Further Construction Progress on the Fourth Heavy Water Reactor at Khushab Nuclear Site

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Pakistan's Khushab nuclear site is located 200 kilometers south of Islamabad and is dedicated to the production of plutonium for nuclear weapons. Originally, the site consisted of a heavy water production plant and a heavy water reactor, both of which became operational in the 1990s. However, Pakistan initiated the construction of a second heavy water reactor between the year 2000 and 2002, a third one in 2006, and the fourth one in 2011. Therefore, today, Pakistan's Khushab nuclear site consists of a heavy water production plant, an original, estimated 50 megawatt-thermal (MWth) heavy water reactor, two heavy water reactors (reactors 2 and 3) that appear to be operational, and a fourth reactor under construction (see figure 1).

The expansion of the Khushab nuclear site with the addition of reactors 2, 3 and 4 appears to be part of a strategic effort by Pakistan to boost weapon-grade plutonium production. This increased capability would allow Pakistan to build a larger number of miniaturized plutonium-based nuclear weapons in order to complement its existing arsenal of highly enriched uranium weapons.

Pakistan has not provided any public information about these three new reactors, or the power output of the original one, estimated to be 50MWth. The three newer reactors are assessed as generating more power than the first one and thus capable of producing more weapon-grade plutonium per year. A technical consultant to ISIS with years of experience in heavy water reactors also assesses that the power of these newer heavy water reactors is likely to be larger than the first one and that over time their power could be increased. The increase in power can be accomplished by using more advanced fuel or adding heat removal capacity.

For years, ISIS has monitored developments at the Khushab complex using commercial satellite imagery to catalog changes at the site, which are contained in reports available on the ISIS website.

ISIS has also been closely monitoring the construction of Khushab's fourth reactor since 2011. As figure 2 shows, Pakistan started the construction of the fourth reactor at the end of 2010/early 2011. A January 2011 image shows the building early in its construction. It is evident that the reactor building size, as well as the overall layout, is very similar to the size and layout of reactors 2 and 3.[1] In April

[1] David Albright and Paul Brannan, *Pakistan Appears to be Building a Fourth Military Reactor at the Khushab Nuclear Site*, February 9, 2011, http://isis-online.org/isis-reports/detail/pakistan-appears-to-be-building-a-fourth-military-reactor-at-the-khushab-nu/12#images.

2011, the frame of the reactor building and the main reactor hall are visible, although it is not clear if there is a reactor vessel in the center of the hall.[2]

In a May 21, 2012 *ISIS Imagery Brief*, ISIS highlighted enhanced security perimeters surrounding all nuclear facilities at the site, certainly a welcome development, and noted the construction on the fourth Khushab heavy water reactor was halfway to completion. As shown in both figures 2 and 3, imagery dated April 2012 clearly indicated that the fourth reactor building was still under construction. At the time, although the reactor building still lacked roofing, the reactor vessel was not visible within the chamber. Recent imagery from November 1, 2013, however, clearly shows that the external construction of the fourth reactor building appears nearly complete (see figure 2 and 3). The immediate area of the fourth reactor exhibits the same layout as reactors 2 and 3. The reactor stack and four of the six auxiliary buildings also present in reactors 2 and 3 appear complete. Two support buildings located immediately to the west of the reactor building are still under construction. The initial section of the cooling tower row is also visible and compared to reactors 2 and 3 appears about 30% complete. What appears to be an electrical substation, also present near reactors 2 and 3, has been constructed 150 meters north of the fourth reactor building.

However, beyond the immediate vicinity, the wider layout of the fourth reactor complex exhibits numerous differences when compared to that of reactors 2 and 3. A set of three identical buildings not seen in the layout of reactors 2 and 3 has been completed north of reactor 4 building. A number of smaller support buildings are under construction east of the reactor while clearings for several other buildings can be seen to the south-east.

Work on the fourth reactor has proceeded at a slower pace than previously predicted, which could be due to the differences in layout or to factors not evident in satellite imagery. Although work on the immediate area of the fourth reactor might be near completion, the November 2013 image shows that a considerable amount of additional construction is still in progress.

Given that satellite imagery provides limited indication of the reactor's operational status, predicting when the fourth reactor will become operational is difficult.

Pakistan is believed to have depended on illicit procurements for the Khushab reactors. An April 2011 ISIS Report shows that under the cover of a Chashma nuclear power reactor procurement organization, Pakistan was operating an illegal network in the United States to procure goods, such as radiation detection equipment and nuclear grade resins, likely for the Khushab reactors and possibly the associated reprocessing plants at Chashma and Rawalpindi.[3] Additionally, according to a recent ISIS report, "*The Future World of Illicit Nuclear Trade: Mitigating the Threat*" Pakistan is expected to maintain or improve its nuclear arsenal via illicit nuclear trade.

