APPENDIX 2:

AGGRAVATING FACTORS: OPERATIONAL AND ORGANIZATIONAL

Poor Governance

As with other aspects of the Iranian economy and industry, virtually every aspect of Iran's nuclear program reflects serious problems of governance. Whether leadership and diplomacy, military and civil defense, international cooperation and supervision, standards and design, site selection and design, security and prevention, or response and recovery, there is very little reason for confidence in the Islamic Republic's management of Iran's nuclear program. Iran's leaders have not only done virtually everything in their power to shatter the international community's confidence in Iran's nuclear program and promises, they have, at the same time, ignored their legal, political, and religious obligation to protect and prepare the Iranian people against the risks of attack. Such a flagrant violation of responsibility and trust is apparent in many dimensions of Iran's nuclear program.

Iran's Defensive Capabilities: The S-300 Mirage

The day after Iran and Russia inaugurated the Bushehr Nuclear Plant on August 21, 2010, Iranian President Mahmoud Ahmadinejad told the al-Jazeera network that "Israel's too weak to attack Iran's nuclear facilities."[195] He added that Jerusalem did not have "the courage to do it...and I do not think its threat is serious."[196]

As for the possibility of a U.S. military strike, the Iranian president was equally dismissive. He told al-Jazeera that "America is not interested in sparking a military confrontation" and that "there are no logical reasons for America to carry out such an act." He ended by questioning America's military credibility before his Arab audience: "Do you believe that an army that has been defeated by a small army in Iraq can enter into a war with a large and well-trained army like the Iranian army?"[197]

The irony is that Iran's leaders have not taken adequate defensive measures to protect the Iranian people against the consequences of their offensive rhetoric and conduct. What makes Khamenei's nuclear policies and Ahmadinejad's provocations—the gamble—so dangerous to the Iranian people is that they have systematically undermined Iran's national security by eroding Iran's diplomatic influence and military power. The Iranian military's ability to defend Iran's nuclear sites against military strikes is negligible. Iran's Air Defense system has become largely outdated.[198] In the event of a strike, there would be a considerable early-warning delay due to Iran's antiquated, semi-automated C4I Battle Management systems. As for Iran's combat aircraft, largely a legacy of the Shah, most analysts predict a long response/scramble time, low operational readiness, low sortie rate, and a high loss rate.

To make matters worse, foreign policy miscalculations have seriously crippled the Iranian military's defensive capabilities. Russia's decision to renege on a deal to upgrade Iran's obsolete air defenses with S-300 ground-to-air missiles has effectively turned Iran's nuclear sites into sitting ducks. Having threatened Israel with destruction, taunted the United States into attacking Iran's nuclear program and military, denied the possibility of a military threat, and accused his own ally, Russia, of selling Iran out to Satan, the President finds solace by telling a cheering crowd in Bojnourd that "the Iranian people don't need missiles to defend themselves."[199]

In fact, far from securing Iran against foreign powers or acting as a deterrent against a nuclear attack, the Islamic Republic's foreign policy and nuclear rhetoric can erode Iran's national security by increasing the risks of proliferation in the Middle East. The possibility of Shia Iran using its nuclear weapon to impose its will on weaker Sunni states creates a clear incentive for oil rich Gulf nations to counter the Islamic Republic's real or imaginary nuclear arsenal with their own nuclear weapons. Should al-Qaeda or other religious fundamentalists with strong anti-Iranian and anti-Shia sentiments take over any of these small states, the risks of a nuclear attack on Iran would be far greater than the risks posed by the Israeli or American nuclear arsenal. In this sense, far from constraining Iran's security, a powerful nonproliferation regime that would establish confidence about the peaceful nature of nuclear programs in the Middle East would be in Iran's interest.

