

# IRAN'S BALLISTIC MISSILE PROGRAM AND ECONOMIC SANCTIONS

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## EXECUTIVE SUMMARY

Iran this week engaged in a series of ballistic-missile drills, launching next-generation short-, medium-, and long-range missiles from silos and missile bases built deep underground and in mountains.<sup>1</sup> It was the third ballistic-missile test since last summer's nuclear deal.<sup>2</sup>

Indeed, the Islamic Republic has the "largest inventory of ballistic missiles in the Middle East," according to the U.S. government's February 2016 Worldwide Threat Assessment. The United States intelligence community further assesses that Iran "would choose ballistic missiles as its preferred method of delivering nuclear weapons, if it builds them. Iran's ballistic missiles are inherently capable of delivering WMD."<sup>3</sup> The development of ballistic missiles capable of delivering a nuclear warhead is prohibited by United Nations Security Council Resolution 2231.

Iran's ballistic missile program began under the Shah but was expanded after the 1979 revolution and the Iran-Iraq War. Today, the Ministry of Defense and Armed Forces Logistics (MODAFL) and Islamic Revolutionary Guard Corps (IRGC) are responsible for Tehran's ballistic missile program. Both the United States and European Union have sanctioned these two entities for their roles in the Islamic Republic's nuclear and ballistic missile programs.

Over the past two decades, the IRGC and MODAFL have expanded their industrial-financial empire.<sup>4</sup> They directly control or indirectly influence many of the largest companies in Iran, especially in those sectors that provide dual-use goods and technology. As explained in this memo, Tehran has used commercial entities as fronts to procure sensitive-technology or to provide goods for military purposes. Today, a wide array of entities and sectors are thus likely involved in Iran's ballistic missile program. This memo outlines the roles of the metallurgy and

1. Thomas Erdbrink, "Iranian Unit Tests Missiles, Accusing U.S. of Threats," *The New York Times*, March 8, 2016. (<http://www.nytimes.com/2016/03/09/world/middleeast/irans-revolutionary-guards-test-nationwide-ballistic-missiles.html>)

2. Amir Toumaj, "IRGC's Latest Ballistic Missile Test Underscores Need for Sanctions," *FDD Policy Brief*, March 9, 2016. (<http://www.defenddemocracy.org/media-hit/amir-toumaj-irgcs-latest-ballistic-missile-test-underscores-need-for-sanctions/>)

3. James Clapper, "Statement for the Record: Worldwide Threat Assessment of the US Intelligence Community," *Testimony before the Senate Armed Services Committee*, February 9, 2016, page 8. ([http://www.armed-services.senate.gov/imo/media/doc/Clapper\\_02-09-16.pdf](http://www.armed-services.senate.gov/imo/media/doc/Clapper_02-09-16.pdf))

4. Emanuele Ottolenghi and Saeed Ghasseminejad, "Who Really Controls Iran's Economy?" *The National Interest*, May 20, 2015. (<http://nationalinterest.org/feature/who-really-controls-irans-economy-12925>)

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mining; chemicals, petrochemicals, and energy; construction; automotive; and electronic, telecommunication, and computer science sectors, as well as that of universities and research institutions.

Countering Tehran's missile program will require a multipronged, U.S. and international effort utilizing diplomatic, military, cyber, covert, and economic tools. Because the development of ballistic missiles requires a wide range of goods, services, and technology, we recommend economic sanctions against all sectors involved in their development.

## BACKGROUND

Iran's ballistic missile program started during the reign of the Shah, but expanded considerably after the 1979 Islamic Revolution.<sup>5</sup> During the following decade, the regime bought its first tactical ballistic missiles – 30 Scuds from Libya.<sup>6</sup> The IRGC soon began reverse engineering the missile-related components to reduce its dependence on foreign countries, although to this day, Iran and North Korea maintain extensive cooperation on ballistic missiles.<sup>7</sup>

Iran's initial focus was on short-range missiles.<sup>8</sup> In the aftermath of the 1980-1988 Iran-Iraq War, however, Tehran's objectives expanded to longer-range missiles, led by the IRGC and the Aerospace Industries Organization – a subordinate of MODAFL. The IRGC began work towards intercontinental ballistic missile (ICBM) capability in the late 1990s or early 2000s, but has to date not tested such weapons.<sup>9</sup>

On the other hand, in 2009, Iran successfully launched its first orbital rocket, the Safir, as part of a satellite launch. Since then, Iran has improved upon the Safir's design.<sup>10</sup> Iran's newer, more powerful satellite-launch system, the Simorgh, is similar to North Korea's Unha rocket and can send larger satellites into higher orbits.<sup>11</sup> Iran was reportedly planning to launch a satellite with a Simorgh rocket in February 2016 – a dangerous development given that satellite-launcher rockets can also be used as ICBMs to deliver warheads.<sup>12</sup>

5. Michael Elleman, "Iran's Ballistic Missile Program," *U.S. Institute of Peace*, August 2015. (<http://iranprimer.usip.org/resource/irans-ballistic-missile-program>)

