear that over the last decade Iran’s centrifuge programme has greatly expanded. In that time, Iran has finished construction of underground cascade halls at Natanz and outfitted them, starting from scratch, with 16428 centrifuges. Iran has also built an entire centrifuge facility at Fordow, with nearly as many centrifuges now installed there (2710) as the underground site’s maximum capacity permits (2976).

Indeed, since Iran resumed uranium enrichment after a period of negotiations with the EU3+3 (China, France, Germany, the UK, US and Russia) in 2006, the number of centrifuges that Iran has installed has increased by many orders of magnitude. In March 2006, Iran had only 164 IR-1 centrifuges installed, which were located in the above-ground Pilot Fuel Enrichment Plant at Natanz. As of October 2014, Iran had 18,462 IR-1 centrifuges and 1347 centrifuges of the more advanced IR-2m and IR-4 types installed at Natanz and Fordow.

These figures, impressive in themselves, actually fall short of demonstrating the full scale of expansion of Iran’s centrifuges and supporting enrichment infrastructure. Iran has acknowledged replacing 1000 centrifuges in 2010, most likely due to wear and tear, malfunction or sabotage – and the overall number of centrifuges that have been replaced may be much higher. The AEOI likely also has a ‘strategic reserve’ of centrifuge materials and parts in case Iran’s declared enrichment facilities are attacked or damaged.

No outside attack is required to damage Iran’s centrifuges, which very often have a short lifespan compared to those used in other countries. Iran’s mainstay IR-1 centrifuge, based


on an outdated URENCO design stolen by AQ Khan, is inherently unreliable.\textsuperscript{22} In
addition, key items in Iran’s uranium enrichment infrastructure require regular
replacement, having a limited lifespan due to factors like the corrosive effects of uranium
hexafluoride. This leaves Iran reliant on constant replacements of the key inputs used to
make centrifuges and their supporting infrastructure, like pressure transducers, carbon
fibre, and high-strength aluminium.

3. Sustaining illicit programmes, from at home and from abroad

How, then, has Iran acquired or produced enough material for the expansion of the
centrifuge programme between the 1990s and today? How much of the equipment at
Natanz and Fordow has been obtained from abroad, and how much has been produced
through domestic means?

The Iranian government has long sought to develop indigenous industrial capabilities to
overcome foreign supply limitations. Policies begun by the Shah to indigenise key parts of
Iran’s military-industrial production capabilities have been greatly expanded under the
Islamic Regime, with the concept of ‘self-sufficiency jihad’ promoted across the industrial
and research arms of the IRGC and Ministry of Defence and Armed Forces Logistics
(MODAFL).\textsuperscript{23} Post revolution, MODAFL’s Defence Industries Organisation (DIO) was
charged with establishing over 240 new military production facilities, greatly expanding
the small number of production sites set up under the Pahlavi regime.\textsuperscript{24} This process of
indigenisation was hastened by the American arms embargo and consequent procurement
difficulties during the conflict with Iraq. At the end of the Iraq war, the IRGC expanded
the concept of the ‘self-sufficiency jihad’ into non-military areas of the Iranian economy.\textsuperscript{25}

For some key technologies relevant to uranium enrichment, the Iranian government has
also sought to enact the principle of production self-sufficiency. For centrifuge
manufacture, two key technologies are high-strength carbon fibre (above T700-grade) and
aluminium alloys (usually of the 7075 series). Both materials are used to make the precision
rotors that spin at supersonic speeds to separate uranium isotopes. These materials also
have utility for manufacturing missile components.

\textsuperscript{22} David Albright and Christina Walrond, ‘Performance of the IR-1 Centrifuge at Natanz,’ Institute for
Science and International Security, 18 October 2011, http://isis-online.org/isis-reports/detail/test1/8,
accessed 11 March 2015.

\textsuperscript{23} Ahmed Hashim, ‘Iran’s Military Situation,’ in Patrick Clawson (ed.), ‘Iran’s Strategic Intentions and
176.

\textsuperscript{24} Ahmed Hashim, ‘Iran’s Military Situation,’ in Patrick Clawson (ed.), ‘Iran’s Strategic Intentions and

\textsuperscript{25} Smyth, G. ‘Iran’s economic jihad: Resistance economics gaining ground in Khamenei circles,’ Executive,
24 July 2014.
**Case study: Carbon fibre**

In August 2011, Iran’s then-Minister of Defence Ahmad Vahidi opened what was described by the Iranian press as the country’s ‘first domestically-run production line’ for carbon fibre. The factory was described by the media as being located in Tehran and owned by Iran’s Aerospace Industries Organisation (AIO), a MODAFL subsidiary responsible for missile development and production. Vahidi described the factory as appropriate for manufacturing carbon fibre for a variety of strategic purposes, including missile-related applications like ‘nozzle heat shields, lightweight composite bodies of motors, [and] solid-fuel missiles’.

Is this factory capable of manufacturing carbon fibre for centrifuge rotors? Analysis by industry experts consulted by Project Alpha suggests that it is not. Indeed, these same experts went on to consult with the UN’s Iran Panel of Experts, which describes the facility’s key features – its ovens, furnaces, abrasion and spooling technology – as being in reasonable condition but outdated, in some cases being ‘more than 30 years old’. Ultimately, the Panel concludes that the factory ‘is assessed by experts in carbon fibre production and manufacturing not to be suitable for use in Iranian centrifuges.’ If this is Iran’s first and only carbon fibre production plant, then the country clearly cannot produce carbon fibre suitable for centrifuge rotors. Moreover, in 2014, the Panel of Experts stated that carbon fibre for Iran’s IR-2m centrifuge rotors was still being imported, with presumably the same applying for Iran’s other carbon fibre-rotor centrifuges. This is unsurprising given that the high-strength carbon fibre used in centrifuge rotors is notoriously difficult to make.

**Case study: Aluminium alloys**

Iran has a thriving domestic aluminium production industry. It is the twenty-second top producer of aluminium in the world and produced 292,702 tonnes of aluminium ingots in the first 10 months of the last Iranian year. In September 2013, the Iranian Mines and Mining Industries Development and Renovation Organisation (IMIDRO) announced plans to invest around USD$11.4 billion as part of a project to nearly quadruple production by 2025, with domestic demand for aluminium claiming to have been growing by 10

---

27 Ibid.
29 Ibid, p. 61.
percent a year. Despite these domestic capabilities, Iran is reliant on alumina from countries such as China, Russia and Canada, typically buying around 350,000 tonnes a year, which Iranian smelters convert into aluminium and aluminium alloys.\textsuperscript{32}

Even though Iran has a thriving aluminium sector, the aluminium used in the rotors of Iran’s IR-1 centrifuges is most likely made abroad. At least one Iranian aluminium producer – the country’s largest aluminium firm, the Iranian Aluminium Company (IRALCO) – claims in sales literature to be able to produce 7000-series aluminium in rod or ingot form.\textsuperscript{33} Yet Iran’s nuclear programme apparently eschews this product: the Panel of Experts has stated that the 7075-grade aluminium that Iran uses for its IR-1 rotors is made outside of Iran, imported, and then finished domestically.\textsuperscript{34} It is conceivable that Iranian nuclear officials prefer the imported product to the domestic product, for US court documents record one Iranian procurement agent stating that his clients – presumably in the nuclear programme – only wanted US- or European-origin aluminium.\textsuperscript{35} Overall, it is possible that Iran has a domestic capability to produce 7075-grade aluminium, but whether that material is used in the nuclear programme is doubtful.