Lack of International Supervision: The Regulatory Black Hole

The Islamic Republic's policies have not only increased the risks of military strikes, they have also diminished the capacity of domestic and international bodies to ensure the safety and security of Iran's nuclear program. While, before Fukushima, Iranian officials claimed to be following Japanese standards for their nuclear program, after Fukushima the Iranian public was fed false assurances about Iran's nuclear capabilities. For example, Iranian nuclear physicist Seyed Mahmoud Reza Aga-Miri, Iran's representative to the SESAME (Synchrotron Radiation Light for Experimental Science and Applications in the Middle East) project, told *Fars News Agency*, "Iranian experts can easily tackle this [Fukushima] disaster and solve Japan's problem. This shows that maybe Iran's practical capabilities are higher than Japan's."[200]

Iran's claims that its nuclear plants comply with the highest up-to-date standards simply do not make sense. As Nima Gerami points out in the Bulletin of the Atomic Scientists, the International Atomic Energy Agency (IAEA) "emphasizes that Iran does not, in fact, follow some important safety protocols." As Gerami points out, Iran is "the

195 "Ahmadinejad: Israel is too weak to attack Iran's nuclear facilities," Haaretz, 22 August 2010.

196 Ibid.

197 Ibid.

198 Anthony Cordesman and Abdullah Toukan, "Study on a Possible Israeli Strike on Iran's Nuclear Development Facilities," Center for Strategic and International Studies Report, 14 March 2009, <http://csis.org/publication/study-possible-israeli-strike-irans-nuclear-development-facilities>.

199 "Ahmadinejad Slams Russia for Selling Out to Satan," Al-Arabiya via Agence France-Press, 3 November 2010, <http://www.alarabiya.net/articles/2010/11/03/124756.html>.

200 Nima Gerami, "Nuclear Safety in Iran, Post-Fukushima," Bulletin of the Atomic Scientists, 3 August 2011, <http://thebulletin.org/web-edition/op-eds/nuclear-safety-iran-post-fukushima>.

only country in the world with significant nuclear activities not to sign the 1994 Convention on Nuclear Safety (CNS), a crucial system of peer review and mutual oversight. (Israel, India, and Pakistan, all outside the Nuclear Non-Proliferation Treaty, have signed the CNS. India and Pakistan have both ratified.)"[201]

An international team of nuclear safety experts from the IAEA did visit Iran from February 20 to March 2, 2010, for an Integrated Regulatory Review Service (IRSS) mission which included a technical visit to the Bushehr Nuclear Power Plant site (BNPP-1). Olena Mykolauchuk, IRSS team leader and head of the State Nuclear Regulatory Committee of the Ukraine—no stranger to nuclear disasters—reportedly commended her Iranian counterparts for "demonstrating significant progress of INRA as a nuclear regulatory authority."[202] Philippe Jamet, director of the IAEA's Nuclear Installation Safety Division, added that through such review missions "both Iran and the international experts contribute to enhancement of nuclear safety and worldwide experience sharing."[203]

Yet while praising "INRA's dedicated staff and conscientious staff" for their recognition of the importance of "the value of peer reviews and international cooperation regarding nuclear safety," the IAEA made it very clear that the "the mission was an objective peer review based on IAEA safety standards and "was neither an inspection, nor an audit."[204] Beyond the niceties, the IAEA peer review's recommendations and suggestions to improve the regulatory effectiveness of INRA were as follows:

- The government should support the prompt enactment of a law establishing INRA as an independent nuclear regulatory authority, as well as provide it with all authority and resources needed to carry out its functions.
- The government is encouraged to join the Convention on Nuclear Safety and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.
- INRA should replace the existing set of ad hoc regulatory requirements with a comprehensive set of national safety regulations.
- The number and expertise of technical staff should be increased and career incentives should be established to attract and retain them.[205]

Although, in 2010, the IAEA's IRRS mission to the Bushehr plant recommended that Iran take these crucial steps to develop a comprehensive system of national nuclear safety regulations, Iran has yet to sign the Convention on Nuclear Safety.