6. "لیبی و موشک اسکاد؛ آغاز راه تبدیل ایران به قدرت موشکی" (Libya and Scud Missiles: The Beginning of Iran's Path Toward Becoming a Missile Power)," *ISNA* (Iran), November 26, 2015. (<http://goo.gl/QsTvRk>)

7. Ali Alfoneh and Scott Modell, "The Iran-North Korea Nuclear Nexus: Unanswered Questions," *Foundation for Defense of Democracies*, January 2016. (<http://www.defenddemocracy.org/content/uploads/documents/Iran DPRK.pdf>)

8. "لیبی و موشک اسکاد؛ آغاز راه تبدیل ایران به قدرت موشکی" (Libya and Scud Missiles: The Beginning of Iran's Path Toward Becoming a Missile Power)," *ISNA* (Iran), November 26, 2015. (<http://goo.gl/QsTvRk>)

9. "Iran's Ballistic Missile Capabilities: A net assessment," *The International Institute for Strategic Studies*, May 7, 2010.

10. Michael Elleman, "Iran's Ballistic Missile Program," *U.S. Institute of Peace*, August 2015. (<http://iranprimer.usip.org/resource/irans-ballistic-missile-program>)

11. Laura Grego, "Iran's Upcoming Simorgh Rocket Launch," *Union of Concerned Scientists*, February 14, 2016. (<http://allthingsnuclear.org/lgrego/irans-upcoming-simorgh-rocket-launch>)

12. Laura Grego, "Iran's Upcoming Simorgh Rocket Launch," *Union of Concerned Scientists*, February 14, 2016. (<http://allthingsnuclear.org/lgrego/irans-upcoming-simorgh-rocket-launch>); Michael Elleman, "Iran's Ballistic Missile Program," *U.S. Institute of Peace*, August 2015. (<http://iranprimer.usip.org/resource/irans-ballistic-missile-program>)

Today, experts believe Iran's nuclear and ballistic-missile programs are closely intertwined.<sup>13</sup> As the Director of National Intelligence James Clapper noted, "Iran's ballistic missiles are inherently capable of delivering WMD."<sup>14</sup> Following last summer's nuclear deal (the Joint Comprehensive Plan of Action, or JCPOA), Iran has continued developing and testing new missiles despite United Nations restrictions on such activity and despite international sanctions.<sup>15</sup> Since the JCPOA's announcement, Iran has conducted three ballistic missile tests in violation of UN Security Council resolutions.<sup>16</sup>

Developing costly indigenous long-range ballistic missiles without acquiring nuclear warheads makes little sense, and Tehran's insistence on developing ballistic missiles casts serious doubt on its intention to abstain from working on programs relevant to nuclear weapons after the JCPOA ends.<sup>17</sup> As David A. Cooper of the U.S. Naval War College explained, "No country that has not aspired to possess nuclear weapons has ever opted to sustain an indigenous intermediate- or longer-range ballistic missile program."<sup>18</sup>

Moreover, Iranian officials have stated that Iran intends to continue work on its ballistic missile program *during* the JCPOA, in violation of the very UN resolution endorsing that deal.<sup>19</sup> Although the nuclear agreement itself does not address ballistic missiles, activities related to their development are restricted for eight years under UN Security Council Resolution 2231. As the resolution states:

Iran is called upon not to undertake any activity related to ballistic missiles designed to be capable of delivering nuclear weapons, including launches using such ballistic missile technology, until the date eight years after the JCPOA Adoption Day or until the date on which the IAEA submits a report confirming the Broader Conclusion, whichever is earlier.<sup>20</sup>

That resolution also prohibits heavy weapon-related trade with Iran for five years unless approved by the Security Council.<sup>21</sup> Iranian officials have announced that they do not feel bound by that provision.<sup>22</sup>

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13. Behnam Ben Taleblu, "Don't Forget Iran's Ballistic Missiles," *War on The Rocks*, August 25, 2014. (<http://warontherocks.com/2014/08/dont-forget-irans-ballistic-missiles/>)

14. James R. Clapper, "Statement for the Record Worldwide Threat Assessment of the US Intelligence Community Senate Armed Services Committee," *Testimony before the Senate Armed Services Committee*, February 26, 2015, page 6. ([http://www.dni.gov/files/documents/Unclassified\\_2015\\_ATA\\_SFR\\_-\\_SASC\\_FINAL.pdf](http://www.dni.gov/files/documents/Unclassified_2015_ATA_SFR_-_SASC_FINAL.pdf))

15. Behnam Ben Taleblu, "Sanctions Delay Lets Tehran Expand Missile Power," *FDD Policy Brief*, January 11, 2016. (<http://www.defenddemocracy.org/media-hit/behnam-ben-taleblu-sanctions-delay-lets-tehran-expand-missile-power/>)

