Parsing claims of North Korean 'miniaturisation'

The extent of North Korea's progress towards a viable and deliverable nuclear weapon is one of the biggest questions facing the United States and Pyongyang's neighbours in Northeast Asia. **Robert Kelley** examines the evidence at hand

Several organisations and individuals have recently issued statements on how close North Korea is to reducing the size of its nuclear explosive devices so that they are able to fit on a missile currently in their arsenal. These statements rely on data that is not publicly available, but have subsequently been cited by South Korean policymakers to justify more aggressive postures towards Pyongyang.

North Korea conducted three nuclear tests – in September 2006, February 2009, and February 2013 – but very little information is available about the design of the tests or the nuclear devices used.

The first test probably used plutonium as the fuel. The yield – about 1 kt – was very low and the test is thought to have been a failure. However, if properly instrumented and diagnosed the test could have provided important knowledge for the designers.

In the second test the yield increased substantially. It is thought to have also been a plutonium device but no radioactive debris was collected, or at least reported publicly.

The third test was even larger and was predicted to have used uranium as the fuel: a belief based on the discovery of uranium enrichment centrifuges, which is a weak extrapolation. However, no radioisotopes were detected in the aftermath of the explosion, meaning it is not possible to distinguish whether the device had a uranium, plutonium, or mixed (composite) fissile core.

Research published by Johns Hopkins University claimed North Korea is now one test away "from success". This seems unlikely given it has probably only conducted two plutonium tests, of which only one was successful.

Chinese scientist Li Bin, a nuclear policy expert associated with Johns Hopkins, believes North Korea had to add chemical high explosives to the second nuclear test to make it work properly. High explosives are used to compress a sub-critical into a critical configuration. An uneven or under-powered explosion will result in a sub-optimal yield, as would incorrectly timed neutron injection or a number of other faults.

Li has not offered proof for his theory but does refer to open-source assertions that North Korea has conducted more than 100 high-explosive experiments since 1980, suggesting it is well aware of the properties of high-explosively driven fissile (or surrogate fissile) materials.

However, a researcher at the Korean Institute for Defence Analysis (KIDA) cites the same 100 conventional high-explosive tests as a reason to believe that North Korea is on the verge of being successful at reducing warhead size. He told *IHS Jane's* that "the firing mechanism remains the last key issue North Korean scientists need tackle in order to reach their objective".

Firing mechanisms are electronic devices that detonate the high explosives that compress fissile materials to initiate a nuclear explosion. They can be tested repeatedly in laboratory circumstances and do not require a full-yield nuclear test. Instead, North Korean scientists would fire the electronics repeatedly with simple timing diagnostics until they had a long history of statistical successes.

Once they had success with electronics timing and reliability, they could do a few implosion tests with surrogate nuclear materials as a final proof before a full-scale nuclear explosion. Therefore, the suggestion that firing systems are a stumbling block for North Korea is not credible; there is no reason to believe they are a key limiting technology.

A third way?

Both researchers also understate the importance of miniaturising a highly enriched uranium (HEU) warhead. When compared with implosion warheads using HEU, gun-type warheads are highly inefficient in their use of nuclear material, being only about 30% as efficient as their implosion brethren. However, they can be safe, simple, and reliable, and can be made easily deliverable by missile.

Examples of the gun-type warhead include the South African nuclear programme of the 1970s/1980s where designers decided the missile-delivered deterrent did not require a nuclear test and was probably completely effective.

Of even greater relevance is the family of early nuclear artillery shells developed by the United States. These simple devices weighed as little as 110 kg and gave unboosted yields of about 1 kt up to the 40 kt high yield (boosted) option of the later W-33 (T-137) 203 mm atomic projectile.

It is also worth noting that one US gun-type weapon, the T-1 Atomic Demolition Munition, was reportedly developed in the US Army's Picatinny Arsenal and not in a nuclear weapon laboratory. Hence, advanced nuclear science and engineering are not even necessary for a project that was first demonstrated in the 1940s.

As the recent statements on North Korea's progress on miniaturisation are not based on publicly available data, they can best be described as extrapolations by analysts with no known nuclear weapon design experience. This would be unimportant if it were not for the fact that their conclusions appear to be reaching key South Korean defence officials.

"I believe North Korea has made considerable progress in warhead miniaturisation," Admiral Choi Yun-hee, incoming chairman of South Korea's Joint Chiefs of Staff, said in October at his parliamentary confirmation hearing. He added: "If there is a possibility of the North using nuclear weapons and imminent danger, we have to launch a pre-emptive strike."