\textit{Iran’s indigenous centrifuge-related manufacturing capabilities summarised}

Iran most likely lacks indigenous production capabilities not just for high-strength aluminium and carbon fibre, but for several centrifuge-essential technologies (see table below). For some technologies, as in the case of carbon fibre, this appears to be due to technical inadequacy. For other technologies, such as the pressure transducers used to precisely measure vacuum condition and gas flow, it may well be due to a preference for foreign-made items. (‘Brand snobbery’ is a concept long associated with the AEOI by counter-proliferation analysts.) Quite possibly, Iran may never become totally self-sufficient in production of prerequisite materials and equipment for the uranium enrichment process, particularly when overseas commercial alternatives remain attractive – and relatively easy to get.

\begin{center}
\begin{tabular}{|l|}
\hline
\textbf{Table 1: Iran’s indigenous centrifuge-related manufacturing capabilities summarised} \\
\hline
\textbf{Technology} & \textbf{Indigenous Production Capabilities} \\
\hline
High-strength aluminium & Likely \\
Carbon fibre & Likely \\
Pressure transducers & Likely \\
\hline
\end{tabular}
\end{center}


Table 2. Iran’s centrifuge-relevant indigenous industrial capabilities

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
<th>Current indigenous production capability?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotors</td>
<td>Aluminium 7075</td>
<td>Possibly</td>
</tr>
<tr>
<td></td>
<td>High-strength carbon fibre</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>Maraging steel</td>
<td>No</td>
</tr>
<tr>
<td>Casings</td>
<td>Aluminium 6061</td>
<td>Yes</td>
</tr>
<tr>
<td>Piping</td>
<td>Aluminium 6061</td>
<td>Yes</td>
</tr>
<tr>
<td>Lubricant</td>
<td>Fluorinated oils</td>
<td>Probably not</td>
</tr>
<tr>
<td>Frequency converters</td>
<td>Capable of output beyond 1000hz</td>
<td>Yes</td>
</tr>
<tr>
<td>Pressure transducers</td>
<td>Corrosion-resistant</td>
<td>No</td>
</tr>
</tbody>
</table>

4. Expanded, but delayed and constrained in key areas

By examining Iran’s enrichment structure at face value, one could be forgiven for thinking that Iran’s nuclear programme has expanded in an unrestrained fashion since the adoption of resolution 1737 in 2006. By installing thousands of additional centrifuges at the Natanz facility, Iran has increased its uranium enrichment capacity by many orders of magnitude. Iran has also constructed an entire new enrichment facility at Fordow and nearly completed the construction of a plutonium-capable heavy water reactor at Arak.

However, a review of Iran’s progress on its major nuclear facilities in comparison to Tehran’s original goals for completion of these facilities (see table 5) reveals a more nuanced picture, and shows important shortcomings in Iran’s nuclear progress. Almost every nuclear goal Tehran has set itself has been missed. Every major nuclear project that Iran has started has been delayed. Key capability goals (such as centrifuge number projections) have been missed.

---

In November 2006, Iran had 359 IR-1 centrifuges installed at the Natanz Pilot Fuel Enrichment Plant, giving it an approximate separative capacity of 359 separative work units (SWUs); as of August 2014, Iran’s installed centrifuges at the Natanz and Fordow sites gave it an approximate separative capacity of 24,000 SWU. See Nick Gillard, ‘How big is 190,000 SWU? Khamenei’s demand examined,’ 10 October 2014, Project Alpha, https://www.acsssi.info/proliferation/item/363-khamenei-swu-demand, accessed 29 December 2014.
Table 3. Comparison of Iran’s stated goals for its major nuclear facilities with actual progress, based on IAEA reporting.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Iran’s stated objective</th>
<th>Was objective met?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saghand uranium mine</td>
<td>Ore production at Saghand forecast to commence by 2006.37</td>
<td>No. IAEA stated in May 2010 that mine did not appear to be in operation.38 Iran officially began operations in Saghand in April 2013, according to a semi-official Iranian website.39</td>
</tr>
<tr>
<td>Gachin uranium mine and mill</td>
<td>Iran has stated that, as of July 2004, mining operations at Gachin had started and the mill had been hot tested.40</td>
<td>Probably not. A semi-official Iranian website states that the first sample of yellowcake produced in Gachin was sent to the Esfahan Uranium Conversion Facility (UCF) in December 2010.41 Samples of ammonium diuranate from Gachin were received at UCF in March 2009, according to the IAEA.42</td>
</tr>
<tr>
<td>Ardakan Yellowcake Production Plant</td>
<td>Operational by late 2006.43</td>
<td>Probably not. Infrastructure and processing buildings completed in 2004, facility officially started production in April 2013, according to a semi-official Iranian website.44 IAEA noted construction at site between 200945 and 2011.46</td>
</tr>
<tr>
<td>Natanz Fuel Enrichment Plant</td>
<td>50,000 centrifuges to be installed.97</td>
<td>No. As of February 2015, there are 16,428 centrifuges installed in the FEP, according to the IAEA.48</td>
</tr>
<tr>
<td></td>
<td>3,132 IR-2m centrifuges to be installed.</td>
<td>No. As of February 2015, there were</td>
</tr>
</tbody>
</table>

40 Ibid. 36.
43 Ibid. 36.
<table>
<thead>
<tr>
<th>Plant/Project</th>
<th>Status</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fordow Fuel Enrichment Plant</strong></td>
<td>Operational (UF6 introduced into cascades) in the summer of 2011, total of 3000 centrifuges to be installed. Partly. Became operational in December 2011, has 2700 centrifuges installed as of February 2015.</td>
<td></td>
</tr>
<tr>
<td><strong>Advanced centrifuge models to be used at Fordow.</strong></td>
<td>No. As of February 2015, only IR-1 centrifuges were installed in the FFEP, according to the IAEA.</td>
<td></td>
</tr>
<tr>
<td><strong>Arak IR-40 Heavy Water Research Reactor</strong></td>
<td>Operational by 2014.</td>
<td>No. As of February 2015, the IAEA noted that some of the reactor’s major components were yet to be installed.</td>
</tr>
<tr>
<td>Reactor vessel to be installed in 2011.</td>
<td>No. Reactor vessel was installed in June 2013.</td>
<td></td>
</tr>
<tr>
<td><strong>55 fuel assemblies to be produced by August 2013; another 140 assemblies by August 2014.</strong></td>
<td>No. By May 2014, 11 assemblies, 36 prototypes and one mini assembly had been produced.</td>
<td></td>
</tr>
</tbody>
</table>

---

50 Ibid. 47.
51 Ibid. 46.
52 Ibid. 44.
56 Ibid. 47, 56.
57 Ibid. 47.
59 Ibid. 47, 56.
61 Ibid. 47, 56, 58.
62 Ibid. 41.
<table>
<thead>
<tr>
<th>Darkhovin 360MW Nuclear Power Plant</th>
<th>To be commissioned in 2015.</th>
<th>No. Construction is not known to have commenced.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fars 10MW Research Reactor</td>
<td>Operational by 2016-2018.</td>
<td>Unlikely to be met.</td>
</tr>
<tr>
<td>New enrichment facility</td>
<td>Construction to commence in or shortly after March 2011</td>
<td>Not known to have commenced.</td>
</tr>
<tr>
<td>New research reactors</td>
<td>Four to five reactors built in the ‘next few years’ after April 2011</td>
<td>Not known to have been built or commenced.</td>
</tr>
</tbody>
</table>

There are, of course, many factors that might be responsible for these delays. Mismanagement is the most obvious factor, in much the same way that maladministration may well have crippled Iran’s economy more so than sanctions. Certainly, officials in Iran’s nuclear programme are likely to suffer the same shortcomings as their colleagues elsewhere, with cronyism and ideologically-driven appointments likely rife in the AEOI. Yet mismanagement alone cannot explain the extent of delays across virtually all aspects of the nuclear programme. That all of these delayed programmes have been targeted by sanctions supports the notion that sanctions have, at the very least, helped slow the nuclear programme.

Sabotage is another factor that has hindered Iran’s nuclear progress, although to an uncertain degree. In June of 2010, a piece of malware, later named Stuxnet, was discovered to have infected several Iranian industrial sites including the Natanz uranium enrichment facility. As cyber forensic experts later determined, Stuxnet had been designed to target specific brands and types of industrial control devices with the intended purpose of causing damage to Iran’s centrifuge cascades at Natanz. Although it has been argued that the Stuxnet attack was responsible for the destruction of at least 1,000 centrifuges at Natanz, the precise effect and extent of any damage caused by the attack is unknown – and most likely unquantifiable. The same likely applies to the impact of other sabotage efforts against Iran’s nuclear programme.

---

67 Ibid. 54.
70 Ibid. 53.
72 David Albright, Paul Brannan, and Christina Walrond, ‘Stuxnet malware and Natanz: Update of ISIS December 22, 2010 report,’ 15 February 2011,
5. Further limitations in Iran’s technical capability

Iran has not just fallen short on many of its own declared nuclear goals; it has also failed to fill numerous gaps in the various pathways that might lead it towards nuclear weapons production. In these areas, too, sanctions may well have been a key factor in constraining Iran’s activities.

