Safeguards and Tamuz: setting the record straight

by H. Gruemm*

Implementing nuclear material safeguards naturally gives rise to political, technical, and economic problems. The Agency had foreseen such problems – even serious ones such as detected diversion or false alarm. Fortunately neither has occurred. But our fantasy did not move us to expect an event like the Israeli attack on Iraq's Tamuz research reactor on 7 June 1981.

This attack focused the attention of the mass media on the effectiveness of the Agency's safeguards. However, the media do not understand the technicalities of nuclear materials safeguards. As this event had not only technical, but highly political ramifications, the media's technical ignorance made it difficult for them to present a balanced picture. As a result, the general public has become concerned and the credibility of safeguards, one of its main pillars, has been questioned.

The purpose of this article is to set the record straight. Because many details concerning the Tamuz facility have already been published, we can in this case go beyond the very tight rules for protecting safeguards information. At the same time this case may be considered as one example of planning and implementation of safeguards in practice.

Two days after the Israeli attack the Director General of the IAEA told the Board of Governors: "We should remind ourselves that the Agency's safeguards system is a basic element of the Non-proliferation Treaty (NPT). During my long time here, I do not think we have been faced with a more serious question than the implications of the Israeli air attack on the Iraqi research reactors. The Agency has inspected them and has not found evidence of any activity not in accordance with the Non-Proliferation Treaty. A non-NPT country has evidently not felt assured by our findings and about our ability to continue to discharge our safeguarding responsibilities effectively. In the interest of its national security it has felt motivated to take military action unilaterally. From a point of principle, one can only conclude that it is the Agency's safeguards regime which has been attacked. Where will this lead us in the future? This is a matter of grave concern which should be pondered well". Responding to this statement the Board of Governors condemned the attack but expressed its continuing confidence in the Agency's safeguards system.

It has been alleged that Iraq was using the Tamuz materials-testing reactor to embark on a nuclear weapons programme. Clearly it is not the task of the Inspectorate to speculate about the intentions of States which possess safeguarded nuclear material or facilities. The IAEA has to assume and to take into account the possibility of diversion in *all* States and in *all* applications of safeguards. In the same way, airport security guards have to consider all passengers as possible carriers of weapons, and cannot afford to exempt well-dressed

Inspection of Tamuz satisfactory

On 15–17 November, two IAEA safeguards inspectors visited the Tuwaitha Nuclear Research Centre near Baghdad in Iraq, and found no evidence of non-compliance with the safeguards agreement concluded between Iraq and the IAEA

At the large research reactor complex which was hit by the Israeli air attack on 7 June, the inspectors established a total inventory of 39 fuel assemblies of French origin containing about 12.5 kg highly enriched uranium This is in full conformity with the results of the inspections carried out on 28–29 June 1980 at the time of arrival of the fuel assemblies in Iraq, and on 18–19 January 1981 after the first air attack on the research centre (see IAEA Bulletin 23/2, June 1981, page 56). Inspectors had visited the research centre on 18 June 1981 immediately after the Israeli air attack, but the Tamuz building was not accessible due to extensive destruction The Iraqi Atomic Energy Commission informed the IAEA on 9 November that, after the removal of unexploded bombs and partly damaged radioactive sources from the Tamuz reactor building, it was now safe to approach the building

One fresh fuel assembly was located in a rack in the reactor hall and the remaining 38 irradiated fuel assemblies were in the pool of the small research reactor Tamuz II which had not been hit by the air attack. The immediately adjoining building which housed the large research reactor Tamuz I showed severe damage The inspectors, G. Rabot of France and V Seleznev of the USSR, also visited the small research reactor IRT-2000 and again verified the presence of all fuel assemblies. The inspectors also inspected the stores of natural and depleted uranium, which were found to be in their original condition.

The inspectors were also invited by the Iraqi authorities to visit the store of yellow-cake This material, whose supply was notified to the IAEA by the supplier states and by Iraq, will become subject to safeguards when it is used, i.e. chemically purified.

