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## **Unprecedented Projected Nuclear Growth in the Middle East:<sup>1</sup> Now Is the Time to Create Effective Barriers to Proliferation**

**By David Albright and Andrea Scheel**

Large civil plutonium stocks are set to accumulate for the first time in the wider Middle East over the next two decades. Countries in this conflict-prone region are planning the construction of at least 12 to 13 new nuclear power reactors (Table 1).

Using a simple calculation to determine the expected plutonium discharge annually from these reactors, ISIS estimates that regional civil plutonium production could total more than 13,000 kilograms, or 13 tonnes by 2020, and nearly 45 tonnes by 2030 (Table 2). Given that just 8 kg of plutonium is enough to fabricate a nuclear weapon, this figure is significant. These quantities indicate that by 2020 the region may possess enough plutonium for almost 1,700 nuclear weapons.

To be usable in a nuclear weapon, this plutonium must first be separated from the irradiated fuel in reprocessing plants. Middle Eastern countries may seek to purchase civil reprocessing plants from suppliers or build them using their domestic capabilities and equipment purchased from abroad. To reduce the risk of proliferation in the Middle East and help lay the basis for a region-wide nuclear weapon free zone (NWFZ), the United States must ensure that plutonium is not separated from irradiated reactor fuel, insist on adequate international inspections of these countries, including the adoption of the Additional Protocol, and develop mechanisms to remove spent fuel from the region.<sup>2</sup> Absent such conditions, the incoming administration should discourage the development of nuclear power.

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<sup>1</sup> In this report, the Middle East is defined broadly. We include Iran, Egypt, Syria, Jordan, Saudi Arabia, Oman, Bahrain, Qatar, Kuwait, United Arab Emirates, Yemen, Tunisia, Algeria, Morocco, Iraq, and Israel. Turkey is also included, because of its proximity and relations to other countries in the region.

<sup>2</sup> U.S. President-elect Barack Obama has not explicitly addressed this issue. President-elect Obama has stated he would support a global five-year moratorium on the construction of enrichment and reprocessing facilities. See: <http://www.isis-online.org/publications/iran/CandidatesonIranandFuelCycleReport.pdf>

These goals are consistent with the recommendations of the Weapons of Mass Destruction Commission chaired by Hans Blix. This commission called on all states in the Middle East to commit themselves for a prolonged period of time to a verified arrangement not to have any enrichment, reprocessing or other sensitive fuel-cycle activities on their territories.<sup>3</sup>

Nuclear power has gained popularity in the Middle East due to projected power shortages in countries with growing populations. Oil producing nations also want to supplement domestic energy needs to allow for export of more oil and gas. Critics often note that oil exporting countries have little need to supplement existing energy sources with nuclear power. However, high international oil prices have led some oil exporting nations, flush with cash, to consider costly nuclear power reactors over other alternatives.

The United States and other Nuclear Supplier Group (NSG) countries have not succeeded in addressing the threat posed by looming plutonium stockpiles in the Middle East. Because of growing insecurity in the Middle East resulting from Iran's nuclear progress in defiance of United Nations Security Council demands, other countries will likely start to consider their own options, perhaps including the acquisition of nuclear weapons. Ensuring the absence of plutonium separation and uranium enrichment capabilities and minimizing stocks of plutonium will reduce the proliferation threat in this unstable region.

The United States should align its policies with the goal of reducing the risk posed by civil nuclear power programs especially in regions of tension like the Middle East. It should steadfastly discourage civil reprocessing of irradiated power reactor fuel both domestically and internationally. Where reprocessing already exists it should work to minimize the size of separated plutonium stockpiles. To reduce the threat of proliferation in the Middle East, the United States should work to accomplish the following goals:

### **A New Norm: No Supply of Nuclear Reactors without Additional Protocol in Force**

Suppliers of nuclear reactors should insist that a recipient country has the Additional Protocol in force. This condition is especially important in the Middle East.

An important indicator of increased risk of proliferation in the Middle East has been when a state does not implement the Additional Protocol. Traditional safeguards are not adequate to detect countries conducting secret plutonium separation or enrichment efforts. Iraq, Iran, Syria,

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<sup>3</sup> The Commission's 2006 final report recommends:

All States should support continued efforts to establish a zone free of weapons of mass destruction in the Middle East as a part of the overall peace process... As a confidence-building measure, all States in the region, including Iran and Israel, should commit themselves for a prolonged period of time to a verified arrangement not to have any enrichment, reprocessing or other sensitive fuel-cycle activities on their territories. Such a commitment should be coupled with reliable assurances about fuel-cycle services required for peaceful nuclear activities. Egypt, Iran and Israel should join the other States in the Middle East in ratifying the Comprehensive Nuclear-Test-Ban Treaty (CTBT).