Reprocessing – a capability necessary for producing plutonium nuclear weapons – is an obvious shortcoming in Iran’s fuel cycle. Despite attempts to develop and acquire reprocessing-relevant capabilities over the past decade, Iran has no reprocessing facility – and without a reprocessing capability, the plutonium track to nuclear weapons is closed to Tehran. The closest the AEOI has to a reprocessing capability is the hot cells that are planned for the IR-40 reactor at Arak, which, according to recent US statements, would be adequate for research-scale plutonium extraction if they are finished. But those hot cells are just empty concrete shells – as Iran itself has acknowledged to the IAEA – because they have been unable to purchase robotic manipulators and radiation-shielded glass from abroad, two key pieces of equipment that are essential for hot cells. With Iran agreeing under JCPOA to abstain from pursuing a reprocessing facility, these hot cells may well stay empty shells for some time to come.

Sanctions and supply-side pressure have played an important role in this. Prior to 2002, Iranian procurers attempted to buy from French suppliers lead glass and manipulators; the sale fell through, most likely due to government pressure. After resolution 1737, potential foreign suppliers have apparently recoiled enough to force the AEOI to try to develop a domestic lead glass capability: journal articles indicate that since 2010, the AEOI has been studying lead glass production processes. The AEOI may have been driven to even more costly measures in pursuit of this capability. Trade websites show that in 2011, an Iranian

---

procured made repeated attempts – apparently unsuccessful – to buy an entire lead glass production line from China.\textsuperscript{77}

The deployment of Iran’s advanced centrifuges, too, has likely been slowed – if not impeded – by sanctions. Despite years of development, the IR-2m, IR-4 and other advanced models have still only been deployed in small numbers at Natanz and Fordow when compared to the much less efficient IR-1. The effect on Iran’s weapon-related capability of this shortcoming is substantial: without the greater separative capacity that these more advanced machines provided when deployed in great number, the time required for Iran to produce enough fissile material for a nuclear weapon remains within internationally-tolerable limits.

The failures in Iran’s advanced centrifuge programme may be caused by many other factors in addition to the effect of sanctions. But there should be no doubt that the hardened global supply environment resulting from sanctions has caused Iran great difficulty in obtaining key materials for these machines, particularly the high-grade carbon fibre used for rotors in the IR-2m and IR-4 machines. In December 2012, for example, 7,200 kilogrammes of high-strength carbon fibre bound for Iran was interdicted and seized in Singapore; the seizure included enough material to produce enough centrifuge rotors to outfit a Fordow-size uranium enrichment facility.\textsuperscript{78} And Iran’s much-touted domestic carbon fibre manufacturing factory, as described earlier, is essentially a Potemkin facility, built with 30-year old technology most likely scrounged from the black market.

6. Iran’s procurement of prohibited items from abroad

Iranian industries, both state-owned and private, have made substantial efforts to build indigenous capabilities in strategic manufacturing areas with relevance for centrifuge production and missile development. But from the evidence available – particularly that offered by the UN Panel of Experts – it is clear that Iran’s nuclear programme continues to rely on key materials, components and machinery made abroad.

Since the adoption of UN Security Council resolution 1737 in 2006, states appear to have heeded the requirement not to supply Iran’s uranium enrichment and heavy water-related programmes. No state has been credibly accused of violating resolution 1737 (or subsequent resolutions) by deliberately providing equipment or expertise to these programmes.\textsuperscript{79}


\textsuperscript{79} North Korea has regularly been accused of providing Iran with nuclear-related assistance, but little – if any – credible evidence of this alleged assistance has been provided. North Korea has been an active supplier to Iran’s ballistic missile programme, however.
Instead, suppliers to Iran’s prohibited programmes have been non-state actors: companies, individuals and networks operating outside the purview of states, frequently in secret.

Nationally-implemented sanctions have thus far been insufficient to stop these procurers, although sanctions have certainly made their job much harder. Buyers for Iran’s prohibited programmes have had to shield their end-users from scrutiny, and have used layered methods of deception to do so. Deception is not inexpensive, however, and even though intelligence-led interdictions – like the seizure of carbon fibre in Singapore – are infrequent, they prove quite costly to procurers when they do occur. In addition to the financial cost, such actions can also have a disruptive effect on networks.

UN Security Council Resolutions are a legal cornerstone for these sorts of interdictions. Resolutions 1737, 1803 and 1929 provided the legal weight for states to undertake the difficult and often expensive work of finding and detaining illicit exports bound for Iran’s proscribed programmes. Indeed, the Panel of Experts report provides strong evidence of the extent to which states have used sanctions as a basis to deny proliferation-sensitive exports to Iran. Over the year prior to June 2014, the Panel of Experts inspected 30 ‘reported cases’ – seizures of goods or material ‘interdicted by States on the basis of intelligence information that they were intended for use in the Islamic Republic of Iran’s prohibited activities.’

Seized items included goods with valuable utility to the uranium enrichment and heavy water processes such as frequency inverters, high-strength alloys, valves and carbon fibre.

Importantly, because of UN sanctions measures (not just on Iran, but on the DPRK as well), the use of interdictions and export denials as a counter-proliferation tool has spread. Once mainly the preserve of authorities in the US, UK, France and Germany, the use of these methods has widened to states in the Middle East and Asia, as several cases show. In December 2010, authorities in the Republic of Korea detained an air cargo shipment of phosphor bronze mesh which was bound for Iran’s heavy water production plant at Arak. In 2012, Bahrain and the UAE were reported to have confiscated several items Iran may have sought for its nuclear programme, including carbon fibre and goods bound for the AEOI. In the same year, Singaporean authorities conducted the seizure of 7,600 kilogrammes of carbon fibre from an Islamic Republic of Iran Shipping Lines vessel.

---

7. The geography of Iran’s illicit procurement

Surprisingly, given that this procurement activity is often covert or clandestine, there is ample evidence of it on the public record. From court records of export control violations; news reports; and publications of international bodies like the UN Panel of Experts, nearly 300 cases can be found of non-state actors supplying or attempting to supply nuclear-related goods to Iran – either to known nuclear end-users, or to suspected nuclear end-users.84 Procurement case data indicates that manufacturers in Europe, the UK and US are the favoured targets for Iranian nuclear procurers, and that China and the UAE are the primary transshipment points for Iran’s nuclear supply chain.85

A more focused analysis of cases of Iran’s missile-related procurement suggests that much of the same trends apply to that activity. As with their counterparts from Iran’s nuclear programme, procurers from Iran’s missile programme have similarly targeted manufacturers in Europe, the UK and US, with transshipment frequently organised via Turkey and the UAE.86 The major difference between Iranian nuclear and missile procurement – further described below – is the ongoing cooperative relationship between Iran and North Korea, for which there is no known equivalent in the nuclear domain.

Preferred suppliers: Western Europe and the US

A number of past case studies on procurement for Iran’s nuclear programme have argued that procurers target firms and institutions in Europe.87 Cirincione, Wolfsthal and Rajkumar, for example, state that Iran has used ‘an active but clandestine procurement network using front companies and false end user certificates to persuade Western European companies to provide nuclear-related, dual-use technologies.’88 Germany, with its mature nuclear sector and flourishing high-tech manufacturing, is often highlighted as the country where most of these goods originate. A recent Jerusalem Post article noted, for

---

84 A review of these cases has been conducted by Project Alpha at King’s College London during 2014.
85 Of course, these data represent known procurement cases – given that illicit procurement is by nature a covert activity, there are doubtless many more procurements and procurement attempts that have gone undetected or unreported. And there is likely a reporting bias to the data: Germany, the US and UK have mature export control regimes and are more likely to detect and report cases of illicit procurement.
example, the ostensibly ‘hundreds of German and Iranian enterprises in a flourishing trade relationship [for dual-use goods].’ 89

Procurement case data aggregated by Project Alpha supports the inference that manufacturers in Europe, and particularly Germany, are favoured targets for Iranian nuclear procurers. In all of the procurement cases surveyed where the national origin of the procured goods was known (147 cases), nearly half of the manufacturers (70) were European. Germany was indeed the most common point of origin in Europe for Iran’s nuclear-related procurements, with known 24 cases involving German-made goods.