Although it remains unknown whether Pakistan intends to build a fifth reactor next to the fourth (as it did with reactors 2 and 3), there is no indication in the recent imagery of any construction of such a facility.

[2] David Albright and Paul Brannan, *Pakistan Doubling Rate of Making Nuclear Weapons: Time for Pakistan to Reverse Course*, May 16, 2011, http://isis-online.org/isis-reports/detail/pakistan-doubling-rate-of-making-nuclear-weapons-time-for-pakistan-to-rever/12#images.

[3] David Albright and Andrea Stricker, *Case Study - Man Charged with Exporting U.S. Goods to Pakistan's Nuclear Program*, ISIS. Report, April 14, 2011, http://isis-online.org/isis-reports/detail/man-charged-with-exporting-u.s.-goods-to-pakistans-nuclear-program/.

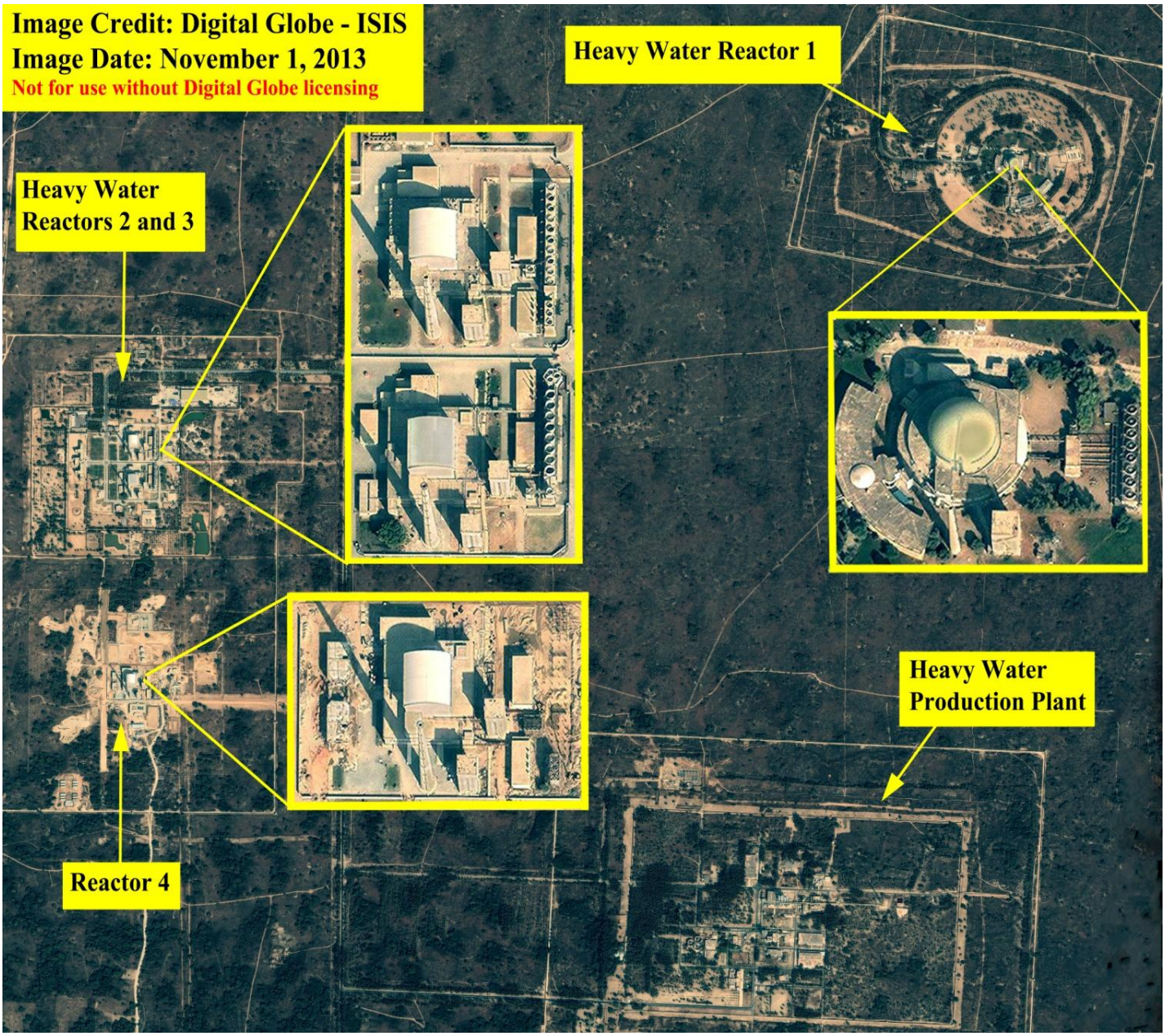

Figure 1. Digital Globe imagery of the Khushab nuclear site on November 1, 2013.

