NATURE | NEWS

Iran’s nuclear plan revealed

Report paints detailed picture of nation’s intention to build a warhead.

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A report released last week by the International Atomic Energy Agency (IAEA) on Iran’s alleged research into nuclear weapons assembles old intelligence into the sharpest picture yet of the weapon that Iran hopes to develop.

The 8 November report is also the IAEA’s strongest statement to date that Iran’s activities violate the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), which explicitly prohibits the development of weapons.

It “contains no new information”, says Ali Vaez, director of the ‘Iran Project’ at the Federation of American Scientists, a think tank based in Washington DC. But by focusing on what is known about Iran’s efforts to build or buy the technologies needed for a bomb, the report suggests that the country is working towards a relatively sophisticated device that could fit on board a medium-range ballistic missile — making it much more difficult to intercept and destroy than one delivered by an aeroplane.

The IAEA, an organization based in Vienna that monitors the nuclear facilities of NPT signatories, has been monitoring Iran’s uranium-enrichment facilities for more than a decade. Those facilities use centrifuges to concentrate the fissile uranium-235 isotope, which makes up less than 1% of natural uranium. When enriched to 3.5–5% of the isotope, uranium can serve as a nuclear fuel; above 90%, it can be used to make a nuclear bomb.

Iran has insisted that its centrifuges are only making fuel-grade uranium, and it has given IAEA inspectors limited access to its facilities. But many questions remain about the nation’s activities and plans to expand its enrichment programme, and most of the IAEA’s reports on Iran have focused on those efforts.

Last week’s report, however, described what is known about Iran’s development of the technologies needed for a nuclear weapon. This includes techniques for shaping uranium metal, something that is

not usually needed in civilian nuclear reactors but is required to make the precisely machined components that can power a nuclear explosion.

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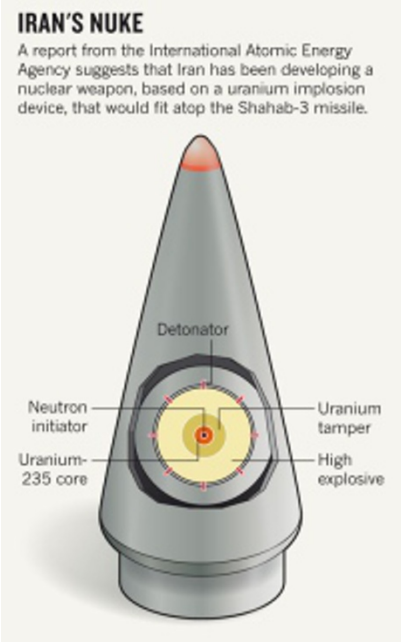
Iranian researchers have also been testing high explosives on tungsten, a dense metal that can serve as a surrogate for uranium. Such studies would be needed if they wanted to compress uranium to the critical mass needed for a self-sustaining nuclear reaction. And they have been looking at devices that, when compressed rapidly, produce bursts of neutrons that could trigger a nuclear chain reaction. The mass and shape of the materials tested seem to be designed to fit atop the Shahab-3, a medium-range ballistic missile developed by Iran.

The agency says that much of the work has been done at the Malek-Ashtar University of Technology in Tehran, but Shahid Beheshti University and Amirkabir University of Technology have also been implicated. A year ago, Majid Shahriari, a nuclear physicist at Shahid Beheshti University, was killed in a bombing by unknown assassins (see *Nature* **468,** 607; 2010).

Weapon design

The work outlined in the report suggests that Iran aims to create a weapon with an “implosion” design, says James Acton, a physicist with the Carnegie Endowment for International Peace, a non-profit think tank in Washington DC. The bomb would be detonated by high explosives surrounding a hollow sphere of highly enriched uranium (see ‘Iran’s nuke’). The core of the sphere would carry a small neutron initiator, possibly made of uranium and the heavy hydrogen isotope, deuterium.

When the explosives detonate in unison, they compress the sphere, squeezing the uranium to its critical mass. Near the point of maximum compression, the deuterium nuclei in the centre would fuse, releasing a burst of neutrons that would trigger the nuclear explosion. The device may also have an outer shell, or ‘tamper’, of low-enriched uranium, designed to hold the weapon together for a fraction of a second longer, further boosting its yield. Acton guesses that this kind of weapon could have a yield of around 10–30 kilotonnes of TNT equivalent, roughly the same as the bomb that fell on Nagasaki in Japan in 1945.



The advantage of the design is that it makes efficient use of uranium-235, so the device would be small enough to fit on a missile. The approach is similar to Pakistan’s early warheads, which were also thought to be uranium-based. Unlike the warheads of the major nuclear countries, the Iranian design would not contain a second fusion stage, which can boost a weapon’s yield into the 100-kilotonne range.

But even a simple implosion device is not an easy option. If the high explosives aren’t detonated simultaneously, then the bomb will fail to explode properly and won’t deliver its maximum yield. Many observers believe that this was the fate of North Korea’s first nuclear test, conducted in 2006 (see *Nature* **443,** 610–611; 2006), although a second test in 2009 seems to have been more successful.

Iran’s choice of uranium could also complicate its nuclear efforts. Most nuclear weapons use plutonium-239, because it captures neutrons better and emits more neutrons as it splits, giving it greater explosive power. The advantage of uranium over plutonium, however, is that it requires smaller production facilities, which are easier to hide.

Some analysts, including Vaez, are unimpressed by the IAEA’s latest report, saying that much of the content dates from the turn of the millennium, and that it does not indicate how far the programme has progressed. But Vaez notes that “it is unprecedented in the scale and scope of the detailed information that it has bared to the public”. That suggests to him that it may be a political push to encourage Russia and China to impose sanctions against Iran.

Acton agrees, although he adds that the report is unlikely to have that effect. For the countries that support Iran's right to enrich uranium for civilian use, political allegiances will always trump technical details, he says. "More evidence is not going to necessarily lead them to change their positions."

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