16. Sam Wilkins, "Iran Tests New Precision-Guided Ballistic Missile," *Reuters*, October 11, 2015. (<http://www.reuters.com/article/2015/10/11/us-iran-military-missiles-idUSKCN0S505L20151011>); "U.S.: Iran Missile Test 'Clear Violation' of U.N. Sanctions," *CBS News*, October 16, 2015. (<http://www.cbsnews.com/news/iran-ballistic-missile-test-un-sanctions-us-ambassador-samantha-power/>); Bradley Klapper, "US official says Iran tested ballistic missile last month, at least 2nd time since nuke deal," *Associated Press*, December 8, 2015. (<http://www.usnews.com/news/politics/articles/2015/12/08/us-official-iran-tested-ballistic-missile-last-month>); Louis Charbonneau, "Iran's October missile test violated U.N. ban: expert panel," *Reuters*, December 16, 2015. (<http://www.reuters.com/article/us-iran-missiles-un-exclusive-idUSKBN0TY1T920151216>)

17. Robert Joseph, "JCPOA: Non-Proliferation, Inspections, and Nuclear Constraints," *Testimony before the Senate Foreign Relations Committee*, August 4, 2015. ([http://www.foreign.senate.gov/imo/media/doc/080415\\_Joseph\\_Testimony.pdf](http://www.foreign.senate.gov/imo/media/doc/080415_Joseph_Testimony.pdf))

18. David A. Cooper, "Iran's Enduring Ballistic Missile Threat," *Statement before the House Committee on Foreign Affairs Subcommittee on Middle East and North Africa*, June 10, 2015. (<http://docs.house.gov/meetings/FA/FA13/20150610/103582/HHRG-114-FA13-Wstate-CooperD-20150610.pdf>)

19. "Iran to test new missiles despite US sanctions: Defense minister," *Press TV (Iran)*, January 18, 2016. (<http://www.presstv.ir/Detail/2016/01/18/446270/Iran-defense-minister-Dehqan-US-sanction-ballistic-missile-program->)

20. UN Security Council, Resolution 2231, July, 20, 2015. ([http://www.un.org/en/ga/search/view\\_doc.asp?symbol=S/RES/2231\(2015\)](http://www.un.org/en/ga/search/view_doc.asp?symbol=S/RES/2231(2015)))

21. *Ibid.*

22. Yigal Carmon, "Iran Openly Declares That It Intends To Violate UNSCR 2231 That Endorses The JCPOA," *MEMRI*, September 22, 2015. (<http://www.memri.org/report/en/print8761.htm>)

## IRGC ECONOMIC PENETRATION AND LINKS TO BALLISTIC MISSILES

The IRGC, the primary driver of Iran's ballistic missile program, has become a dominant force in the Iranian economy.<sup>23</sup> According to the U.S. Treasury, it is Iran's most powerful economic actor.<sup>24</sup> Exact figures are difficult to gauge due to the IRGC's opaque nature and the scope of its off-book enterprises, but experts calculate that the Guard controls 20 to 30 percent of Iran's economy,<sup>25</sup> and its annual income may be as high as one-sixth of national GDP.<sup>26</sup> According to the State Department, the IRGC has displaced the legitimate private sector, creating a preferential system that favors a select group of insiders.<sup>27</sup>

In parallel to its other economic inroads, the Guard simultaneously maintains a strong presence in the banking sector to bolster its procurement network and finance projects across the country. This presence also provides the IRGC with special access to foreign currency to support its foreign procurement network. Ansar Bank and Mehr Bank – both under U.S. and EU sanctions – are among the leading financial institutions controlled by the IRGC.

A ballistic missile program is a sophisticated, capital- and technology-intensive endeavor that requires expertise from sectors ranging from construction to robotics and computer science. In pursuing Iran's ballistic missile program, the IRGC and MODAFL have acquired firms that can provide access to:

- Raw and processed materials
- Human capital and expertise
- Foreign procurement networks

## METALLURGY AND MINING

The ballistic-missile program requires expertise in both metallurgy and mining, and the IRGC has purchased a network of firms in both.<sup>28</sup> Iran's mining sector is a supplier of raw and processed materials for military uses, including

23. Ali Alfoneh, "How Intertwined Are the Revolutionary Guards in Iran's Economy?" *American Enterprise Institute*, October 22, 2007. (<http://www.irantracker.org/analysis/how-intertwined-are-revolutionary-guards-irans-economy>); Emanuele Ottolenghi, "The Iran Nuclear Deal and its Impact on Iran's Islamic Revolutionary Guards Corps," *Testimony before the House Foreign Affairs Subcommittee on the Middle East and North Africa*, September 17, 2015. ([http://www.defenddemocracy.org/content/uploads/documents/Ottolenghi\\_HFAC\\_IranDeal\\_IRGC.pdf](http://www.defenddemocracy.org/content/uploads/documents/Ottolenghi_HFAC_IranDeal_IRGC.pdf))

24. U.S. Department of the Treasury, Press Release, "Treasury Submits Report to Congress on NIOC and NITC," September 24, 2012. (<http://www.treasury.gov/press-center/press-releases/Pages/tg1718.aspx>)