Recent events in other parts of the world have shown dangers of basing policy regarding weapons of mass destruction on extrapolation. In South Korea's case it should not be the basis for a pre-emptive strike that could start a war.

Robert Kelley *is a former nuclear weapon analyst at the US Los Alamos National Laboratory and a director at the IAEA*

4 DECEMBER 2013 VOL 50 • ISSUE 49

IHS Jane's Defence Weekly

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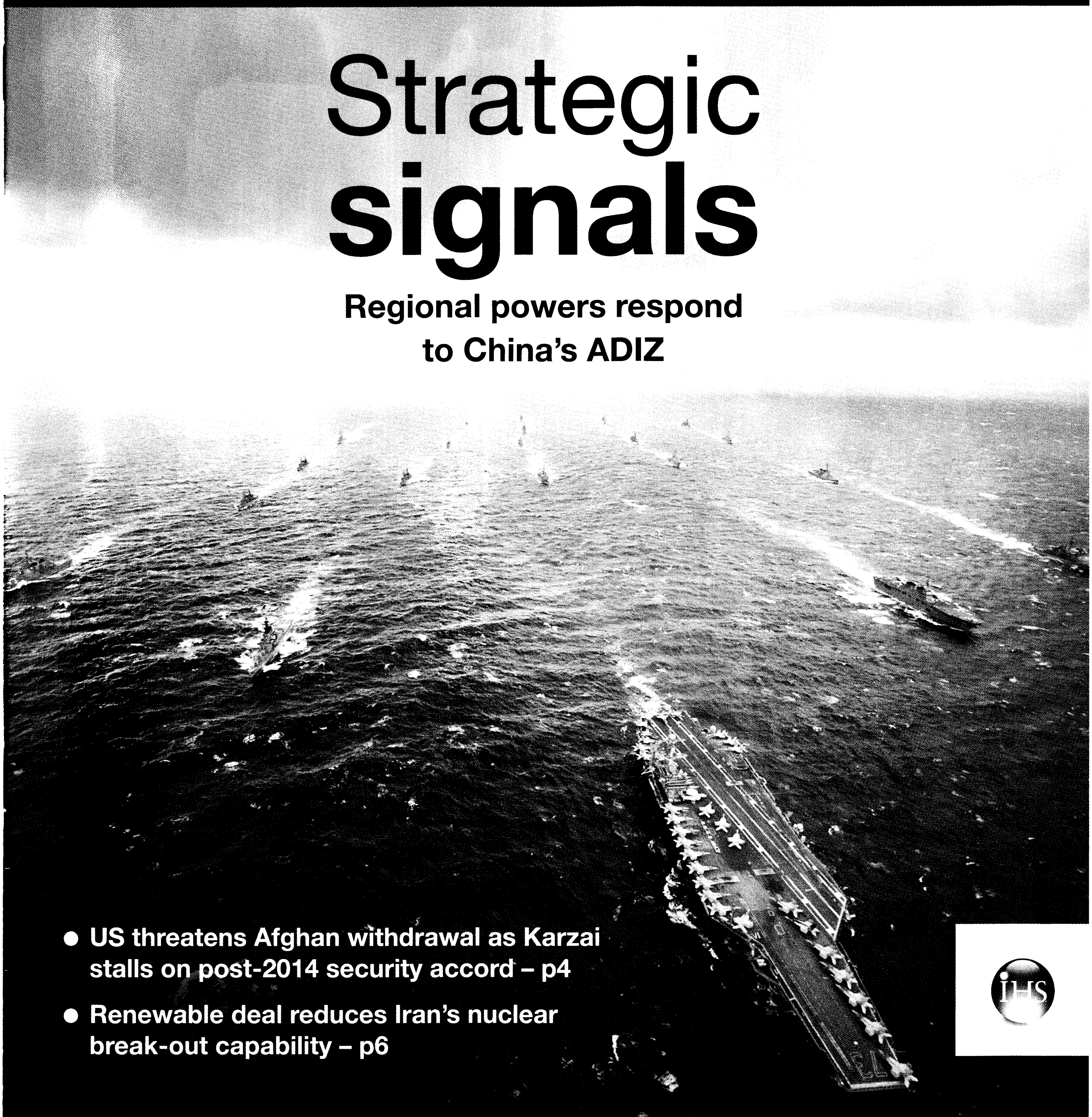

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