

# Irreversibility in Nuclear Disarmament: Lessons learned from South Africa, Iraq, and Libya

## Talking Points

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Thank you for inviting me to this important conference!

The lessons from the denuclearization of South Africa, Iraq, and Libya have influenced me greatly as I think about future denuclearization efforts. I am very glad to share those insights with you today.

“Irreversible Nuclear Disarmament” requires two things:

One, the disarmament must be verified

Two, something or some process prevents a country from reversing course and reacquiring a nuclear weapons program.

Most of my research has focused on verifying that the first point has been accomplished and I will spend my time today talking about nuclear disarmament verification.

The history of these three countries shows that the determination a country has been denuclearized is determined more by the political judgement rather than on purely technical grounds.

“Has this country made the strategic decision to abandon its nuclear program?” seems to be the criteria that such decisions are based on.

The technical input from the inspections can, at best, support that political judgement. This implies that considerable care must be taken to explain decisions made during the inspection process to the political stakeholders. More about this later.

In what might be an attempt to limit the political biases inherent in this evaluation, the UN Security Council, in UNSC Resolution 1284, called upon the Executive Chairman of UNMOVIC to evaluate and report to the Security Council on whether or not Iraq had fully cooperated.

How well that worked can be judged by the subsequent Gulf War.

But let us turn to South Africa as the clearest “proof” that the judgement of disarmament is basically a political process by reviewing its timeline for verification.

1991: South Africa acceded to the NPT and IAEA inspectors came in for the initial visit called for in South Africa’s comprehensive safeguards agreement.

South Africa declared it had what turned out to be the equivalent of six gun-type weapons of HEU in metal form. Apparently, the inspectors’ suspicions were raised by this, but their mandate was just to verify declarations about amounts and not to determine uses before South Africa acceded to the NPT.

Late 1991-4: The IAEA, acting under the Standard Physical Inventory Verification inspections, visited more and more facilities that were related to their nuclear weapons site.

During this period, the IAEA tried to reconstruct South Africa’s total nuclear material flow. This proved impossible given the amount of material “hung up” in South Africa’s enrichment process together with the International Community’s unfamiliarity with aerodynamic enrichment. (More technical experts are now “theoretically” informed about this process though their practical experience with it is still very low.)

As a consequence, instead of a material accounting of the material flow throughout the country, the IAEA limited its scope to understanding the material produced at the enrichment facility.

A major milestone occurred in March 1993, when President F. W. de Klerk acknowledged that South Africa had acquired nuclear weapons.

That declaration opened up another channel for verifying both the material produced and that South Africa had denuclearized. These investigations worked in synergy by using the consistency between non-nuclear weapon components produced (and destroyed) and the special nuclear material.

This is the so-called weaponization related material. Unfortunately, we don't know exactly which destroyed non-nuclear components the IAEA inspectors used in their analysis. As we will see, however, they played an important role in providing confidence that South Africa had denuclearized.

It is interesting to note that the IAEA Action Team in Iraq also used information about weaponization—a firing set, lenses for Iraq's implosion design, things like that—to help build confidence they understood Iraq's nuclear weapons program.

In September 1993—two years to the month after South Africa's safeguards agreement enters into force—the IAEA issued the report “The Denuclearization of Africa” describing why they were satisfied that South Africa was fully denuclearized.

In October 1993, the UN General Assembly lifts UN sanctions against South Africa.

In 2011—20 years after the start of UN Physical Inventory Inspections started—the last drum of LEU was measured, confirming South Africa's material declarations. Clearly, this was not needed for the political decision that South Africa had denuclearized.

Obviously, the full technical verification wasn't available in a politically meaningful timeframe.

I hasten to add that I don't think that it was necessary!