But the data suggests that Iranian procurers have targeted firms in other countries as often as they have targeted German firms, and perhaps even more so. There are nearly as many recorded cases (21) where manufacturers in the United Kingdom have been involved in supplying Iran’s nuclear programme. And surprisingly, given the virtual embargo that the United States has against Iran, American manufacturers have been involved in supplying nuclear-related goods to Iran on twice as many occasions (36 cases) as companies in Germany.

Figure 1. Points of origin for known and suspected nuclear-related procurements by Iran, excluding state-to-state transfers, 1982-present

<table>
<thead>
<tr>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 30 cases</td>
</tr>
<tr>
<td>20 to 30 cases</td>
</tr>
<tr>
<td>Zero to 10 cases</td>
</tr>
<tr>
<td>Zero cases</td>
</tr>
</tbody>
</table>

Some caveating is required considering the limitations of the data. First, these data represent known procurement cases – given that illicit procurement is by nature a covert activity, there are doubtless many more procurements and procurement attempts that have gone undetected or unreported. Second, there is likely a reporting bias to the data: Germany, the US and UK have mature export control regimes and may be more likely to detect and report cases of illicit procurement. Despite these limitations, though, the data provide a useful picture of where Iran has obtained goods for its nuclear programme – and show that the problem of illicit procurement is a widespread one, and not just limited to Europe.

**Transshipment hubs: China and the UAE**

Two countries have been singled out in past studies as key transshipment points for illicit trade to Iran, including trade in nuclear-related goods: China, mainly because of the volume of global trade that passes through its ports; and the UAE, because of its proximity to Iran. According to one estimate, 90 per cent of goods destined for Iran’s prohibited
missile and nuclear programmes transit through China. And as Karim Sadjadpour noted in 2011, ‘[t]he UAE...is a top source of Iranian imports and a key transshipment point for goods—legal and illegal—destined for the Islamic Republic.’

Data on public cases of known or suspected nuclear-related procurements supports the notion that China and the UAE are the primary transshipment points for Iran’s nuclear supply chain. In nearly a third of the procurement cases (38 of 122) where a transshipment point has been reported, goods transited through or were stopped in China. Far more reported cases, though, have involved China than the UAE; although it is the second-most commonly-reported transshipment point, only 13 cases of transshipment through the UAE are known.

Figure 2. Transshipment points for known and suspected nuclear-related procurements, excluding state-to-state transfers, 1990-present

<table>
<thead>
<tr>
<th>Cases</th>
<th>More than 30 cases</th>
<th>20 to 30 cases</th>
<th>Zero to 10 cases</th>
<th>Zero cases</th>
</tr>
</thead>
</table>

---


Beyond China and the UAE, there is something of a ‘long tail’ of countries which have been used for Iranian nuclear-related transshipment. Some of these locations are unsurprising – Turkey (8 cases) and Malaysia (3 cases), for instance, have been widely reported as alternative hubs to the UAE for Iran’s trade, both licit and illicit. Other results are perhaps less anticipated. Spain (4 cases) and Austria (5 cases) have been used for transshipment. And more transshipment cases have been reported in the US (6 cases) than in Malaysia and Singapore (2 cases), despite them both being major South-East Asian ports between China and Iran. Of course, these figures must be read with caution: the same reporting biases exist in the transshipment data set as with the points of origin data.

At the very least, transshipment data suggests that the problem of illicit transshipment is more widely dispersed than previous estimates have judged. Countries well beyond those thought of as traditional trade hubs for Iran must remain alert for the transit of goods destined for Iran’s nuclear programme.

**China as a procurement hotspot**

‘Out of necessity, the Islamic Republic of Iran purchases some [nuclear equipment] spare parts from some developing and growing Eastern countries’.


While China is well-understood to be the major transhipment point for nuclear-related goods bound for Iran, its growing role as a manufacturing locus for these items is also worth examining. Evidence of this status can be found in the 2014 report of the Iran Panel of Experts, which lists 30 items seized by UN member states under suspicion of being destined for Iran’s UN-proscribed programmes, and then inspected by the Panel. Of those items, eight had been manufactured in China – far more than any other country. These goods included not just commodities but precision-manufactured metal parts, exotic alloys, and frequency inverters, a complex electronic component with utility in the uranium enrichment process.

With China’s rapid industrial growth and the expansion of Chinese firms into advanced technology manufacturing (including for China’s domestic and export nuclear sectors), it is

---


unsurprising that Chinese companies should be targeted by Iranian procurers. China also offers perhaps the world’s most advanced online environment in which to source nuclear-useable goods: China-based Internet-trading platforms which match industrial suppliers with commercial buyers, including Alibaba.com, enable buyers to identify and source proliferation-sensitive goods with unparalleled ease.\(^\text{95}\)

Still, though, there are significant limitations to China’s importance in Iran’s nuclear supply chain. As Ali Akbar Salehi alludes to in the above quote, China is not necessarily Iran’s favoured manufacturer for nuclear-related items. Rather, the AEOI seems to prefer ‘prestige’ European and US brands. Analysis of open source images taken inside Iranian enrichment facilities show a concentration of high-end European and American-made dual-use equipment: for example, Pfeiffer and Leybold vacuums and Siemens industrial control equipment, made in Germany; and MKS pressure transducers, made in the US. It seems that Chinese manufacturers are a fall-back option when US or European supply-side controls are too hard to circumvent.

**The North Korean missile procurement channel**

Despite frequent assertions of and speculation regarding nuclear-related cooperation between Iran and North Korea, no credible evidence of any such relationship has been presented in the past decade.\(^\text{96}\) By comparison, in the missile domain, Iran and North Korea have had a thriving relationship for more than 30 years, with technology, expertise, and even complete platforms being supplied from Pyongyang to Tehran.\(^\text{97}\) North Korean missile technology forms the basis for Iran’s Shahab series of medium-range ballistic missiles, and propulsion and guidance technology from Pyongyang has been incorporated into Iran’s space launch vehicles (SLVs).\(^\text{98}\) Iran even obtained 19 complete BM-25 medium-range ballistic missile systems from North Korea, although these seem to have been mothballed.\(^\text{99}\)

How active is this channel today, and how – if at all – has it changed in the face of sanctions and negotiations? These questions are difficult to answer, as this partnership is

---


\(^{96}\) For one example, Bernstein provides an unfounded assertion that North Korea has provided uranium mining assistance to Iran, an allegation that has never been made by the IAEA nor any other competent authority. See Jeremy Bernstein, ‘Nuclear Iran’, Cambridge, MA and London: Harvard University Press, 2014, p.77.


ostensibly covert and publicly unacknowledged by both Tehran and Pyongyang. Still, there are some indications on the public record that missile-related transfers have continued well into the negotiating period, including transfers of sensitive components that could substantially increase Iran’s missile capability. Between September 2014 and April 2015, according to Bill Gertz, North Korea made two shipments to Iran of MTCR-controlled missile components including large-diameter rocket motors suitable for a long-range missile or SLV.\footnote{Bill Gertz, ‘North Korea Transfers Missile Goods to Iran During Nuclear Talks,’ The Washington Free Beacon, 15 April 2015, http://freebeacon.com/national-security/north-korea-transfers-missile-goods-to-iran-during-nuclear-talks/, accessed 26 May 2015.} And if Gertz’s reports are credible, then it may be the case that this channel is more of a cooperative one than simply a supplier-customer relationship: in 2013, Gertz reported that Iranian technicians from UN-designated MODAFL subsidiary, the Shahid Hemmat Industries Group (SHIG), had been collaborating with North Korean engineers on an 80-ton rocket booster that could be used in both nations’ long-range missile programmes.\footnote{Bill Gertz, ‘Iran-North Korea Missile Cooperation Undermines Recent Geneva Nuclear Deal,’ The Washington Free Beacon, 27 April 2013, http://freebeacon.com/national-security/iran-north-korea-missile-cooperation-undermines-recent-geneva-nuclear-deal/, accessed 26 May 2015.}