25. Greg Bruno, Jayshree Bajoria, and Jonathan Masters, "Iran's Revolutionary Guard," *Council on Foreign Relations*, June 14, 2013. (<http://www.cfr.org/iran/irans-revolutionary-guards/p14324>); Emanuele Ottolenghi and Saeed Ghasseminejad, "Who Really Controls Iran's Economy?" *The National Interest*, May 20, 2015. (<http://nationalinterest.org/feature/who-really-controls-irans-economy-12925>); Frederic Wehrey, Jerrold D. Green, Brian Nichiporuk, Alireza Nader, Lydia Hansell, Rasool Nafisi, and S. R. Bohandy, "The Rise of the Pasdaran: Assessing the Domestic Roles of Iran's Islamic Revolutionary Guards Corps," *RAND Corporation*, 2009. ([http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND\\_MG821.pdf](http://www.rand.org/content/dam/rand/pubs/monographs/2008/RAND_MG821.pdf)); Mark Gregory, "Expanding business empire of Iran's Revolutionary Guards," *BBC (UK)*, July 26, 2010. (<http://www.bbc.com/news/world-middle-east-10743580>)

26. Parisa Hafezi and Louis Charbonneau, "Iranian nuclear deal set to make hardline revolutionary guards richer," *Reuters*, July 6, 2015. (<http://www.reuters.com/article/2015/07/06/us-iran-nuclear-economy-insight-idUSKCN0PG1XV20150706>)

27. U.S. Department of State, "Joint Statement on Iran Sanctions," June 23, 2011. (<http://www.state.gov/r/pa/prs/ps/2011/06/166814.htm>); U.S. Department of State, "Treasury Targets Iran's Islamic Revolutionary Guard Corps," February 10, 2010. (<http://www.state.gov/r/pa/prs/ps/2010/02/136595.htm>); U.S. Department of the Treasury, Press Release, "Fact Sheet: Treasury Sanctions Major Iranian Commercial Entities," June 23, 2011. (<http://www.treasury.gov/press-center/press-releases/Pages/tg1217.aspx>)

28. Emanuele Ottolenghi and Saeed Ghasseminejad, "Here's how to stop Iran's Revolutionary Guard from profiting off of the nuclear deal," *Business Insider*, October 7, 2015. (<http://www.businessinsider.com/heres-how-to-stop-the-irans-revolutionary-guard-from-profiting-off-of-the-nuclear-deal-2015-10>)

ballistic missile production. The country is believed to have the world's largest reserves of zinc and the second-largest reserves of copper<sup>29</sup> – both of which are used for reduced-visibility treatments in missiles to keep them from detection and interception.<sup>30</sup> The publicly traded Iran Zinc Mines Development Company is the principal owner and producer of Iranian zinc, with a \$94-million market value.<sup>31</sup> The company is majority-owned by the IRGC.<sup>32</sup>

Iran produces zirconium products, used widely in both its ballistic missile and nuclear programs.<sup>33</sup> Iran does not have domestic zirconium resources, but can purchase the element from producer countries such as China, Russia, South Africa, Mozambique, Malaysia, India, Brazil, Senegal, and Ukraine.<sup>34</sup> Data from Iran's Customs Administration show that China is the main exporter of zirconium powder and zirconium oxide to the country.<sup>35</sup> The Zirconium Production Plant in Isfahan produces zirconium tubes and is controlled by the Atomic Energy Organization of Iran (AEOI).<sup>36</sup>

The metallurgy sector is also critical to ballistic-missile production. Iran's largest aluminum producer – Iran Aluminum Company, or IRALCO – supplied the country's nuclear program with aluminum to build centrifuges,<sup>37</sup> and the revenue it generates from both illicit and legitimate business helps fill the IRGC's coffers. The European Union sanctioned IRALCO in December 2012 for supporting Iran's proliferation of sensitive nuclear activities.<sup>38</sup>

Ballistic missiles also require aluminum to increase the performance of solid- and liquid-rocket propellant,<sup>39</sup> and as of mid-2012, IRALCO had a contract to supply aluminum to the EU-designated Iran Centrifuge Technology

29. "Industry & Mining," *Invest in Iran/Organization for Investment Economic and Technical Assistance of Iran*, accessed September 13, 2015. (<http://www.investiniran.ir/en/sectors/industry>)

30. "Missile Technology Control Regime (MTCR) Annex Handbook-2010," *The Missile Technology Control Regime*, August 25, 2010, page 17-8. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

31. "توسعه معادن روي ايران (Iran Zinc Mines Development Company)," *Tehran Stock Exchange*, accessed February 8, 2016. ([http://new.tse.ir/instrument/کروي\\_IRO1ROOI0001.html](http://new.tse.ir/instrument/کروي_IRO1ROOI0001.html))

32. "توسعه معادن روي ايران (کروي) (Iran Zinc Mines Development Company)," *Tehran Securities Exchange Technology Management Company*, accessed September 13, 2015. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=22787503301679573>); The IRGC owns a combined 51.8 percent of IZMDCO through five companies: Mehr Eghtesad Financial Group (18.4%), Mehr Eghtesad Iranian Investment Company (18.39%), Tadbir Garan Atieh Iranian Investment Company (9.11%), Negin Sahel Royal Company (3.26%), and the mineral company Calcimin (2.65%).