Let us take a look at the conclusions of the IAEA's final report on South Africa. It states:

"The findings from the team's examination of records, facilities and remaining non-nuclear components of the dismantled/destroyed nuclear weapons and from the team's evaluation of the amount of HEU produced by the pilot enrichment plant are consistent with the declared scope of the nuclear weapons program. The team found no indication to suggest that there remain any sensitive components of the nuclear weapons program which have not been either rendered useless or converted to commercial non-nuclear applications or peaceful nuclear usage." (paragraph 31)

"Consistent with" and "no indication" are far from what might be termed absolute confidence. My point is that it doesn't have to be! Verification must be pragmatic. There will be gaps and inconsistencies because people are human.

They are, however, starting to shape what can be considered a meaningful approach toward verifying disarmament: The **Technically Coherent Picture**.

This phrase made its first formal appearance in an official document in connection with Iraq in the IAEA's 1997 Fourth Consolidated Report of the Director General under Paragraph 16 of UN Security Council Resolution 1051:

"The results of the IAEA's investigation have over many years yielded a **technically coherent picture** of Iraq's clandestine nuclear program"

And

"Although certain documentary evidence is missing and some gaps in knowledge remain, the following can be stated with regard to Iraq's clandestine program..."

The report then went on to list all the important findings, that taken together, formed the basis for the IAEA concluding:

"there are no indications to suggest that Iraq was successful in its attempt to produce nuclear weapons."

If you need further proof that Iraq had not developed a nuclear weapon, the Iraq Survey Group stated in its final report:

“Aggressive UN inspections after Desert Storm forced Saddam to admit the existence of the program and destroy or surrender components of the program.”

“Iraq did not possess a nuclear device.”

Before I go on, I have to state that some, perhaps many, IAEA inspectors involved in disarming Iraq consider the phrase “Technically Coherent Picture” used in that report just that; a phrase one of their number invented to transition between acknowledging some uncertainty and stating their conclusions.

I think it was much more than that.

I think it forms the basis for a methodology of inspections based on the principle that technical recommendations can be made to policy makers in a politically meaningful timeframe.

The methodology has to acknowledge that there will be gaps and even inconsistencies in the story the inspectors have reconstructed **provided** they are not significant.

The methodology should also provide a mechanism for evaluating the significance of gaps and inconsistencies.

We at Sandia have developed such a methodology.

**Its driving principle is that inspectors should search for gaps in declarations and inconsistencies between their observations and documents they find and the story the host nation is putting forth.**

It is important to have a systematic approach to inspections and this statement is the first step in that process.

This methodology should be applied across the host nation’s entire nuclear enterprise and not just focusing on a single sector like the production of special nuclear materials.

Nuclear weapons are highly engineered artifacts and there are many, many connections between components of a design that influence each other. Significant inconsistencies

can arise anywhere between these components and a systematic approach must be taken to find them.

The Technically Coherent Picture methodology—as developed by Sandia—makes the evaluation of gaps and inconsistencies quantitative by blending multi-criteria decision making with Bayesian statistics.

A by-product of this methodology is that each decision made as part of the inspection process is documented by the decision-making process along with alternatives and why those were rejected. Decisions made can then be used to explain to policy makers exactly why the conclusions are still valid even if there are small gaps or insignificant inconsistencies. This is just as important when reporting back to a single government as it is when reporting back to an international organization.

To sum up:

- Stakeholders want proof that inspectors are operating objectively.
- They want evidence in a politically meaningful time that the host country has made the strategic decision to denuclearize.
- Showing that there are no significant gaps or inconsistencies in the inspectors' understanding of their nuclear weapons program can support a decision by the policy makers that the host country has made this strategic decision.

The Technically Coherent Picture methodology can supply all of those.

As some of you might know, Sandia is the engineering laboratory of the three US nuclear weapon design labs. As such, it has led the way in applying systems engineering toward nuclear weapons design.

This concept of tracing back decisions to what drives them—their requirements, if you will—is consistent with the concept of applying systems engineering to the disarmament verification process.

But that is a talk for another time.