**Expansion of trade and illicit procurement**

With the agreement of the JCPOA and the gradual easing of sanctions that will follow, many of Iran’s past and present trading partners will be looking to expand or re-engage bilateral trade ties. In March 2014, for example, a South Korean trade delegation visited Iran with the aim of expanding business in the mining, industrial, and food sectors, and approximately a week later Seoul’s finance ministry lifted a ban on South Korean trade with Iran in the auto, construction, pharmaceutical, and telecommunications industries. (Seoul retains sanctions in the key shipbuilding and shipping sectors, however).\footnote{I-wei Jennifer Chang, ‘The Iran sanctions and South Korea’s balancing act,’ Middle East Institute, 2 June 2014, http://www.mei.edu/content/map/iran-sanctions-and-south-korea%E2%80%99s-balancing-act, accessed 29 December 2014.} India, Turkey and others have shown similar interest, and trade delegations have visited Iran from the UK, France and Germany, despite the strict sanctions imposed by their governments.\footnote{Government of India, Ministry of Commerce and Industry, Department of Commerce, ‘Annual report 2012-2013: Commercial relations, trade agreements, and international trade organisations,’ http://commerce.nic.in/publications/anualreport_chapter6-2012-13.asp, accessed 29 December 2014.}\footnote{Michael Rubin, ‘Iran-Turkey trade jumps again,’ American Enterprise Institute, 5 March 2013, http://www.aei.org/publication/iran-turkey-trade-jumps-again/, accessed 29 July 2014.}

Will increases in trade lead to expansion in illicit nuclear- or missile-related procurement along these bilateral channels? The answer is not clear. The prevalence of US-origin equipment in Iran’s nuclear and missile programmes shows that there is not always a correlation between trade volume and illicit procurement. And as long as Iran’s bilateral trade partners make serious efforts to enforce sanctions prohibiting trade in particular dual-
use items, as well as sanctions prohibiting trade with certain Iranian end-users, there does not have to be a connection between levels of trade and illicit procurement.

8. The future of Iranian nuclear procurement

The JPCOA agreed with Iran on the 14th July 2015 includes specific provisions intended to prevent procurement contributing to undeclared nuclear activities over the next decade. These collectively are known collectively as the “Procurement Channel” and will be operationalised by the Procurement Working Group of the JCPOA’s Joint Commission, which consists of the EU3+3 and Iran.

Even before the JPCOA was concluded, there were some indications that renewed talks between Iran and the EU3+3 had caused a pause, or at least a reduction, in Iranian efforts to illicitly obtain supplies for their nuclear facilities. As the Panel of Experts noted in June of 2014:

“Several States noted that procurement associated with the Islamic Republic of Iran’s prohibited activities appears to have slowed over the past six to nine months. One State that has previously undertaken multiple interdictions related to the Islamic Republic of Iran noted that only two such seizures were made in the second half of 2013. A second State, which tracks such issues closely, also reported that with only a few exceptions, illicit procurement appeared to be less active.

This slowdown could be explained by the Islamic Republic of Iran using more opaque means of procurement, or States reporting less actively. It may also be the case that the Islamic Republic of Iran has deliberately slowed the pace of procurement, possibly coinciding with a change in the political climate under President Rouhani and the initiation of the Joint Plan of Action.”

Other sources, though, suggest that procurement had not been substantively affected by the talks. A confidential US briefing given in November of 2014 to the Panel of Experts and cited by Foreign Policy stated that the US ‘had observed no recent downturn in procurement’. According to the report, the US had seen a ‘relative decrease in centrifuge enrichment related-procurement,’ but ‘an increase in procurement on behalf of the IR-40 Heavy Water Research Reactor at Arak.’ Similarly, in late 2014 a German Customs

Investigation Bureau official noted that his office had seen no decrease in the number of suspected sanctions violations involving Iran.\textsuperscript{107}

9. The JCPOA’s procurement channel

The Joint Comprehensive Plan of Action includes measures intended to ensure that single and dual-use goods of nuclear relevance cannot be diverted to support any clandestine nuclear programme in Iran, and that Iran cannot unduly stockpile such goods for nuclear end uses in the future. These measures form what the plan calls the ‘procurement channel’, which will be operationalised through a Procurement Working Group of the Joint Commission. Iran has committed to ensure that all procurement of nuclear-relevant goods – whether for nuclear end-uses or civil end-uses – will be procured through this mechanism. This is a somewhat unique mechanism, which raises numerous operational and political questions.\textsuperscript{108}

It is important to note that while the procurement channel is meant for nuclear-relevant goods, many of the items that Iran will have to procure through it have industrial and commercial uses, including in the petrochemical sector. The procurement channel will thus be relevant to many firms seeking to re-engage with Iran in the wake of the agreement and is likely to be a dominant feature of trade with Iran over the next decade. Moreover, the agreement places a substantial compliance burden on the service sectors and on exporting states – much more so than is usual for trade control arrangements.

The channel was first publicly mentioned in an earlier iteration of the JCPOA, outlined in April 2015, which stated that a procurement channel would be established but contained no detail about how it would function.\textsuperscript{109} The JCPOA goes considerably further, specifying how the procurement will function and what goods will pass through it.

In terms of the scope of the procurement channel, the relevant paragraphs are outlined in section 6.1 of Annex IV of the JCPOA: \textsuperscript{110}

“6.1 With the purpose of establishing a procurement channel, the Joint Commission will, except as otherwise provided by the United Nations Security Council resolution endorsing this JCPOA, review and decide on proposals by states seeking to engage in:


\textsuperscript{108} The closest precedence is the mechanism implemented against Iraq in the 1990s.


\textsuperscript{110} Paragraph 6.1.3 also addresses the issue of whether Iran can buy stakes in uranium producing entities outside the territory.
6.1.1 the supply, sale or transfer directly or indirectly from their territories, or by their nationals or using their flag vessels or aircraft to, or for the use in or benefit of, Iran, and whether or not originating in their territories, of all items, materials, equipment, goods and technology set out in INFCIRC/254/Rev.12/Part 1, and, if the end-use will be for Iran's nuclear programme set out in this JCPOA or other non-nuclear civilian end-use, all items, materials, equipment, goods and technology set out in INFCIRC/254/Rev.9/Part 2 (or the most recent version of these documents as updated by the Security Council), as well as any further items if the relevant State determines that they could contribute to activities inconsistent with the JCPOA; and,

6.1.2. the provision to Iran of any technical assistance or training, financial assistance, investment, brokering or other services related to the supply, sale, transfer, manufacture, or use of the items, materials, equipment, goods and technology described in subparagraph (a) above”.

**What is controlled under the JCPOA?**

In practice, there are three main categories of goods that will routinely be referred to the procurement working group. These are Nuclear Suppliers Group ‘Trigger List’ items, NSG dual-use items, and non-listed items with a nuclear utility (akin to ‘catchall’ goods).

**A. Trigger List goods**

Trigger list goods are typically identifiable as items with a clear nuclear fuel cycle utility. They include nuclear reactors, complete centrifuges, and other items that are ‘specially designed or modified’ for a nuclear end-use. There is in fact an internationally-recognised list of these items, and it is this list that is recognised by the JCPOA. Typically, these items do not have other commercial uses, although there are niche specialist end-uses for some trigger list items, such as heavy water (deuterium oxide), which has uses in the oil industry as well as certain specialist scientific applications.

According to the text of the JCPOA, Trigger List exports will be reviewed by states, the Procurement Working Group and the IAEA in order to ensure that they are used for stated end-uses.

In practice, there will likely be few exports to Iran that fall into this category. The main items are likely to relate to the redesign of the Arak heavy water reactor. International support for any future reactors (including light water reactors and fuel for such reactors) will likely also have to be referred to the Procurement Working Group, although Security Council Resolution 2231 states that approval in advance by the Security Council is not required.\(^{111}\)

**B. Dual-use goods**

The JCPOA requires that proposed exports of NSG-controlled dual-use goods be referred to the procurement channel. The NSG dual-use list includes manufacturing equipment, 

---

\(^{111}\) The Security Council resolution may contain exclusions for light water reactors, which are exempt from the current sanctions resolutions.
parts and components that can be used in or to make nuclear-relevant technologies, but that can also be used for other industrial and commercial applications.