33. "Missile Technology Control Regime (MTCR) Annex Handbook-2010," *The Missile Technology Control Regime*, August 25, 2010. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

34. U.S. Department of the Interior, U.S. Geological Survey, "Mineral Commodity Summaries 2016 – Zirconium and Hafnium," February 2016. (<http://minerals.usgs.gov/minerals/pubs/commodity/zirconium/mcs-2016-zirco.pdf>)

35. "میزان واردات زیرکون در ايران (The Amount of Zirconium Import in Iran)," *National Geoscience Database of Iran*, accessed February 19, 2016. (<http://www.ngdir.ir/mineminerals/PMineMineralChapterDetail.asp?PID=7749>)

36. "Zirconium Production Plant (ZPP)," *Nuclear Threat Initiative*, August 21, 2013. (<http://www.nti.org/facilities/162/>)

37. Louis Charbonneau, "Glencore bartered with firm linked to Iran nuclear program," *Reuters*, March 1, 2013. (<http://www.reuters.com/article/us-iran-sanctions-glencore-idUSBRE92007C20130301>)

38. Emanuele Ottolenghi and Saeed Ghasseminejad, "Congress should keep foreign investors from working with Iran's Revolutionary Guard," *The Hill*, January 19, 2016. (<http://thehill.com/blogs/pundits-blog/international/266254-congress-should-keep-foreign-investors-from-working-with>)

39. "Missile Technology Control Regime (MTCR) Annex Handbook-2010," *The Missile Technology Control Regime*, August 25, 2010, page 14-3. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

Company.<sup>40</sup> In September 2015, IRALCO won a case against the European Union annulling the decision to include it on the sanctions list (the United States has never designated the firm).<sup>41</sup>

Iranian research centers are also working on developing the technology to produce high-strength aluminum alloys and small particles<sup>42</sup> to build liquid propellant tanks and increase the performance of solid- and liquid-rocket propellant. In 2015, Iranian media reported that researchers at Amir Kabir University had produced a high-strength aluminum alloy.<sup>43</sup> Experts believe that the Arak facility is capable of producing high-strength aluminum for centrifuge rotors and castings.<sup>44</sup>

## CHEMICALS, PETROCHEMICALS, AND ENERGY

The chemical and petrochemical industries are critical to the explosive system, fuel materials, and composite materials needed for a ballistic missile program.<sup>45</sup> The IRGC and MODAFL control companies in these industries that include but are not limited to:

- Kermanshah Petrochemical Industries Co. (market value: \$416 million)<sup>46</sup>
- Pardis Petrochemical Co. (\$1.6 billion)<sup>47</sup>
- Parsian Oil & Gas Development Co. (\$3 billion)<sup>48</sup>
- Shiraz Petrochemical Co. (\$510 million)<sup>49</sup> and Shiraz Oil Refinery Co. (\$217 million)<sup>50</sup>
- Tabriz Oil Refinery Co. (\$427 million)<sup>51</sup>

Petrochemical and oil refinery facilities can be used as a cover for a ballistic-missile procurement network to produce liquid propellant. Moreover, missiles use composite and composite-modified double-base propellants as

40. “Council Implementing Regulation (EU) No 1264/2012 of 21 December 2012 implementing Regulation (EU) No 267/2012 concerning restrictive measures against Iran,” *Official Journal of the European Union*, December 22, 2012, page 356/57, entry 6. (<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:356:0055:0060:en:PDF>)

41. European Union, “Judgment of the General Court of 15 September 2015—Iralco v Council,” November 3, 2015. (<http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1454969209018&uri=CELEX:62013TA0158>)

42. “ساخت دستگاه تولید نانوذرات در دانشگاه تهران” (Researchers at Tehran University Built a Machine to Produce Nano-Particles), *ISNA* (Iran), December 29, 2012. (<http://goo.gl/SRBH5p>)

43. “تولید محکمترین آلیاژ آلومینیوم با دستاورد محققان ایرانی” (Iranian Researchers Produced the Strongest Aluminum Alloy), *ISNA* (Iran), March 10, 2015. (<http://goo.gl/1VLQtX>)

44. Simon Henderson and Olli Heinonen, “Nuclear Iran: A Glossary,” *The Washington Institute for Near East Policy and Harvard University’s Belfer Center for Science and International Affairs*, March 2015. ([https://www.washingtoninstitute.org/uploads/Documents/pubs/PF121-3rd-edition\\_HendersonHeinonenHR2.pdf](https://www.washingtoninstitute.org/uploads/Documents/pubs/PF121-3rd-edition_HendersonHeinonenHR2.pdf))

45. “Missile Technology Control Regime (MTCR) Annex Handbook-2010,” *The Missile Technology Control Regime*, August 25, 2010. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

46. “صنایع پتروشیمی کرمانشاه” (Kermanshah Petrochemical Industries), *Tehran Securities Exchange Technology Management Company*, accessed February 6, 2016. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=38437201078089290#>)

47. “پتروشیمی پردیس” (Pardis Petrochemical), *Tehran Securities Exchange Technology Management Company*, accessed February 6, 2016. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=20562694899904339#>)

48. “سترش نفت و گاز پارسیان” (Parsian Oil and Gas Development Co.), *Tehran Securities Exchange Technology Management Company*, accessed February 6, 2016. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=23441366113375722#>)

49. “گسترش نفت و گاز پارسیان” (Shiraz Petrochemical), *Tehran Securities Exchange Technology Management Company*, accessed February 6, 2016. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=38568786927478796#>)

50. “پالایش نفت شیراز” (Shiraz Oil Refinery), *Tehran Securities Exchange Technology Management Company*, accessed February 10, 2016. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=33683240001985963>)

51. “پالایش نفت تبریز” (Tabriz Oil Refinery), *Tehran Securities Exchange Technology Management Company*, accessed February 10, 2016. (<http://www.tsetmc.com/Loader.aspx?ParTree=151311&i=48753732042176709>)

fuel to provide the propulsive energy they need.<sup>52</sup> Since 2008, the AEOI has produced high-purity graphite<sup>53</sup> used in Iran's nuclear<sup>54</sup> and ballistic missile<sup>55</sup> programs.