*The WMDC Report: Weapons of Terror: Freeing the World of Nuclear, Biological, and Chemical Arms* (Stockholm: Weapons of Mass Destruction Commission and EO Grafiska, 2006), p. 8.

Algeria, and Libya evaded detection of their clandestine nuclear programs despite permitting traditional inspections by the International Atomic Energy Agency (IAEA). In the case of Libya, part of its evasion strategy was to refuse to accept the more intrusive inspections embodied in the IAEA's Additional Protocol. Without the Additional Protocol and often further transparency measures in place, the IAEA cannot provide adequate assurances that a country's nuclear energy program is purely civilian in nature.

Currently, of fifteen Middle Eastern countries that have expressed interest in nuclear power, fewer than half have signed or ratified the Additional Protocol.<sup>4</sup> Only Jordan, Turkey, Libya, and Kuwait have the Protocol in force; Iran, Iraq, Morocco, and Tunisia have signed it. Iran suspended its compliance with the Protocol in early 2006 in defiance of the UN Security Council. Despite this move, Russia has continued construction of the Bushehr reactor. Egypt announced in 2007 that it would not sign the Additional Protocol, yet Russia has given no indication that it will prevent its firms from bidding to build a nuclear reactor at El Dabaa.<sup>5</sup> The Obama administration should work to institutionalize the norm that the supply of a nuclear reactor requires that a state have the Additional Protocol in force.

## **Voluntary Moratorium on Reprocessing and Enrichment in the Middle East**

Middle Eastern countries seeking nuclear power should agree to a moratorium on the development of reprocessing and enrichment capabilities. Egypt has rejected such a moratorium. In September 2008, Egypt's ambassador to the United States Nabil Fahmy rejected such a moratorium saying, "if we're looking at enrichment by way of a proliferation issue, then...you bring in other factors, such as what are other states doing, who has it, who does not."<sup>6</sup>

The United Arab Emirates (UAE) has recently indicated that it may renounce acquisition of these capabilities and rely on supplier countries for both fuel provision and spent fuel repatriation. UAE Foreign Minister Sheikh Abdullah bin Zayed Al Nahyan stated that "the Government of the UAE has... adopted a policy renouncing the development of any domestic enrichment or reprocessing capabilities in favor of long-term arrangements for the external supply of nuclear fuel."<sup>7</sup> Such announcements are beneficial to reducing the threat of proliferation and should be encouraged as a matter of U.S. policy.

## **NSG Agreement Not to Provide Reprocessing and Enrichment Technology**

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<sup>4</sup> International Atomic Energy Agency, *Strengthened Safeguards System: Status of Additional Protocols, Latest Status Report*, Oct. 9, 2008. Available at: [http://www.iaea.org/OurWork/SV/Safeguards/sg\\_protocol.html](http://www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html)

<sup>5</sup> Maggie Michael, "Egypt Refuses to Sign U.N. Nuclear Watchdog Protocols for Stricter Inspections," Associated Press. Dec. 12, 2007.

<sup>6</sup> Miles Pomper and Peter Crail, "The Middle East and Nonproliferation: An Interview with Nabil Fahmy, Egyptian Ambassador to the United States," *Arms Control Today*, Vol. 38, Sept. 2008.

<sup>7</sup> Sheikh Abdullah bin Zayed al Nahyan, "Remarks by His Highness Sheikh Abdullah bin Zayed al Nahyan on the Occasion of the Public Launch of The UAE Policy on the Evaluation and Development of Peaceful Nuclear Energy," April 20, 2008. [http://www.uae-us.org/assets/File/White\\_Paper\\_Launch\\_HH\\_Sheikh\\_Abdullah\\_Speech\\_-\\_English.pdf](http://www.uae-us.org/assets/File/White_Paper_Launch_HH_Sheikh_Abdullah_Speech_-_English.pdf)

The NSG should agree to refuse sales of reprocessing and enrichment technologies to countries in the Middle East and elsewhere where proliferation remains a concern, including to countries that have not signed the Nuclear Non-Proliferation Treaty. A small number of Middle Eastern countries may argue that they need to purchase civil uranium enrichment or plutonium reprocessing technologies. They can be expected to argue that such facilities would serve as a regional supplier for enriched uranium fuel for power reactors, or a regional reprocessing plant, where plutonium could be extracted for recycling spent fuel for re-use in power reactors as mixed-oxide (MOX) fuel. Media reports said that the Turkish government is interested in obtaining an enrichment plant, though the government later denied such plans. Nonetheless, at the June 2008 NSG meeting, Turkey objected to a regional ban on the supply of uranium enrichment or reprocessing plants.