Many goods captured by the NSG dual-use list can be used for petrochemical and aerospace applications – for example, bellows-sealed values, vacuum pressure transducers, carbon fibre, and filament winding equipment. As such, it is likely that that many exports destined to nominally industrial (rather than nuclear) end uses will be referred to the Procurement Working Group.

As discussed further below, the exporting state or the Procurement Working Group can request that end-use verification be undertaken to confirm that the goods have not been diverted to nuclear end-uses. In practice, this will require access to non-nuclear sites.

C. Non-listed goods

Since UN Security Council sanctions were first adopted against Iran’s nuclear programme in 2006, the majority of cases reported to the UN’s Iran sanctions Panel of Experts have related to goods not listed by the NSG’s Trigger List or dual-use list. This highlights that Iran has required – and will continue to require – non-listed items for its nuclear fuel cycle. As such, it has been necessary to include provisions on non-listed goods in the JCPOA.

In practice, the JCPOA provides states with an option to refer cases to the procurement channel, should they believe that the export of the goods is relevant to the JCPOA. This is loosely the equivalent of the ‘catchall mechanism’ that has been included in previous UN Security Council sanctions resolutions, and is also implemented by many states as part of their export control regulations. It should be noted that this mechanism in the JCPOA does differ from traditional catch all controls, however: in particular, it seems unlikely that non-listed goods destined for Iran’s declared nuclear program would be blocked by the procurement working group.

D. Trade services and technical assistance

Paragraph 6.1.2 of the JCPOA text covers the provision of services and assistance in conducting nuclear-related trade with Iran. The measures in this paragraph apply to both dual-use and trigger list goods. The inclusion of dual-use goods in the scope of this paragraph is unusual and will create substantial challenges for the trade service sectors, including the shipping, finance and insurance sectors. In this context, UN Security Council document S/2015/28 provides a starting point in considering how commercial entities might comply.112

---

E. Arms and missile-related goods

The JCPOA does not refer to the supply of arms or missile-related technologies to Iran, although these are covered by the Security Council Resolution 2231. The missile-related sanctions in this resolution are likely to extend to Missile Technology Control Regime-listed dual-use goods. At this stage, it is unclear how overlaps in missile-related and nuclear-related controls will be handled. In practice, it appears that rather than containing a prohibition (i.e. ‘sanctions’), the resolution will contain a requirement that arms and missile transfers be authorised by the Security Council – authorisations that will likely be withheld for 5 years and 8 years, respectively.

Role of the Procurement Working Group

In addition to the European External Action Service, which will administer the Procurement Working Group (PWG), there will be seven participating states: the UK, US, France, Germany, Russia, China and Iran.

The PWG will respond to specific requests by states to export goods to Iran. In practice, this will involve each state forwarding to the PWG licence applications received at the national level that are deemed relevant to the JCPOA. The participants will have 20 working days (extendable to 30) to consider any one export. The review will take place in parallel to national export licence assessment.

The PWG requires consensus to authorise exports to Iran: if any one participant objects, the export will not be approved. However, any party can refer cases to the PWG’s parent body, the Joint Commission if they feel that the JCPOA is not being honoured (i.e., Iran could take issue with the refusal of a licence and refer it to the Joint Commission).

It is not yet clear if and how often referrals may be refused. Reasons for refusal are likely to include the risks of stockpiling and the risk of diversion to military and missile end uses. If the JCPOA breaks down, the procurement channel will cease operation.

The number of cases that the PWG will have to review is difficult to predict. The number of exports to nuclear end-uses is likely to be relatively low. However, the inclusion of NSG dual-use goods in the scope of work for the procurement channel could greatly expand the number of cases it reviews. The closest parallel is the case of Iraq in the 1990s: the International Atomic Energy Agency’s Iraq Nuclear Verification Office, which undertook a similar role, purportedly reviewed some 18,000 contracts over the course of its lifetime.

The potentially high volume of referrals creates challenges. Each participating government must be able to review each referral as if it were an export licence. Typically, an individual licence assessor at the national level may deal with a few hundred to (at most) a few thousand licence applications per year. Applied to the PWG, this could mean that each participating government would need to devote several specialist staff to the task. This will

---

be particularly important given the relatively tight timescales for the review of licence proposals (20 working days). The JCPOA also does not define what language referrals should be submitted in, so there is a possibility that translation time would also need to be accounted for.

**The role of the International Atomic Energy Agency**

The IAEA is requested to monitor and verify the JCPOA. In practice, in the context of the Procurement Channel, it is likely that the IAEA will have to confirm that any procurements made through the procurement channel are consistent with the JCPOA. This will mean ensuring that the end-use for nuclear goods has been declared and that the number of goods being procured is consistent with the needs of the programme (i.e., that goods are not being unduly stockpiled). The IAEA will have to act promptly for this role to be carried out successfully: those states that participate in the procurement channel are required to indicate within 20 working dates whether or not they object to the proposed export.

The second role for the IAEA is likely to be in verifying that goods imported to Iran are being used as intended. This will involve conducting end-use verification of export of Trigger List items to Iran. Therefore, the IAEA would have to be necessary to be selective about which imports it undertakes end-use verification. In practice, this task will likely be wrapped into the IAEA’s inspection plan for Iran which already includes periodic visits to some sites. It is conceivable that visits may be required for other sites, meaning that the access process specified in the JCPOA would be used.

The third role will be in monitoring Iran’s declarations against Iran’s actual imports. This is routine business for the IAEA, although in the case of Iran, the Agency will have access to additional information provided by Member States.

**The role of industry and the private sector**

The procurement channel exists to facilitate trade. Industry and the private sector can benefit from the existence of the procurement channel. Nonetheless, it is not envisaged that there will be direct interaction between the procurement channel and industry in terms of referrals. Instead, national licensing agencies will act as go-betweens, referring cases to the procurement channel as necessary.

The only foreseen exception to this rule is with regards to awareness-raising and outreach. Procurement channel officials might, with the consent of national authorities, conduct awareness raising activities for the private sector. This could include issuing guidance on compliance and due diligence.

It should be noted that paragraph 6.1.2 appears to require trade service providers to take measures beyond those that they usually would for traditional export controls. Further guidance on interpreting this paragraph will be required.
**Iran’s role**

Iran’s central role in the procurement channel has some interesting elements. Iran will participate in the Procurement Working Group and be involved in the decision-making process to decide what goods it can and cannot import, although Iran cannot override decisions of the other members on its own. Iran is also required to attest that the stated end-use for goods that it imports through the channel is accurate. Specifically, Iran is required to provide “a statement of the proposed end-use and end-use location, along with an end-use certification signed by the Atomic Energy Organisation of Iran or the appropriate authority attesting the stated end-use”.

This latter role is unusual: usually, it is the actual end-user that would sign an end-user undertaking. By requiring bodies authorised by the Iranian government to sign end-user undertakings, the Joint Commission can hold the Iranian government responsible for diversion of any products. It does, nonetheless, require Iran to put in place mechanisms to provide such attestation. It is also unusual for commercial entities that are importing goods to be required to know the control-status of the goods. Therefore, an industry outreach and education campaign will be required in Iran.

**Other States**

The purpose of the Procurement Working Group is to consider exports of nuclear-relevant goods from other states to Iran. Conceivably, Iran could import such goods from any of the 193 UN member states (and indeed other countries). Therefore, a central aspect of the procurement channel will involve referral of relevant exports from states to the procurement channel. This will most likely be implemented by export licensing organisations in each state. Logistics and practical matters will have to be worked out, including in relation to the language of submission.

States will also be able (and in some cases required) to conduct end-user verification of dual-use exports to Iran. The Joint Committee will provide assistance to states in undertaking this activity and Iran is required to provide access to conduct such end-use verification. Nonetheless, this could be a resource-intensive task for states and may deter some states from exporting goods to Iran when end-use verification would be necessary.

As is standard practice with UN sanctions resolutions, states will likely also be required to submit implementation reports to the UN Security Council. Historically, reporting rates for sanctions resolutions have been low. High-level diplomacy should therefore be used to ensure complete and accurate reporting.

Consideration should also be given regarding how to build capacity at the national level to help implement and support the procurement channel. Certain synergies exist with the mechanisms of Security Council Resolution 1540. These should be taken advantage of.
10. Monitoring illicit procurement

Iran’s nuclear programme has been constructed largely using goods that have been imported illicitly from other countries. The JCPOA includes a requirement that all procurement be made through the procurement channel specifically to prevent illicit trade in the future.