## CONSTRUCTION

A ballistic missile program also requires the construction of testing and production facilities, above- and underground storage areas, and launch facilities. In October 2015 and again in January 2016, the IRGC unveiled two underground sites for storing missiles.<sup>56</sup> Given the highly sensitive nature of those programs, it is unlikely that the IRGC employed outside contractors to pursue them. Instead, the storage sites were likely built by the IRGC's construction conglomerate, Khatam al-Anbia (KAA).

KAA has the tools and experience to build underground tunnels. As FDD's Emanuele Ottolenghi stated in congressional testimony in September 2005,<sup>57</sup> KAA employs more than 135,000 people, works with over 5,000 contractors, and has over 800 reported subsidiaries.<sup>58</sup> Among its projects are 51 Oil Ministry contracts worth \$17 billion<sup>59</sup> and a Tehran metro line that is part of a \$7-billion metro-expansion program.<sup>60</sup> One KAA subsidiary is developing several metro projects to lengthen and improve connections to Tehran and its international airport.<sup>61</sup> The equipment needed to dig infrastructure tunnels is the same as that needed to build underground military facilities.<sup>62</sup>

## AUTOMOTIVE

A ballistic missile program requires vehicles to carry, erect, and launch missiles. The technology used in producing them is not significantly different from that of regular vehicles. By acquiring firms in the automotive sector, the

52. "Missile Technology Control Regime (MTCR) Annex Handbook-2010," *The Missile Technology Control Regime*, August 25, 2010, pages 4-2, 4-10. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf)). These composite propellants use synthetic rubber such as hydroxyl-terminated polybutadiene (HTPB), carboxy-terminated polybutadiene (CTPB), polybutadiene-acrylic acid polymer (PBAA), or polybutadiene-acrylic acid acrylonitrile terpolymer (PBAN).

53. "تولید گرافیت با خلوص بالا در کشور" (Iran Produced Highly Pure Graphite)," *Tabnak* (Iran), July 23, 2008. (<https://goo.gl/Ceh8v0>)

54. Simon Henderson and Olli Heinonen, "Nuclear Iran: A Glossary," *The Washington Institute for Near East Policy and Harvard University's Belfer Center for Science and International Affairs*, March 2015. ([https://www.washingtoninstitute.org/uploads/Documents/pubs/PF121-3rd-edition\\_HendersonHeinonenHR2.pdf](https://www.washingtoninstitute.org/uploads/Documents/pubs/PF121-3rd-edition_HendersonHeinonenHR2.pdf))

55. "Missile Technology Control Regime (MTCR) Annex Handbook-2010," *The Missile Technology Control Regime*, August 25, 2010. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

56. "IRGC's 2nd Underground 'Missile City' Unveiled," *Tasnim News Agency* (Iran), January 5, 2016. (<http://www.tasnimnews.com/en/news/2016/01/05/963050/irgc-s-2nd-underground-missile-city-unveiled>)

57. Emanuele Ottolenghi, "The Iran Nuclear Deal and its Impact on Iran's Islamic Revolutionary Guards Corps," *Testimony before the House Committee on Foreign Affairs Subcommittee on Middle East and North Africa*, September 17, 2015. ([http://www.defenddemocracy.org/content/uploads/documents/Ottolenghi\\_HFAC\\_IranDeal\\_IRGC.pdf](http://www.defenddemocracy.org/content/uploads/documents/Ottolenghi_HFAC_IranDeal_IRGC.pdf))

58. Massimo Calabresi, "New Iranian Sanctions Target Revolutionary Guards," *Time Magazine*, June 10, 2010. (<http://content.time.com/time/magazine/article/0,9171,1995869,00.html>)

59. Nargas Rasooli, "51 قرارداد بین وزارت نفت و مجموعه خاتم بیسته شد" (51 Contracts Signed between the Ministry of Petroleum and Khatam al-Anbiya)," *Magiran* (Iran), May 23, 2012. (<http://www.magiran.com/npview.asp?ID=2507886>)

60. Ladane Nasser, "Tehran to End Initial \$7 Billion Metro Expansion by March," *Bloomberg*, October 22, 2014. (<http://www.bloomberg.com/news/articles/2014-10-22/tehran-to-end-initial-7-billion-metro-expansion-by-march>)

61. "Tehran Metro Line 7 Project The deepest subway in country," *Sepasad Company Website*, accessed February 10, 2016. (<http://www.sepasad.ir/en/index.php/tehran-metro-line-7-project-the-deepest-subway-in-country>)