Such capabilities are not necessary in the Middle East for nuclear power to thrive at least during the next several decades, yet would significantly increase the risk of proliferation.

### **Spent Fuel Take-back and Fuel Assurances**

Reactor suppliers in cooperation with other NSG members and the IAEA should negotiate spent fuel take-back arrangements as well as a guaranteed fuel supply with Middle Eastern countries. Russia has done so with Iran's Bushehr reactor. Although these arrangements would leave a country with a considerable amount of plutonium-rich spent fuel, they would cap the amount of plutonium in the country and remove all of it after the reactor shuts down, preventing the emergence of "plutonium depots".

It is important that any take-back arrangements not be equivalent to reprocessing contracts with a supplier country, such as those that France and Britain signed years ago with Japan and several European countries. Otherwise, Middle Eastern countries could obtain nuclear weapons-usable plutonium in separated form or as MOX fuel.

### **Verifiable Fissile Cutoff Treaty**

The Obama administration should make a key priority of persuading Israel to join the negotiations of a universal, verified treaty that bans the production of plutonium and highly enriched uranium for nuclear explosives, commonly called the Fissile Material Cutoff Treaty (FMCT). As an interim step, the United States should press Israel to suspend any production of fissile material for nuclear weapons. Toward this goal, the United States should change its relatively new policy of seeking a cutoff treaty that does not include verification. The Bush administration's rejection of the long-standing U.S. policy of requiring verification was a mistake that the incoming administration needs to rectify.

### **Conclusion**

The initiatives outlined above would establish international confidence in the peaceful nature of Middle Eastern nuclear programs. These steps are vital to gaining the future support of all nations in the region for a Middle East zone free of nuclear weapons. An appropriate confidence building measure would include the re-creation of a multilateral negotiation forum for sustained

discussion about a regional NWFZ and other pressing security issues. Because of the volatility of the Middle East and the high potential for nuclear proliferation, the Obama administration must take the lead in creating more effective barriers to proliferation before these nuclear reactors are constructed.

# TABLE 1 MIDDLE EAST NUCLEAR REACTOR PROJECTS - November 2008

Country	Reactors Operable 2009-2010				Reactor Start-up Planned or Possible 2014				between 2015-2017				Reactor Construction Planned 2020				between 2025			
	Site	No.	MWe	Type	Site	No.	MWe	Type	Site	No.	MWe	Type	Site	No.	MWe	Type	Site	No.	MWe	Type
Iran	Bushehr	1	1000	PWR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	Darhovin	1	360	PWR	0	0	0	0	0	0	0	0
Turkey	0	0	0	0	Akkuyu	4	4000	PWR	0	0	0	0	0	0	0	0	0	0	0	0
Egypt	0	0	0	0	0	0	0	0	El Dabaa	1	1000	?	0	0	0	0	0	0	0	0
Jordan	0	0	0	0	0	0	0	0	Aqaba	1	1600	PWR	0	0	0	0	0	0	0	0
Morocco	0	0	0	0	0	0	0	0	Sidi Boulbra	1	1000	PWR	0	0	0	0	0	0	0	0
UAE (GCC)*	0	0	0	0	0	0	0	0	Abu Dhabi	2	3200	PWR	0	0	0	0	0	0	0	0
Tunisia	0	0	0	0	0	0	0	0	0	0	0	0	?	1	900	?	0	0	0	0
Algeria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	?	?	?
Libya	0	0	0	0	0	0	0	0	0	0	0	0	?	?	?	?	0	0	0	0
Yemen**	0	0	0	0	0	0	0	0	<del>?</del>	<del>5</del>	<del>5000</del>	<del>PWR?</del>	0	0	0	0	0	0	0	0

\*GCC= Gulf Cooperation Council; United Arab Emirates will be the main site of nuclear power consortium for GCC countries, including the UAE, Bahrain, Kuwait, Oman, Qatar, and Saudi Arabia

\*\*Yemen- project plans currently canceled, as indicated by strike-through; not calculated in plutonium estimates

**How this data was compiled:**

News reports containing official government announcements were chiefly used to create this table. Where necessary, extrapolations were made regarding probable dates of reactor construction, likely megawatt electric (MWe) output, and anticipated number of plants, where reports conflicted. Some data will likely change as reactor plans are finalized.