A continuance of illicit trade would thus constitute non-compliance with the agreement. The Security Council resolution supporting the JCPOA spells out the consequences of this non-compliance, but if taken to its fullest extent, a violation could result in the use of the UN sanctions snapback mechanism.

Broader issues

The procurement channel is a hugely complex mechanism. As such, it raises numerous broader issues and challenges.

A. Commercial confidentiality

In order to be able to review referrals, the Procurement Working Group will require access to key information on proposed exports (See box 1). The need to share commercial information with several states could naturally cause to concerns about confidentiality at the national or industry level. It is notable, therefore, that the provision of certain information (including pricing information) is not specifically required under the JCPOA terms. Nonetheless, exporters may be hesitant about providing other required information and assessors may be hindered by the lack of pricing information. This trade-off has nonetheless been agreed.

Box 1. Necessary information for proposed nuclear-related exports

(a) a description of the item; (b) the name, address, telephone number, and email address of the exporting entity; (c) the name, address, telephone number, and email address of the importing entity; (d) a statement of the proposed end-use and end use location, along with an end-use certification signed by the AEOI or the appropriate authority of Iran attesting the stated end-use; (e) export license number if available; (f) contract date, if available; and (g) details on transportation, if available; provided that if any of the export license number, contract date, or details on transportation are not available as of the time of submittal of the proposal, such information will be provided as soon as possible and in any event as condition of approval prior to shipment of the item.

B. Corruption

The requirement for the Iranian government or authorised parties to provide attestation for end use undertakings could lend itself to corruption and profiteering. The Joint Commission may thus wish to monitor who in Iran is involved in the authorisation (i.e. whether they have links with the Islamic Revolutionary Guards Corps, or other entities about whom the international community retains concerns)
C. Precedents for other states

The JCPOA makes clear that it does not set a precedent for other states. Nonetheless, consideration should be given in due course as to what the implications of the procurement channel are for the international non-proliferation framework. Presently, states that implement an Additional Protocol to their safeguards agreement with the IAEA provide the IAEA with reports on exports (and imports) of certain Trigger List goods.\(^\text{114}\) Could and should this reporting requirement be extended to dual-use goods? Are there grounds for extending the requirement for the IAEA to verify the nuclear need associated with Trigger List transfers? These are questions that are politically difficult. Nonetheless, they should be considered in the fullness of time.

D. Inspection and Enforcement

The procurement channel will provide a mechanism for Iran to fulfil its legitimate nuclear needs and the JCPOA prohibits procurement outside of the channel. Nonetheless, the possibility cannot be discounted that Iran (or Iranian entities) will procure listed or unlisted goods illicitly to support either nuclear or non-nuclear end uses.

The JCPOA, as endorsed by UNSCR 2231, includes provisions to detect and respond to Iranian illicit trade. This includes “calling on” states to inspect shipments to Iran. It will also include the standard provisions of national export control legislation as required under UNSCR 1540.

If Iran fails to adhere the requirements of the JCPOA with regards to ending its use of illicit procurement methods for dual-use goods, the full enforcement actions of UNSCR 2231 could be used, including the so-called snapback mechanism, which would see UN sanctions imposed on Iran.

Despite the inclusions of these provisions, UNSCR 2231 could actually be viewed as weaker than UNSCR 1929 (the last main UN sanctions resolution on Iran), as resolution 2231 does not renew the mandate of the UN Panel of Experts, which has hitherto been changed with inspecting suspected sanctions violations. In the absence of such a body, it is unclear what investigatory action will be undertaken when a suspected breach occurs. This is a potential flaw in the JCPOA.

11. Beyond Iran: preventing proliferation-related trade

The previous sections of this report highlighted the degree to which Iran has been able to utilise illicit trade to advance its nuclear and missile programmes. However, it is not the first country to do so. In fact, since the 1970s, at least half a dozen countries have employed similar techniques to advance similar programmes. The prevalence of illicit procurement suggests that there may be systematic root causes – issues that must be

\(^{114}\) Actually, an outdated version of the Trigger List from the 1990s.
addressed if illicit trade is to be systematically prevented in the future. Such solutions may be centred at three levels in the international system: the multilateral level, the national level, and the level of the company or individual.

**Improving multilateral efforts**

There are several international instruments that should contribute to efforts to prevent illicit trade. Perhaps the main instrument is UN Security Council resolution 1540, which requires all UN Member States to take a variety of measures to prevent such trade. However, the requirements of resolution 1540 are also complemented by other UN sanctions resolutions and the voluntary export control regimes.

There are several challenges that limit the effectiveness of the international architecture in preventing illicit trade beyond those of national and company implementation.

**Rules and commitments**: the non-proliferation framework is a patchwork made up of various treaties, regimes, and unilateral undertakings. Each of these has a different purpose, scope and membership. Examining the utility of this patchwork framework in the context of Iranian illicit trade highlights several gaps and inconsistencies between the various measures that should be reconsidered.

Examples of these gaps include:

1) UN sanctions resolutions on Iran referring to the control lists of the NSG and MTCR but failing to include a mechanism by which the sanctions can be updated as the lists are updated. This resulted in Iran being able to procure uncontrolled substitutes for controlled vacuum pressure transducers.\(^{115}\)

2) The absence of a “sub-control list” to control items of high utility to Iran’s nuclear and ballistic missile programmes but which are not usually controlled by the export control regimes because of the disproportionate impact of controlling all international trade in such goods.

**Information sharing**: Better information sharing among states and with the private sector has the potential to vastly improve efforts to counter illicit trade, but information sharing is currently sub-optimal for many reasons. For example, information on illicit trade often comes from sensitive intelligence sources. However, the work of Project Alpha has demonstrated that there is a large volume of useful information that can be collated, analysed and shared from public, non-sensitive information sources without needing to be classified. Alpha’s illicit procurement cases studies and work to understand trends in illicit trade are two such examples. Efforts should be undertaken to explore how such

information can be systematically collected and shared amongst the various actors in the non-proliferation regime.

There are other information barriers, real or perceived, that disrupt the effectiveness of the non-proliferation regime. Alpha’s research has found that the UN panels of experts and the IAEA find it difficult to share information and to discuss specific procurements, even though both are bodies of the UN. Many states are also reluctant to share details of interdictions or prosecutions with multilateral organisations due to perceived sensitivities in the process.

A focused effort could overcome many of these information barriers. At the intergovernmental level, the 20 countries of the Proliferation Security Initiative’s (PSI) Operational Experts Group should take a lead on sharing information with the more than 80 other states that participate in PSI. The UN Security Council, supported by the UN’s Department of Political Affairs, should also redouble efforts to encourage states to report in line with the requirements of UN resolutions and adopt new rules with regards to information sharing within the UN system.

**Adherence and membership:** Another set of issues relates to adherence (complying with the requirements of a regime as a non-member) and membership of the various elements of the non-proliferation regime. While Alpha’s work has shown that the manufacturing base for sensitive technologies continues to be centred in ‘advanced’ economies, the role of countries outside of the regime are nonetheless important. Countries such as India and Pakistan have the capability to manufacture and export sensitive goods, for example, and countries such as Malaysia and the UAE could be transit points for goods destined to programmes of concern.

A key challenge for states adhering or wishing to adhere to certain multilateral agreements is that they cannot access the resources available to formal Member States. For example, the export control regimes typically include ‘information exchange’ meetings where states share cases and concerns with other members. The regimes also have technical working groups where issues related to the interpretation of the control lists can be discussed. At present, adhering non-members cannot access such fora and are thus less able to effectively implement export controls as a result. Additionally, some mechanisms, such as PSI, also provide members with access to other useful resources such as training materials. As issues of membership of the export control regimes are slow to resolve, consideration should be given to how to overcome these issues outside of the export control regimes.

All three sets of issues were considered in the design of the model procurement channel for Iran that was set out in the previous section. However, the procurement channel is a limited-duration country-specific initiative. In order to prevent illicit trade more generally, it is necessary to adapt the rules-based non-proliferation regime to account for the issues. This is evidently a difficult task that requires careful consideration.
**Improving national implementation**

Since 2004, all states have been required to implement export controls and related measures to prevent illicit trade. However, obligations and commitments at the international level mean little unless they are implemented on the ground. Alpha’s research has shown that implementation of non-proliferation controls in countries around the world is varied. The image below shows states’ thoroughness in reporting relevant obligations under UN SCR 1540.