62. "پروژه سد مخزنی و بند تنظیمی مشمپا" (Moshampa Dam Construction Project)," *Sepasad Company Website*, accessed September 13, 2015. (<http://www.sepasad.ir/fa/index.php/moshampa-dam-project>)

IRGC both eliminates its reliance on non-IRGC vehicle producers and reinforces the secrecy of its missile program. A mobile missile-launcher vehicle, also known as a transporter erector launcher, is designed to bear the heat and impact caused by the launching process. According to the handbook published by Missile Technology Control Regime (an international partnership for preventing missile proliferation), “most rocket and missile launches ... require vehicles, especially for transport and handling. Vehicles modified to carry, erect, and launch missiles are distinctive because they generally have no other practical use.”<sup>63</sup>

Previously, Iran used its automotive industry to evade sanctions and procure banned items for its nuclear program. For example, Tehran used an Iranian-owned factory in Germany that produced gas cylinders for hybrid cars to get access to dual-use technology and materials, including carbon fiber and hardened steel, which are used in Iran’s second-generation centrifuges.<sup>64</sup>

The IRGC is active in the automotive sector, with five companies listed on the Tehran Stock Exchange: Bahman Group, Iran Tractor Manufacturing, Iran Tractor Foundry Company, Motorsazan Diesel and Gas Engines, and Iran Casting Industries. Notably, Bahman Group has a market value of \$326 million. It controls 24 companies,<sup>65</sup> including a share in Bahman Investment Co., another public company whose market value is estimated at \$86 million.<sup>66</sup>

## ELECTRONIC, TELECOMMUNICATION, AND COMPUTER SCIENCE

The electronic, telecommunication, and computer science industries are involved in ballistic-missile testing and production facilities, and in missile-control systems.<sup>67</sup> The telecom sector is one of the largest non-oil economic sectors in the country,<sup>68</sup> and the IRGC and MODAFL are both invested in these sectors through public companies such as the Mobile Telecommunication Company of Iran, the Telecommunication Company of Iran, and Iran Electronic Industries (IEI), among many others. IEI’s subsidiaries include Shiraz Electronics Industries, Iran Communication Industries, Electronic Components Industries, Information System of Iran, Isfahan Optics Industries, Iran Electronics Research Institute, Security of Telecommunication and Information Technology and Iran Space Industries Group.<sup>69</sup> Tehran regularly claims that a purpose for its ballistic missile program is to launch satellites, including for telecommunications.<sup>70</sup>

In September 2008, the U.S. Treasury designated Iran Electronics Industries, Shiraz Electronics Industries, and Iran Communications Industries pursuant to Executive Order 13382. As Treasury explained:

63. “Missile Technology Control Regime (MTCR) Annex Handbook-2010,” *The Missile Technology Control Regime*, August 25, 2010. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

64. Michael Birnbaum and Joby Warrick, “A mysterious Iranian-run factory in Germany,” *The Washington Post*, April 15, 2013. ([https://www.washingtonpost.com/world/europe/a-mysterious-iranian-run-factory-in-germany/2013/04/15/92259d7a-a29f-11e2-82bc-511538ae90a4\\_story.html](https://www.washingtonpost.com/world/europe/a-mysterious-iranian-run-factory-in-germany/2013/04/15/92259d7a-a29f-11e2-82bc-511538ae90a4_story.html))

65. “Ownership Status of Companies,” *Bahman Group*, April 30, 2011. (<http://www.bahmangroup.com/en/index.php/companies/ownership-status>)

66. Bahman Group owns 32.6 percent of Bahman Investment.

67. “Missile Technology Control Regime (MTCR) Annex Handbook-2010,” *The Missile Technology Control Regime*, August 25, 2010. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

68. Khouroush Avaei, “What to Expect in Iran’s Telecom Sector,” *Al-Monitor*, August 18, 2013. (<http://www.al-monitor.com/pulse/originals/2013/08/expect-iran-telecom-sector.html#>)

69. “Iran Electronics Industries (IEI),” *Iran Watch*, January 20, 2015. (<http://www.iranwatch.org/iranian-entities/iran-electronics-industries-iei>)

70. “Iran Ready to Send ‘Mesbah’ Satellite into Orbit,” *Tasnim News Agency* (Iran), March 10, 2015. (<http://www.tasnimnews.com/en/news/2015/03/10/681942/iran-ready-to-send-mesbah-satellite-into-orbit-official>)

Iran Electronics Industries, as well as two subsidiary organizations, Shiraz Electronics Industries and Iran Communications Industries, are being designated because they are owned or controlled by Iran's MODAFL. MODAFL, which was designated under Executive Order 13382 on October 25, 2007, controls other previously designated entities DIO, and Aerospace Industries Organization, which is the overall manager and coordinator of Iran's missile program.<sup>71</sup>

The telecommunication, electronics, and computer science industries play a vital role in any missile program. According to the Missile Technology Control Regime, "The limited space on rocket systems and UAVs requires the design and manufacture of small yet very capable ... [electronic] systems" to send and receive data, and to control the missile in different phases.<sup>72</sup>