**TABLE 2 MIDDLE EAST CUMULATIVE PLUTONIUM ESTIMATES (kg Pu discharged per GWe net)**

Country	Reactor	No-Type	MWe	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Iran	Bushehr	1-VVER PWR	1000	65	195	390	650	910	1170	1430	1625	1755	1820	1820	1820	1820	1820	1820	1820	1820	1820	1820	1820	1820
	Darkhovin	1-? PWR	360	0	0	0	0	0	0	0	23.4	70.2	140.4	234	327.6	421.2	514.8	608.4	702	795.6	889.2	982.8	1076	1170
Turkey	Akkuyu	4-VVER PWR?	4000	0	0	0	0	65	325	910	1950	2990	4030	5070	6110	7150	8190	9230	10270	11310	12350	13390	14430	15470
Egypt	El Dabaa	1-VVER PWR?	1000	0	0	0	0	0	65	195	390	650	910	1170	1430	1690	1950	2210	2470	2730	2990	3250	3510	3770
Jordan	Aqaba	1-EPR PWR	1600	0	0	0	0	0	104	312	624	1040	1456	1872	2288	2704	3120	3536	3952	4368	4784	5200	5616	6032
Morocco	Sidi Boulbra	1-VVER PWR	1000	0	0	0	0	0	0	65	195	390	650	910	1170	1430	1690	1950	2210	2470	2730	2990	3250	3510
UAE (GCC)	Abu Dhabi	2-EPR PWR	3200	0	0	0	0	0	0	0	208	624	1248	2080	2912	3744	4576	5408	6240	7072	7904	8736	9568	10400
Tunisia	?	1-PWR?	900	0	0	0	0	0	0	0	0	0	0	58.5	175.5	351	585	819	1053	1287	1521	1755	1989	2223
Algeria	?	?	?	0	0	0	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?
Libya	?	?	?	0	0	0	0	0	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?
Yemen	canceled	5-? (PWR)	5000	0	0	0	0	0	0	0	325	975	1950	3250	4550	5850	7150	8450	9750	11050	12350	13650	14950	16250
<b>TOTAL kg Pu produced/year (cumulative)</b>				<b>65</b>	<b>195</b>	<b>390</b>	<b>650</b>	<b>975</b>	<b>1664</b>	<b>2912</b>	<b>5015</b>	<b>7519</b>	<b>10254</b>	<b>13215</b>	<b>16233</b>	<b>19310</b>	<b>22446</b>	<b>25581</b>	<b>28717</b>	<b>31853</b>	<b>34988</b>	<b>38124</b>	<b>41259</b>	<b>44395</b>

**ESTIMATED Pu TOTALS BY COUNTRY- 2020**

Turkey	5070																							
UAE	2080																							
Iran	2054																							
Jordan	1872																							
Egypt	1170																							
Morocco	910																							
Tunisia	58.5																							
<b>TOTAL</b>	<b>13214.5</b>																							

**ESTIMATED Pu TOTALS BY COUNTRY- 2030**

Turkey	15470																							
UAE	10400																							
Jordan	6032																							
Egypt	3770																							
Morocco	3510																							
Iran	2990																							
Tunisia	2223																							
<b>TOTAL</b>	<b>44395</b>																							

**How these calculations were determined:**

- In the case of Turkey, the first reactor is estimated to discharge its first irradiated fuel in 2014, the second in 2015, the third in 2016, and the fourth in 2017.
- Take back of Bushehr fuel is expected to start seven years after the first spent fuel discharge, or in 2017. Each year, the oldest discharged fuel is removed. The rest remains in the spent fuel ponds. After 2019, the amount of plutonium residing in the spent fuel in Iran is expected to remain constant.

For methodology used in determining plutonium estimates, including plutonium discharge rates by reactor type, see David Albright, Frans Berkhout, and William Walker, *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities and Policies* (Oxford: Stockholm International Peace Research Institute and Oxford University Press, 1997), Appendix B.