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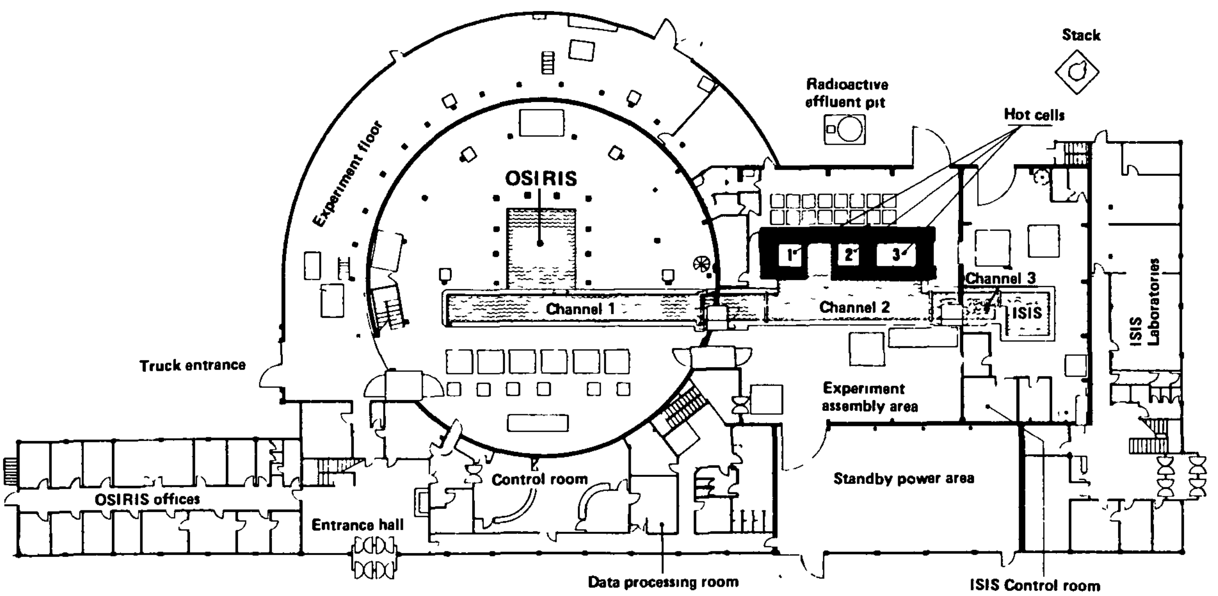

Figure 1. The internal layout of the Osiris-Isis research reactor complex at Saclay, France. To maintain confidentiality of its safeguards information, the Agency cannot publish details which it has about the Tamuz reactors. However, they are known to be similar to the Saclay installation, information about which has already been published. (Diagram courtesy Technicatome)

gentlemen. So we did not exempt Iraq and considered all technical possibilities for diversion of the nuclear material present and to be expected in Iraq.

Two strategies for diversion

The development of safeguards for the Tamuz-1 reactor started, as in other cases, long before the first fuel arrived there. It was obvious that in the case of a powerful research reactor of this type (Fig. 1) two main diversion strategies have to be countered. first, the diversion of highly enriched uranium contained in standard fuel elements, and second, the production of plutonium in fertile elements specially manufactured for that purpose.

Let us consider the first strategy which, we think, would be effectively countered by our standard approach for pool-type reactors. In June 1980 our inspectors were present when the first fuel arrived. The fuel elements were counted, identified, and the actual enrichment of the uranium contained in them was determined. Thus the Inspectorate certified an initial inventory of about 12 kg of highly enriched uranium*, and thus diversion of the fuel then present could *not* have led to a nuclear explosive. Taking into account the need to deploy limited manpower most effectively, it was decided to perform two to three inspections a year as long as no further fuel elements were shipped to Iraq. No further shipment has been made. This means that there was and there is no possibility of manufacturing a nuclear explosive by way of diversion strategy 1; since the reactor has not become operational, there was equally no such possibility by way of diversion strategy 2.

In September 1980 the reactor was the target of an air attack which did little damage. As a consequence, however, military protective measures were taken. access was restricted and a black-out imposed. The second safeguards inspection was made in January 1981, during the night and under war conditions. Lighting was adequate except that, in rooms where large windows were not blacked-out, only strong flashlights were permitted. The fuel elements stored in a channel underwater were satisfactorily identified and accounted for, as was the stored natural and depleted uranium.

It was intended that when more fuel elements were delivered from France, the facility would be inspected more frequently. When more than one significant quantity of unirradiated or nearly unirradiated highly enriched uranium was present on the site, it would, in theory, have been possible to make a bomb quickly; and so the Agency would have had to detect such a possible diversion in a short time. An inspection every two weeks was envisaged. It was also expected that the French experts and technicians who helped construct the reactor would remain in Iraq as advisors for several years. They would have remained responsible for the reactor for some time, and would have transferred it to the Iraqi Government only after a period of operation which would have made the fuel highly radioactive.