What is fairly clear from the IAEA's peer review alone is that Iran is developing its nuclear program without establishing an nuclear regulatory authority, or granting it the necessary authority, resources and staff to carry its functions, that Iran lacks a comprehensive set of national safety regulations, and that Iran has not joined key conventions on nuclear safety. The main national laws and regulations concerning nuclear power remain the Atomic Energy Act of 1974 and the Radiation Protection Act of 1989.[206]

The limited nature of Iran's technical cooperation projects with the IAEA for the 2009-2011 cycle points to "an environmental radiological monitoring of the Isfahan UCF site surrounding in normal and emergency situation and characterizing pathways of exposure to individuals and the public (IRA2007016)," but beyond a technical document on monitoring environmental radiological threats and pathways around the Isfahan site, there is very little in the 16 initiatives listed by the IAEA that addresses emergency response preparations" (to suggest technical documentation, let alone mobilization or preparation for the medical, economic and environmental consequences of nuclear catastrophe at Isfahan and elsewhere).[207]

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201 Ibid.

202 "International Experts Conclude IAEA Peer Review of Iran's Safety Regulation of Bushehr NPP," IAEA press release, 2 March 2010, <http://www.iaea.org/newscenter/pressreleases/2010/prn201003.html>.

203 Ibid.

204 Ibid.

205 Ibid.

206 International Atomic Energy Agency Iran factsheet, March 2009, <www.pub.iaea.org/MTCD/publications/PDF/cnpp2009/countryprofiles/Iran/Iran2008.htm>.

207 Ibid.

208 Nima Gerami, "Nuclear Safety in Iran, post-Fukushima," Bulletin of the Atomic Scientists, 3 August 2011, <http://thebulletin.org/web-edition/op-eds/nuclear-safety-iran-post-fukushima>.

209 Ibid.

210 Ibid.

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Management Problems: Lack of Standards

It is impossible to manage Iran's nuclear fuel cycle without a clear set of standards. Yet, in a paper on the Iranian Nuclear Fuel Cycle Experience presented at the World Nuclear Association's Annual Symposium, Dr. M Ghannadi-Maragheh, vice-president of the Atomic Energy Organization of Iran (AEOI), shows how much of Iran's nuclear fuel cycle remains incomplete. Indeed his paper has gaping holes in areas such as safeguards, quality control, waste disposal, and medical treatment. Iran's Atomic Energy Organization appears to have no standards or is only just beginning to define standards for crucial areas of the nuclear fuel cycle. Where standards do exist, they are often no more than ISO translations prepared by the Institute of Standards and Industrial Research of Iran. Or they are incompatible. For example, according to Ghanadi-Maragheh, "Russian design of (Yellow Cake Production) for constructing of plant and equipment was not familiar to non-Russian contractors—as Western designs are—and Russian documents and drawings were not according to Iranian standards."[213] While one cannot judge an entire organization based on the quality of its leadership, Ghannadi-Maragheh's paper provides a glimpse into a hopelessly disorganized nuclear fuel cycle defined by negligence, amateurism, and lack of professionalism at the highest levels of the AEOI. The absence of standards, lack of process, and poor integration of Iran's fuel cycle points to fundamental organizational and management problems—a poor organization of knowledge, definition of roles, distribution of authority, and division of functions within the AEOI, and, consequently, negligence of some of the most crucial sectors of Iran's nuclear program, including the management of Russian and other foreign contractors.

Earthquakes: Fukushima Redux

As with Japan's Fukushima nuclear plant, the Bushehr nuclear plant sits in a seismic zone along the fault lines of the Arabian and Eurasian continental plates. In 2002, a 4.6 magnitude earthquake hit Bushehr. More recently, the Iranian Seismological Center detected a 5.2 magnitude earthquake on March 5, 2011, in the Kohgiluye and Boyerahmad province and a 4.8 magnitude earthquake on May 8, 2011, in Bushehr province.[214]