There are substantial challenges in understanding the variance in national implementation. The most complete dataset on this subject is the one maintained by the 1540 Committee – the 1540 matrices. Even with this dataset there are substantial problems: the published matrices are all at least five years out of date at the time of writing. Some countries, such as China, have opted for their matrices not to be published. The questions contained in the matrices are also not well-designed to give a realistic understanding of how implementation works (or not) on the ground. Finally, the matrices do not take into account the particular threats facing states: does it manufacture sensitive goods? Is it a transshipment state?

Reviewing criminal prosecutions of proliferation-related cases is another way through which the level of national implementation can be gauged, albeit in a more crude way. There is so far no comprehensive dataset that captures those states that have made one of more prosecutions of a proliferation-related crime, but a dataset complied by Project Alpha provides some indication of those countries that have undertaken prosecutions.
Another useful building block to understand this problem is the geographical location of manufacturers of proliferation-sensitive goods. Project Alpha has researched and characterised the manufacturing bases for more than 18 proliferation-sensitive, nuclear-related technologies. We have deliberately examined a diverse range of nuclear-related goods: from simple commodities to elaborately-manufactured precision items, with supply chains ranging from the short and simple to the long and complex.

The manufacturing base for proliferation-sensitive goods is relatively well-spread across the world (see figure 7). No one country or region has a monopoly on their production; nor is it confined to those states in possession of nuclear weapons, although the five Nuclear Weapon States as recognised in the Treaty on the Non-Proliferation of Nuclear Weapons are able to produce most of the proliferation-sensitive items that we examined. Companies in the United States produce all of the items; companies in the UK produce almost all of them. Russia, France, and China are close behind.

The prosecution of export control violators is an important aspect of a country’s ability to deter illicit proliferation-related trade. While many states have enacted export control legislation, this does not necessarily mean that these states have actually prosecuted those suspected of violating these laws. Of course, the effectiveness of a country’s export control system cannot be evaluated by counting the number of prosecutions secured by governments; however, the existence of an effective judicial enforcement system is a vital prerequisite to the full implementation of a state’s non-proliferation commitments.

The visualisation shows those states that are known to have prosecuted individuals and companies for WMD-related export control violations. This graphic should be used with caution: the nature of global enforcement activity against WMD-related proliferation means that not all cases may be publicly known. Any errors should be brought to the attention of Project Alpha.

---

116 The prosecution of export control violators is an important aspect of a country’s ability to deter illicit proliferation-related trade. While many states have enacted export control legislation, this does not necessarily mean that these states have actually prosecuted those suspected of violating these laws. Of course, the effectiveness of a country’s export control system cannot be evaluated by counting the number of prosecutions secured by governments; however, the existence of an effective judicial enforcement system is a vital prerequisite to the full implementation of a state’s non-proliferation commitments. The visualisation shows those states that are known to have prosecuted individuals and companies for WMD-related export control violations. This graphic should be used with caution: the nature of global enforcement activity against WMD-related proliferation means that not all cases may be publicly known. Any errors should be brought to the attention of Project Alpha.
Most of the major manufacturers of proliferation-sensitive goods are members of the main export control regimes. These countries also tend to have in place the legal mechanisms required to implement effective export controls.

**Figure 5. Global producers of ‘chokepoint’ nuclear-related dual-use technology**

Combining an understanding of the manufacturing base for proliferation-sensitive goods with trends in illicit trade and national capabilities to respond, it may be possible for national and multilateral authorities to begin to construct prioritised outreach plans. These could be used to align and prioritise the work of the various export control outreach programmes that work to build capacity for states to implement nonproliferation controls.117

**Improving implementation by companies and individuals**

Measures such as UNSCR1540 reaffirm that it is the responsibility of states to ensure compliance with non-proliferation controls. In reality, however, it is often the private sector that must implement states’ commitments and obligations in practice. It is companies that manufacture nearly all of the chokepoint technologies studied and it is through the supply chains of such companies that goods typically find their way to programmes of concern.

From studying multiple cases of corporate involvement in proliferation, it is clear that companies can become involved in proliferation innocently, through ignorance or through complicity. It is important to note that companies are not unitary actors: there are

117 Project Alpha is a partner of Expertise France in implementing two EU outreach control programs from September 2015. The methodology for the training draws largely upon the materials produced by Project Alpha and will be available via the EU’s Export Control Hub website after the program begins.
examples of individual groups or sites within a firm being complicit where the main headquarters site is ignorant (or even innocent).\textsuperscript{118}

**Figure 6. Factors driving involvement and restraint in proliferation\textsuperscript{119}**

<table>
<thead>
<tr>
<th>Type of actor</th>
<th>Non-complicit</th>
<th>Complicit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Innocent</td>
<td>Ignorant</td>
</tr>
</tbody>
</table>

**Factors driving involvement**

<table>
<thead>
<tr>
<th>Motive</th>
<th>Profit</th>
<th>Profit</th>
<th>Profit &gt; Ideology</th>
<th>Profit &lt; Ideology</th>
</tr>
</thead>
</table>

**Factors driving restraint**

<table>
<thead>
<tr>
<th>Legal and normative</th>
<th>✓</th>
<th>✓</th>
<th>x</th>
<th>x</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deterrence by threat of financial or custodial penalty</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>x</td>
</tr>
<tr>
<td>Prevent by financial or custodial penalty</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

In the last few years, substantial progress has been made in reducing the likelihood that innocent or ignorant firms will become involved in proliferation. Progress also been seen to counter the involvement of ‘ignorant’ firms in proliferation through the setting of standards for international compliance programmes in several sectors. For producers of nuclear and dual-use goods, the NSG good practice guidelines for corporate social responsibility provide a baseline standard for internal compliance programmes (a standard that has been promoted through Alpha’s Partners against Proliferation initiative) and related awareness-raising activities.

Trade compliance standards are also emerging in other areas including maritime transport and academia.\textsuperscript{120} \textsuperscript{121} These various guides and standards are also being published through the 1540 ‘effective practice’ mechanism in order to promote adherence on an international


\textsuperscript{119} Extract from draft paper: Salisbury, D., Stewart, I., ”Non-State Actors as Proliferators: Preventing their Involvement”, Project Alpha, King’s College London.


basis. Nonetheless, further work is required to promote the use of these guidelines and to encourage relevant industry or academic sectors to take ownership of the documents.  

Finally, non-proliferation is increasingly being incorporated into other compliance programmes. For example, the EU has been studying whether it is possible to integrate internal compliance programmes associated with export licensing issues with the requirements of the Authorised Economic Operator programme. The conceptual objective of such linkage is to promote export compliance among the trade community and help companies and governments to identify ‘good’ companies.  

Overall, understandings and expectations about the role of companies in preventing proliferation have advanced for the better over the last few years. This creates a new challenge: how to ensure that these initiatives contribute to a holistic yet balanced non-proliferation governance framework that successfully addresses the risks of illicit trade without overburdening the stakeholders involved.

12. Conclusions

Iran advanced its programme largely through the use of illicit procurement. It was as a result of the use of such techniques that Iran was able to deploy some 19,000 centrifuges the time when the JPOA came into effect in 2014.

Iran’s extensive use of illicit trade in the past decade or more means that such trade must be prevented if confidence is to exist in the JCPOA. Inclusion of a procurement channel in the agreed parameters is an important development. It will be a complex measure to implement, however, and questions remain about how potential violations will be investigated.

Consideration should also be given to the question of how to prevent illicit trade more generally. The 2016 Comprehensive Review of 1540’s implementation provides an opportunity for this. However, the problem requires a multi-pronged effort that can weave together the various elements of the non-proliferation toolset.

---

122 The EU outreach programme on dual-use goods will work to promote adherence to such guidelines. This will include listing the documents on the EU export control website and utilising the documents as reference materials when preparing outreach materials. Finally, the current review of the EU export control regulations provides an opportunity to promote adherence of these measures within the European Union.

www.acsss.info