

## **Further Discussion of the New, Large Khushab Reactor**

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Since the release of our report on the Khushab site in Pakistan, we have received several comments and criticisms and we want to share our reaction and some additional information. Some people have pointed out that the footprint of the first Khushab reactor is similar in size to the one under construction, implying that the power of both reactors is similar. However, in examining reactors, particularly those for military production, the building size is a poor indicator of the reactor's power. In addition, the reactor buildings and their associated surface facilities look noticeably different, so the new reactor does not appear to be a replica, and it is logical to assume it serves a different purpose than the first reactor.

Moreover, construction of the new reactor started soon after the first began operations, undermining the argument that the second reactor is a one-to-one replacement of the first. If, on the other hand, the first reactor had failed completely soon after starting, requiring a replacement reactor, then construction of the second reactor would have been expected to be rapid, which it isn't, again undermining the argument.

We remain convinced that a better indicator of a reactor's potential power is the size of the reactor vessel. The operating reactor vessel is significantly smaller than the vessel with a five-meter diameter under construction, according to knowledgeable sources who have examined imagery of both vessels.

The vessel in the reactor under construction is about the same size as the vessels or tanks of the production reactors at the Savannah River Production facility. These are reactors which started in the mid-1950s operating at a nameplate power of about 300 MWth. But the operators were soon able to increase their power to between 500 and 1000 MWth. Within a decade, the reactors had been increased to over 2000 MWth. Given the expense of heavy water, Pakistan would be under pressure to use the vessel efficiently. With this assumption, it is straightforward to arrive at the estimate that the reactor is capable of operating in excess of 1000 MWth, according to an expert in building and operating heavy water production reactors. It is true that Pakistan could operate their reactor at less than its maximum potential power, but the capability remains and could be developed over time. In any case, this new reactor will provide Pakistan with a significant increase in annual plutonium production.

The most straightforward design would use heavy water as both a moderator and a cooling agent. Alternatively, if heavy water was in short supply, the design could use heavy water as a moderator and regular water as a coolant. This design would require about half as much heavy water, but would have a slight decrease in total power.

Thomas B. Chochran of the Natural Resources Defense Council suggested that the circular object is thick concrete and metal shielding meant to block high heat and dangerous radiation from a reactor that could be much smaller—implying that Pakistan would first construct the shield before the reactor vessel. However, reactors are typically not built in such a way. Rather, the reactor vessel itself is built first, and then the wall shielding heat and radiation is constructed around it afterwards. In the case of the construction of the new Khushab reactor, there appears to be only one round metal object, thus signifying it as the reactor vessel. In addition, the metal rings comprising the new reactor vessel were originally seen piled outside the reactor building. They were then hoisted inside the building using a crane and welded together inside the building. The metal used in conjunction with concrete in a shield would be in the form of small pieces of wire and rebar. The round metal structure visible in the new reactor site at Khushab, appears to be more substantial and not very likely to be comprised of wire or rebar. Therefore, Chochran's speculation that the round object is shielding the reactor vessel and not the reactor vessel itself is in our opinion unlikely.

On reflection, we believe our conclusion about the potential size of the reactor remains justified, based both on the available information and our calculations. We cannot know now what power this reactor will ultimately reach; however, this reactor is capable of providing Pakistan with a large supply of plutonium many times greater than its current annual output. We continue to welcome comments and encourage a full debate on this new reactor and its implications for regional and international security.