President Ahmadinejad's belated efforts to relocate residents of the villages near the Bushehr nuclear facility have failed, and there is little evidence to suggest that the Iranian military and provincial governments have the financial, military, logistical, medical, and communications and control facilities necessary to detect, monitor, and treat radiation and chemical toxins released near urban centers. Iran's neighbors are also worried. Kuwaiti geologist Dr. Jassem al-Awadi has warned that in the event of an earthquake, "the ominous results will be similar to those of the Chernobyl disaster for the whole region."[215] According to al-Awadi, an earthquake could spark massive fallout that would reach Kuwait and other Gulf Cooperation Council states. With Kuwait only 276 km (171.4 miles) from Bushehr, he expressed doubts about whether the IAEA has been imposing its safety standards at the plant. According to Dina Esfandiary, a research assistant at the International Institute for Strategic Studies (ISIS), Bushehr, unlike Chernobyl, has had some design upgrades, including a containment dome built out of reinforced concrete, but radiation could escape if an earthquake damaged the Bushehr plant's containment dome. According to Esfandiari, "Bushehr is located on the coast; any accident would directly affect Iran's neighbors, particularly Kuwait, the UAE and Saudi Arabia, due to the winds in the Gulf region blowing from East to West."[216]

In addition, the Persian Gulf's water supplies would also be disrupted because of the nature of coastal currents circling counter clockwise."[217] The contamination of the Persian Gulf would pose an immediate risk to Arab states as they rely on desalination plants for their fresh water. Essentially, an accident at Bushehr would contaminate their water supply.

Design and Parts: Resurrecting Obsolete Technology

While the meltdown of the reactors at Fukushima was caused by the disruption of the cooling systems at Fukushima due to the external shocks from an earthquake and a tsunami, the risks of a man-made disaster at Bushehr are much worse than those from a massive natural disaster. As a hybrid nuclear plant that combines German design from the 1970s with Russian technology from the '90s adopted for Iran,

211 International Atomic Energy Agency Iran factsheet, March 2009, <www.pub.iaea.org/MTCD/publications/PDF/cnpp2009/countryprofiles/Iran/Iran2008.htm>.

212 Ibid.

213 M. Ghannadi-Maragheh, "Iranian Nuclear Fuel Cycle Experience," presented at the World Nuclear Association Annual Symposium, 3-5 September 2003.

214 "Recent seismicity map of Iran," Iranian Seismological Center accessed 8 July 2011, <www.irsc.ut.ac.ir>.

215 "Kuwait Warns of Bushehr Disaster: Reactor is in Earthquake Zone," World Tribune, 1 October 2010, <http://www.worldtribune.com/worldtribune/WTARC/2010/ME_iran0964_10_01.asp>.

216 Dina Esfandiary, "Bushehr plant can resist quake, but still endangers Gulf," International Institute for Strategic Studies, 4 April 2011, accessed 8 July 2011, <www.iiss.org/whats-new/iiss-in-the-press/april-2011/bushehr-plant-can-resist-quake-but-still-eandangers-the-gulf/>.

217 Ibid.

Bushehr is flawed at the level of conception, design and operation. As late as February 28, 2011, the Russian operators of the plant were forced to remove the nuclear fuel to "thoroughly clean the reactor core and the primary cooling system to remove metal shards left by the cooling pumps failure."[218] Iran's state-run Mehr news agency quoted Alexander Sadonikov, Russia's Ambassador to Iran, as stating that the delay was necessary since it is better "to prevent unwanted consequences rather than to regret it later."[219]

The failure of Bushehr's cooling pump is not a function of natural disaster, but rather potentially deadly technological flaws. Originally a joint venture with Siemens AG and AEG Telefunken in 1975, Iran planned to build two pressurized water reactors subcontracted to TyssenKrupp AG based on the design of the German Biblis Nuclear Power Plant. The first reactor at Bushehr was scheduled for completion in 1980, and the second, in 1981. Dogged by more than 30 years of delay, abandoned after the revolution of 1979, damaged during the Iran-Iraq war in the 1980s, subjected to a hot and humid climate in which even stainless steel can rust, Iran signed a contract with Russia's Ministry for Atomic Energy to revive the plant in 1995 by installing the V-320 915 MEe VVER 1000 pressurized water reactor. The project was scheduled for completion in 2001 and then, after yet another series of delays the Russians blamed on the lack of experience of Iranian subcontractors, the completion date was rescheduled for September 2007.