## RESEARCH INSTITUTIONS

The IRGC and MODAFL have their own universities – Imam Hossein University<sup>73</sup> and Malek Ashtar University of Technology<sup>74</sup> respectively – and maintain close cooperation with the leading research universities in the country, particularly their aerospace departments. Iran's Aerospace Industries Organization, a division of MODAFL, also has its own research facilities working on Iran's missile program.<sup>75</sup>

Iran's research universities are best positioned to provide the technology and expertise for a full-scale ballistic missile program. We recommend further investigation into certain departments within those universities that may serve as critical nodes for that program. For example, the EU sanctioned the aerospace department of Sharif University of Technology in 2012 for its role in proliferation-sensitive nuclear activities and the development of nuclear-weapon delivery systems. Canada designated its department of engineering for similar charges.<sup>76</sup>

## CONCLUSION AND RECOMMENDATIONS

Iran's ballistic missile program is controlled by the IRGC and MODAFL. To counter that program – pursued in violation of U.S. and international law – the United States should deploy new tools and sanction measures against the wider network of the IRGC and ministry entities. The following recommendations are economic tools, but the U.S. government should also consider using covert, military, and cyber resources. Additionally, in the diplomatic arena, the U.S. government should also engage its partners in the Missile Technology Control Regime to promote export control procedures to address the procurement of sensitive materials.<sup>77</sup>

71. U.S. Department of the Treasury, Press Release, "Treasury Designates Iranian Military Firms," September 17, 2008. (<https://www.treasury.gov/press-center/press-releases/Pages/hp1145.aspx>); The press release further details Iran Electronics Industries' military products, the military equipment Shiraz Electronics Industries produces for the Iranian military, and Iran Communications Industries' military communication equipment.

72. "Missile Technology Control Regime (MTCR) Annex Handbook-2010," *The Missile Technology Control Regime*, August 25, 2010, page 11-8. ([http://www.mtcr.info/english/MTCR\\_Annex\\_Handbook\\_ENG.pdf](http://www.mtcr.info/english/MTCR_Annex_Handbook_ENG.pdf))

73. "Imam Hussein University of the Revolutionary Guards," *Iran Watch*, April 1, 2013. (<http://www.iranwatch.org/iranian-entities/imam-hussein-university-revolutionary-guards>)

74. "Malek Ashtar University," *Iran Watch*, August 27, 2008. (<http://www.iranwatch.org/iranian-entities/malek-ashtar-university>)

75. For more on AIO, see: "Aerospace Industries Organization (AIO)," *Iran Watch*, March 17, 2010. (<http://www.iranwatch.org/iranian-entities/aerospace-industries-organization-aio>)

76. "Sharif University of Technology," *Iran Watch*, accessed February 8, 2016. (<http://www.iranwatch.org/iranian-entities/sharif-university-technology>)

77. The Missile Technology Control Regime, accessed February 18, 2016. (<http://www.mtcr.info/english/>)

1. The United States should impose sanctions on the sectors identified in this memo, and secondary sanctions on companies that engage in significant business with them. These sanctions could build on the precedent that Congress and Treasury have set of targeting sectors connected to Iran's nuclear program, as well as the sector sanctions Treasury developed against Russia in response to its annexation of Crimea two years ago.
2. Washington should do a comprehensive study of the individuals and entities involved in Tehran's ballistic missile development and add them to the Specially Designated Nationals list under its counter-proliferation authorities. It should also include high-ranking Iranian officials on its target list, and not only focus on middlemen and procurement agents.
3. Similar to the reporting requirements in the Iran Freedom and Counter-Proliferation Act of 2012, Congress should require that the administration report on which sectors of Iran's economy are contributing directly or indirectly to the development of the country's ballistic missile program.
4. Congress should, similar to the reporting requirements in the Iran Threat Reduction and Syria Human Rights Act of 2012, require the Government Accountability Office to list all foreign investors in the sectors identified here insofar as they are connected to Iran's ballistic missile program. This report should be expanded to include all foreign persons engaging in business with these sectors.
5. Congress should require that publicly traded companies report to the Securities and Exchange Commission on a quarterly basis if they have conducted any transactions with the sectors identified here as relevant to Iran's ballistic missile program.
6. Iran's ballistic missile program is still dependent on the importation of materials and expertise. Washington should therefore work with allies to strengthen export controls on dual-use goods, technology, materials, and equipment for those sectors involved in Iran's ballistic missile development.
7. The United States should pressure its UN partners to impose sanctions on Iranian and non-Iranian entities that violate ballistic missile restrictions. The U.S. and its European allies should unilaterally sanction any Iranian entities (or secondary entities located outside Iran) engaged in illicit procurement for the country's ballistic missile program, including those importing goods for that program in violation of UNSCR 2231.
8. The United States should expand sanctions against IRGC- and MODAFL-controlled companies. Even if these firms are not directly involved in ballistic-missile development, they may warrant sanctions under other U.S. authorities because of their ownership by designated entities. Washington should examine its existing authorities and develop new tools if they are insufficient to sanction all IRGC- and MODAFL-controlled entities.

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