**'Pit-Stuffing': How to Disable Thousands of Warheads and Easily Verify Their Dismantlement**

by Matthew Bunn

Technology exists which makes it possible to disable thousands of nuclear warheads, rapidly, permanently, and verifiably -- and to verify their dismantlement with a minimum of cost and intrusion.

This technology, which might be called "pit-stuffing," was originally developed by the Los Alamos National Laboratory to ensure that warheads that had been determined to be unsafe would not go off accidentally -- but it has never been applied to arms control. How does it work? Every modern "boosted" nuclear weapon has at its core a "pit" -- a hollow sphere of plutonium or highly-enriched uranium, with a tiny tube through it that allows the tritium to be fed into the hollow inside the sphere. If a steel wire is fed in through this small tube until the inside of the pit is "stuffed" with tangled wire, the pit can no longer be compressed enough by the explosives surrounding it to sustain a nuclear chain reaction -- the weapon is physically incapable of going off.

I believe this "safing" technology should be applied to permanently disable nuclear weapons. If the end of the wire is pushed inside the sphere, it cannot be pulled back out -- the weapon is permanently disabled. The only way to get the weapon to work again is to dismantle it, remove the pit, cut the pit open and take the wire out, remanufacture the pit, and reassemble the weapon -- a long and costly process. (While it might be possible to develop a means to pull the wire back out through the tube, it should also be possible to fray the end of the wire before pushing it in, making it impossible to pull it back out. Additional "red team" studies should be done to confirm this.)

In the past, the rate at which the costly and time-consuming process of dismantling nuclear weapons could be accomplished posed a physical limit on how rapidly nuclear arms could be reduced. Pit-stuffing overcomes that problem; in principle, it would be possible to disable thousands of nuclear weapons in just a few weeks. The physical act of stuffing the pit takes only one or two minutes for one person, using a small device developed for the "safing" mission at Los Alamos -- though disabling "live" warheads would take somewhat longer, because of the necessary safety procedures involved in doing anything at all to a nuclear weapon.

Once the pit has been stuffed with wire, this fact can be easily confirmed by a variety of means, such as a gamma-ray image of only, for example, one square inch of the pit. It should be possible to devise simple means to confirm the presence of the wire without revealing substantial design information.

This approach would also make it possible to verify warhead dismantlement with minimal cost and intrusiveness. Inspectors could observe as technical experts from the inspected party inserted the wires into the pits of warheads that were to be dismantled in the future. Since the inspected party would do the actual insertion, very little design information would be revealed. Wires could be inserted into the pits of all weapons the parties had agreed to eliminate. Since this

disablement can be accomplished very rapidly, each inspection visit could witness the disablement of hundreds of warheads, so only a few inspection trips would be required.

Then the inspectors would leave, and the inspected party would dismantle the warheads on whatever schedule was convenient, in complete privacy. After the dismantlement was complete, the inspectors would return and be shown the canisters containing the "stuffed" pits. By taking gamma-ray images as described above, the inspectors could confirm that the containers contained hollow spheres of plutonium stuffed with tangled wire -- a virtually sure sign that these were in fact the pits from the warheads observed before, which had been dismantled in the interim. (In the current post-Cold War environment, and with Russia's collapsing federal budget, it appears highly implausible that either side would go to the enormous trouble of manufacturing thousands of hollow plutonium spheres stuffed with wire just to fool the other side about its warhead dismantlement.)

In a certain sense, the wire can be thought of as a tag placed inside the pit, rather than on the surface of the warhead, so that it stays with the pit through the process of dismantlement, and can be checked after dismantlement is complete. If the two governments wanted even higher confidence, each wire could probably have a unique gamma-ray fluorescent tag, which would allow it to be uniquely identified from outside the pit canister, matching the "stuffed" pit with the specific warhead into which that particular wire was stuffed. The feasibility of such tags needs to be examined further, however, along with the long-term compatibility of the tag material and the plutonium of the pit. Another approach to such unique matching of pits to the warheads from which they came would be to take a somewhat more elaborate gamma-ray image of the tangled wire inside each warhead, from several different angles, after the wire was inserted; after dismantlement, similar images could be taken of a few of the pits, selected at random, making it possible to match the unique tangles of wire inside to the tangles inside the warheads from which the pits came.

Thus, a limited number of inspections that would reveal very little design information could potentially offer high confidence that particular observed nuclear weapons had in fact been dismantled, with that dismantlement resulting in particular observed stockpiles of pits. Moreover, the pits would now be unusable in weapons unless they were remanufactured. No presence within the confines of the dismantlement facility itself would be required, and no information concerning warhead production, or warhead dismantlement and remanufacturing for maintenance purposes, would be revealed. Most of the other approaches that have been considered for verifying the dismantlement of nuclear warheads -- such as setting up perimeters around the dismantlement facility and counting the number of warheads coming in and the pits coming out -- involve far higher costs and greater intrusiveness, or do not achieve as high confidence. And these other approaches do nothing to prevent the pits from being reassembled into new weapons, unlike pit stuffing. In addition, pit-stuffing can be applied to the thousands of pits from warheads that have already been dismantled. This would ensure that these pits, too, could not be re-used without being cut open and remanufactured, and identical inspections, by showing that the item in the canister was a hollow sphere of plutonium stuffed with wire, would help to confirm that these were in fact pits from previously dismantled weapons, and not some other form of plutonium.

Of course, a steel wire is only one of many things that could be used to "stuff" the pits. Originally, for ensuring the safety of the unsafe weapons, aluminum powder was used -- which could be removed by simply shaking the powder back out through the hole. Another approach was to fill the inside of the pit with epoxy -- but putting anything organic in with the plutonium leads to chemical reactions that reduce long-term safety, and the bonding of the epoxy and the plutonium made the pit a "mixed waste" (both radioactive and toxic) under U.S. regulations. The idea of the steel wire was to make it possible to "stuff" the pits in a way that would have no impact at all on the safety of long-term storage, either of the weapons, or of the pits themselves after the weapons were dismantled. Another possibility would be to stuff the pit with hundreds of tiny "barbells" whose wide parts are just small enough to fit in through the tube -- making it virtually impossible to shake or pull them back out.

U.S. and Russian experts should be directed to immediately begin working together to analyze the pros and cons of pit-stuffing. Studies should be undertaken to examine:

- means to ensure that the wires cannot be removed without cutting open the pit;
- the safety of the stuffed pits during long-term storage and pit disassembly;
- the best approaches to verifying the presence of the wire without compromising sensitive design information; and
- the best approaches to uniquely matching a stuffed "pit" to the warhead from which it came, should political leaders decide they want such a capability.

Within a few months, it should be possible to answer these questions and confirm the potential of pit-stuffing.

Pit-stuffing has the potential to be a remarkable new tool in the arms control toolbox, enabling fast dramatic reductions in nuclear arms -- and verification that those arms have really been dismantled. This approach could make a huge contribution to the goal of ensuring the "transparency" and "irreversibility" of nuclear arms reductions, repeatedly agreed to by Presidents Clinton and Yeltsin. This technology can offer policy-makers new options -- and deprive them of excuses for not pursuing deep, transparent, and irreversible reductions in nuclear arms.