These delays speak volumes about the technical challenges of assembling a nuclear plant out of a collage of old, rusted and incompatible parts, under embargo conditions that have made it virtually impossible for Iran to tap into German expertise and documentation about more than 80,000 pieces of equipment and spare parts. Russian experts have thus had to graft the existing German stock with Russian technology, a costly process that has required constant additional testing and monitoring of the plant. In a joint press conference held February 26, 2009, with the Russian head of Rosatom, former Soviet prime minister Sergei Kirienko, Reza Aghazadeh, the head of the Atomic Energy Organization of Iran, explained the reason for delays at Bushehr quite succinctly. According to Aghazadeh, "24% of the parts and equipment used at the Bushehr power plant are German, 36% Iranian, and 40% Russian."[220] Expressing his satisfaction with the technical progress at the plant, Aghazdeh said that, "one must admit that changing the technology of a western reactor to a Russian one poses many difficulties, and naturally, this is the first nuclear plant of its kind and this nature to be put to use."[221] Kirienko agreed. He stressed that the Siemens technology at the plant was more than 30 years old, and that is was necessary to carry out extensive experiments and tests in a responsible manner. As he put it:

"Until now, no one has succeeded in operationalizing such a plant, and, actually, completing the Bushehr nuclear plant is not the same as constructing a new plant but rather it is completing a plant that has been constructed by a company from another company, and consequently, we have had to make extremely important technical decisions about it."[222] When pressed to explain a decade of delays, the Russian nuclear boss wryly added that: "Of course, it is 35 years past the deadline."[223]

In a post-Fukushima world in which Germany is looking to decommission 17 nuclear power stations, including its Biblis reactor in Hesse built in 1975, Iran's approach to nuclear power seems to hinge on the denial of fact and distortion of truth. Rather than putting safety first, the head of Iran's Atomic Energy Agency, Aghazadeh, claims that he expects the Bushehr nuclear reactor, one based on the Biblis design, and under construction since 1975, to generate power for another 50 years—an absurd proposition given that most nuclear plants that are correctly maintained have a 30- to 40-year lifecycle. The fact that Bushehr has experienced problems with its cooling system before launch due to shards, and has required years of additional testing, is a clear warning about the liabilities ahead.

Inappropriate Fuel Design: The Arak Anomaly

Iran's leaders regularly use Iran's nuclear program for publicity stunts that come at the price of eroding confidence in the actual operation of the plants. Design anomalies at Iran's heavy water reactor plant at Arak, under construction since 2004, is a case in point. According to a report by the Institute for Science and International Security, the Arak reactor fuel assembly unveiled by President Ahmadinejad during his spring 2009 site visit are "of a surprising shape for a small 40 megawatt-thermal heavy water reactor and raise questions about whether it is indeed a fuel assembly for this reactor."[224] According to ISIS, the fuel element resembles those used in an RBMK (Reaktor Bolshoy, Moshchnosti Kanalniy) Soviet-era reactor (similar to Chernobyl), "a descendant of the large Soviet plutonium reactors built in the 1940s and 1950s."[225] Although the ISIS study considered it highly unlikely that like the RBMK, the Arak reactor was also designed for on-line refueling, they were left puzzled: "Even if this fuel assembly is intended for the Arak reactor, why would Iran seek to build a heavy water reactor around such an inappropriate fuel design?" They offered two possible explanations: One was that NIKIET, a Russian nuclear design institute with extensive experience designing the RBMK graphite-moderated power reactors and the VVER family of pressurized light water reactors, including the Iranian Bushehr reactor, could have helped Iran build the Arak reactor. Yet they added that "NIKIET has no known experience in heavy water moderated reactors of which only a few have ever been built in Russia."[226] The other possibility was that "Iran could have displayed a RBMK uranium oxide fuel assembly for publicity purposes, allowing Ahmadinejad to proclaim that Iran had "mastered" this important step of the reactor's

218 Peter S. Green, "Failure at Iran's Bushehr Nuclear Plant Raises Concerns about Safety," The Washington Post, 7 March 2011.