Figure 2. Digital Globe/Newsweek/GeoEye imagery showing the evolution of the fourth Khushab reactor between January 2011 and November 2013.

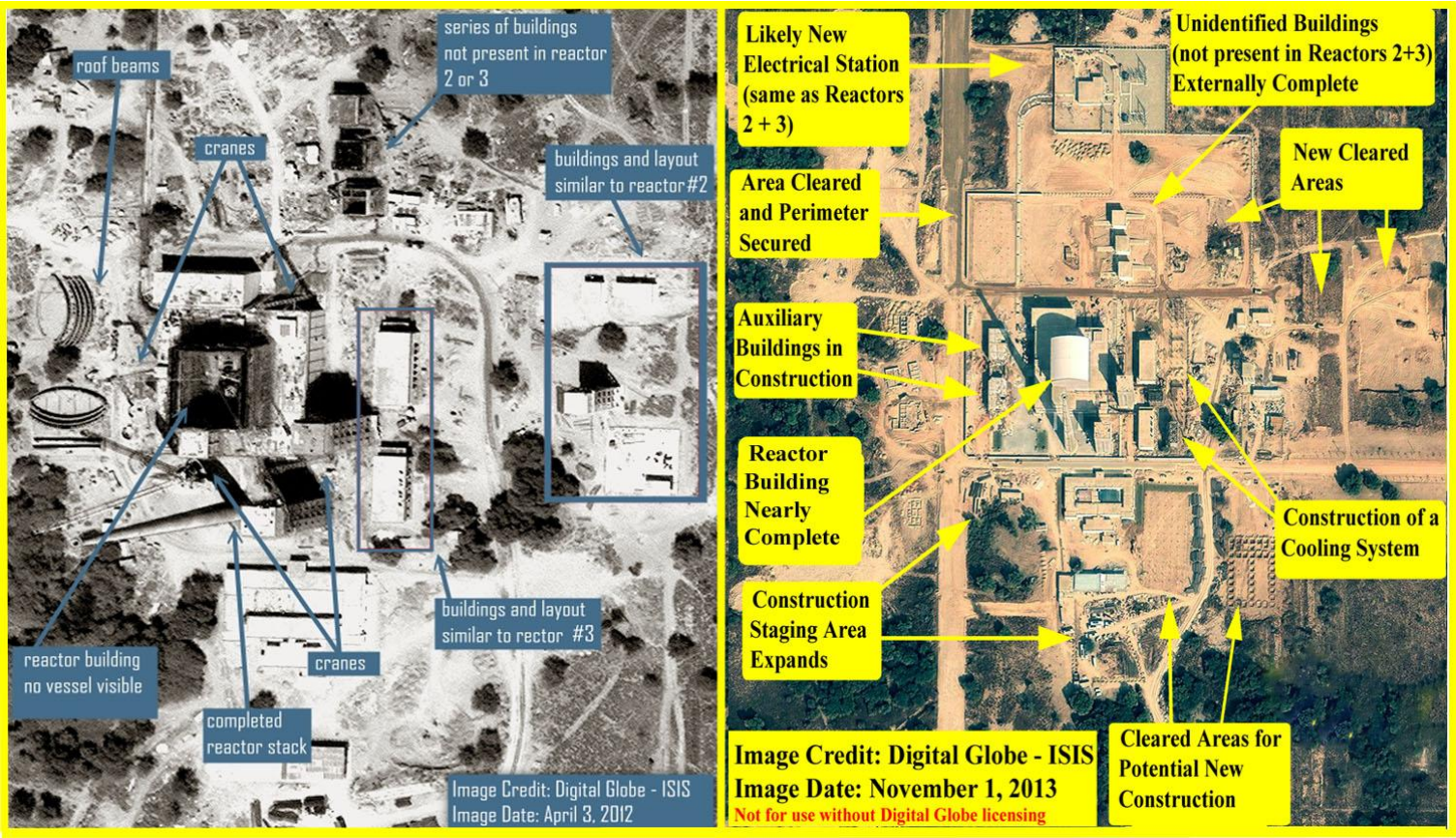

Figure 3. Digital Globe imagery showing the evolution of the fourth Khushab reactor between April 2012 and November 2013.