219 Ibid.

220 "ASR-Iran News Analysis," <http://www.asriran.com/fa/pages/?cid=66101>(Persian).

221 Ibid.

222 Ibid.

223 Ibid.

224 David Albright, Paul Brannan and Robert Kelley, "Mysteries Deep Over Status of Arak Reactor Project," 11 August 2009, <http://www.isisnuclearіran.org/assets/pdf/ArakFuelElement.pdf>.

225 Ibid.

226 Ibid.

fuel cycle."[227] ISIS's examination of photographs from Ahmadinejad's visit to the Fuel Manufacturing Plant at Esfahan during which he declared the plant operational also exposed glaring inconsistencies as "images from the tour indicate that much equipment is missing."[228]

Contaminated Supply Chain: The Smuggler's Haven

The Islamic Republic's failure to build confidence in Iran's nuclear program has had a dramatic impact on the quality, security and progress of Iran's nuclear program. The 30-year delay in starting Bushehr, and the delay, cost, and safety concerns that plague the plant to this day reveal Iran's plight. Rather than procuring nuclear parts from reliable sources such as Germany's Siemens corporation, embargos and sanctions have forced Iran to turn to the dubious chain of nuclear junk dealers operating out of Pakistan and the United Arab Emirates. For all intents and purposes, Iran's Atomic Energy Organization has had to become part of an illicit and informal nuclear underground, with all the associated problems related to quality, price, and security of smuggled parts originating from dubious sources. While enrichment technology is generally not sold to non-nuclear weapons states, the purchase of used nuclear equipment—including contaminated centrifuges—in the black market casts doubt on the Atomic Energy Organization of Iran's planning, procurement, and quality control standards. It also exposes Iran's nuclear program to grave security risks associated with double agents.

Abdul Qadeer Khan reportedly told investigators that the contaminated centrifuges found in Iran by the International Atomic Energy Agency were "broken and used centrifuges" sold as "scrap" to a Karachi-based company, ALCOP.[229] An associate of Khan reportedly bought the centrifuges from ALCOP and sold them to Iran. Iran reportedly paid 2 million Pakistani rupees (about $30,000) for contaminated Pakistani junk that not only jeopardized the safety and security of Iran's nuclear program but also the credibility of Iran's claims about the nature of its nuclear program. When one considers the fact that Iran was reported to have paid the same intermediary more than $3 million for the whole lot, the grave dangers posed by the Iranian leadership and parliament's failure to hold the Atomic Energy Organization of Iran accountable for purchasing nuclear junk at exorbitant prices becomes obvious. Iran has essentially degraded and delayed its own nuclear program by abandoning legitimate nuclear suppliers to settle for scrap purchased from questionable sources in the Pakistani black market.

Ideological Constraints: Diminished Expertise

The ideological subjugation of the Atomic Energy Organization of Iran, and the lack of independence of Iran's Nuclear Regulatory Authority, points to the absence of an institutional framework for checking and monitoring Iran's nuclear program. The rise of religious and political apparatchiks whose primary concern is propaganda has come at the expense of Iran losing the professional depth, scientific expertise and the international cooperation necessary for building trust and relationships that are critical components of developing the expertise.

Iran's development of its nuclear industry under a veil of secrecy means that there is no process for checking the claims or supervising the operations of the Atomic Energy Organization of Iran. It is not at all clear who is promoted to what position in the organization according to what level of scientific expertise, financial acumen, or management experience. The lack of transparency, accountability, and supervision has had serious repercussions in terms of ensuring compliance with international safety standards. Scientists who do point out problems with the design, construction, procurement, operation, and organization of Iran's nuclear program expose themselves to retribution for pointing out the obvious. A grotesque political culture premised on nuclear xenophobia and paranoia has not only arrested, delayed, and damaged Iran's nuclear development, it has transformed Iran's nuclear program into a national and religious symbol whose management, operations, quality and security cannot be questioned.

In the aftermath of Fukushima, Japan's cooperation with other advanced nuclear states meant that Japan could instantly draw on a deep global reservoir of knowledge, expertise and equipment. Thus, in the nuclear industry as in other industries, it is interdependence—not dated and paranoid ideologies premised on national independence—that enhances standards, ensures quality, drives productivity and delivers progress. The excessive and unnecessary politicization of Iran's nuclear program under the guise of developing "indigenous" science is absurd, risky, and entirely unnecessary given that virtually all other Iranian industries—from oil to automotive, pharmaceutical to agriculture—rely on discoveries and technologies that originate in other countries. What should guide the development of Iran's nuclear program is not any religious or political ideology, but quality, safety, functionality, maintenance and other basic scientific and economic values that establish trust in a product.

Security and Sabotage: The Stuxnet Precedent

Beyond the dangers of working with obsolete and incompatible technology, Iran's nuclear plants lack adequate security and are vulnerable to sabotage. The vulnerability of Iran's nuclear program led Dmitry Rogozin, Russia's ambassador to NATO, to warn that the computer virus that had attacked the Russian-built nuclear plant at Bushehr could have led to a nuclear disaster on the scale of Chernobyl.[230] Demanding a NATO investigation into the incident, Rogozin said that a virus had hit the computer systems at Bushehr. Comparing the computer virus impact to an explosive mine, he said that "this virus, which is toxic, is very dangerous, and could have serious implications…these 'mines' could lead to a new Chernobyl."[231]

Rogozin's claims prompted the acting director of the Iranian Atomic Energy Commission, Mohammad Ahmadian, on February 4 to call for an investigation to verify Rogozin's claims about major damage to Bushehr. Yet, despite the concern of the Russian government about the threat to Bushehr, vice-president Ali Akbar Salehi,

227 Ibid.

228 Ibid.

229 "Pakistan's Khan says centrifuges sold to Iran as scrap," Associated Press, accessed 28 December 2010, <http://www.breitbart.com/article.php?id=D91J2F800&show_article=1>.

230 "Russian's Nato envoy: Iran-bound Stuxnet worm could have caused Chernobyl," Reuters, 26 January 2011.

231 Ibid.

denied that the month-long delays at Bushehr were due to Stuxnet. He claimed that "during a washing process prior to loading the actual nuclear fuel, a small leak was observed in a pool next to the reactor and was fixed."[232]

The Institute for Science and International Security reported that Symantec, the computer security company, had established that the Stuxnet virus "first infected four Iranian organizations in June and July 2009, and that in March, April, and May 2010, two of the original organizations were infected again."[233] Symantec tracked 12,000 collateral infections and concluded that the worm had targeted "the domestic portion of Iran's supply chain for industrial control systems," including the Siemens 315 and 417 programmable logic controllers (PLC). It would change the frequency of the converters controlling the speed of the centrifuge rotors. The Stuxnet virus malware targeted about 1000 IR-1 centrifuges out of about 9,000 deployed at the Fuel Enrichment Plant at Natanz, that the attack would last about seven minutes in a cycle that would be repeated every 35 days, and that the code would disable alarm and warning systems while sending false data to the command and control centers to conceal the sabotage.[234]

Stuxnet did much more than buy time by reducing Iran's capacity to produce enriched uranium. It demonstrated the ability of foreign intelligence to launch a precise cyber-attack premised on being able to reproduce code based on having access to the most intricate operational details about Iran's nuclear sites and equipment. It exposed a gaping breach in the security of Iran's nuclear program. Foreign intelligence agencies had not only hijacked the command and control systems of Iran's nuclear plants without being detected, but were able to penetrate Iran's nuclear sites and nuclear establishment with malware by infecting Windows machines using USB keys. While it could not identify the authors of Stuxnet, ISIS concluded that "Stuxnet's elaborate nature and its updating show a firm determination to sabotage Iran's nuclear program."[235]

Assassinations and Disappearance: Endangered Scientists

Finally, the Islamic Republic's failure to protect Iran's leading nuclear scientists and engineers from becoming suspects and targets in a deadly game of nuclear poker is cause for concern. On July 23, Daryoush Rezaienejad, a 35-year-old academic working for the Iranian Defense Ministry, was shot in the neck and killed. Last November, Majid Shahriari, a member of the engineering faculty at Shahid Beheshti University in Tehran, was assassinated. Fereidoun Abbasi, another professor at Shahid Beheshti hailed as Iran's academic of the year, was wounded in an attack. Both were members of the "Nuclear Society of Iran." Abbasi's name appeared on the UN Security Resolution 1747 of March 24, 2007, describing him as a "senior ministry of defense and armed forces logistics scientist with links to the Insitute of Applied Physics, working closely with Mohsen Fakhrizadeh-Mahabadi, believed by Western intelligence to be in charge of the Iranian nuclear weapons program."[236] In January 2010, Massoud Ali Mohammadi, a particle physicist and supporter of the opposition movement, was blown up outside his home. In December, another nuclear scientist, Ardeshir Hassanpour, reportedly died from a gas poisoning incident. Rumors were that he was killed by Mossad. Another nuclear physicist, Shahram Amiri, was reportedly abducted on a pilgrimage to Mecca that June, and in 2007, Ali Reza Asghari, a high-ranking Revolutionary Guard general, reportedly vanished after checking into a hotel in Istanbul.[237] In January 2012, another Iranian nuclear scientist, 32-year-old Mostafa Ahmadi Roshan, was killed in Tehran when his bomb-rigged car exploded (Figure 40).

Yet instead of creating a safe and secure environment for Iran's nuclear scientists and engineers, the cloud of suspicion and secrecy surrounding Iran's nuclear program converts Iran's best minds into pawns in a game of nuclear poker in which they have become obvious targets of foreign intelligence agencies or hostages of Iran's clumsy security establishment. Instead of taking steps to protect Iran's best and brightest minds, the Islamic Republic treats them, their families, and the rest of Iran's nuclear officials and workers as sacrificial chips.

As if assassinations and disappearances had not done enough damage to Iran's nuclear program, accidents have also taken their toll. Rosatom declared that five of the Russian experts involved in the construction of the Bushehr nuclear plant were among the 44 passengers who died in a Tu-134 plane crash in Petrozavodsk. According to Amir Oren of Haaretz, the experts including lead designers Sergei Rizhov, Gennadi Benyok, Nicolai Tronov and Russia's top nuclear technological expert, Andrei Topinov, had all worked on Bushehr through Hydropress, one of the main companies responsible for Bushehr's construction.[238] Given that so much of the Bushehr plant has been about technical improvisation, it will be very hard to replace the Russian experts with firsthand knowledge of Bushehr's technical peculiarities.

Figure 43: Mostafa Ahmadi Roshan and son (Photo: AFP/Getty Images)

232 John Leyden, "Iran nuclear plant shutdown due to leak," The Register, 5 October 2010, <www.theregister.co.uk/2010/10/05/stuxnet_unrelated_nuke_plant_leak/>.

233 David Albright, Paul Brennan, and Christina Walrond, "Stuxnet Malware and Natanz: Update of ISIS December 22, 2010 Report," Institute for Science and International Security (report), 15 February 2011.

234 Ibid.

235 Ibid.

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