* One significant quantity is an amount of nuclear material from which, taking into account any conversion process involved, a nuclear explosive device could be made. Eight kilograms is one significant quantity of plutonium, and the significant quantity of uranium (enriched to more than 20% in U-235) is 25 kg

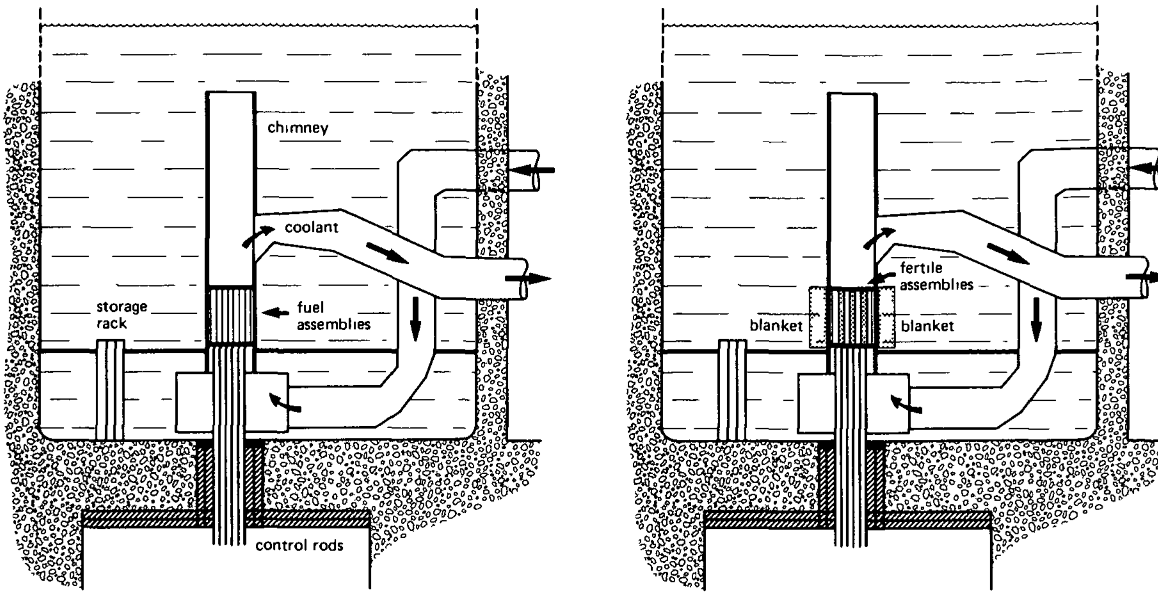

Figure 2. Vertical section of the Osiris-type reactor. On the left is shown the normal arrangement of the core. On the right fertile elements to produce plutonium have been inserted into the core and around the coolant guide channel. The difference this makes to the reactor is immediately apparent.

Since this would have resulted in an increased conversion time perhaps the frequency of inspections could then have been decreased somewhat and surveillance measures – tamper-proof automatic twin-camera systems – established.

The presence of dummies in the core and spent fuel would have been excluded by looking at the characteristic Cherenkov glow.

To divert a significant quantity of nuclear material all, or at least a substantial part, of the fuel elements present at the facility would have to have been removed. It is completely out of the question that such an overt act of diversion, which would have made it impossible for the reactor to operate, could have escaped the attention of Agency's inspectors.

The second path: producing plutonium

Let us consider now the second diversion strategy, i.e. the undeclared production of plutonium. At the end of 1979, the Agency was notified that natural and depleted uranium had been transferred to Iraq. According to Article 81 of INFCIRC/153*, the presence of this material had to be taken into account. Consequently the Agency calculated how much plutonium the reactor was capable of making. Negligible amounts of plutonium accumulate in the highly enriched fuel elements. It was found that the most effective method would require removing the 'reflector' elements from the reactor and dispersing 15 to 20 'fertile' elements – containing natural or depleted uranium – among core elements. Additionally the coolant guide-channel containing the core would be surrounded by an external blanket of fertile elements (Fig. 2). Such blanket elements might require additional cooling which could only be provided by introducing conspicuous hardware. Another possibility would be to surround the core with dense arrays of vertical irradiation channels which are usually present only in small numbers for isotope production, such channels would have to be filled with fertile material.

In its optimum configuration, the reactor could produce about 1 or 2 significant quantities a year. But this would require a high throughput of fuel – several cores per year – which would of necessity become known to the Agency, through its inspections, and from information which France is committed to provide in advance. It is likely that fuel supply would have been interrupted immediately in such a case. Furthermore, the substantial modifications of the reactor necessary for such plutonium production of which Iraq should notify the Agency in advance would be easily detected by visual inspection, the time between inspections being covered by the automatic surveillance cameras. Again we can conclude that production of significant amounts of plutonium in this type of reactor would certainly have been detected and prevented.

* Information Circular number 153 is the document on which all NPT safeguards agreements are based It spells out in great detail the provisions to be included in safeguards agreements, it contains the outline of such provisions rather than mere guidelines. It contains strict requirements for the IAEA to follow when drafting agreements unless a particular situation warrants a departure from the standard text.

It has been claimed that a laboratory located 40 meters below the reactor (the figure was later corrected to 4 meters), which allegedly had not been discovered by IAEA inspectors, could have been used for clandestine plutonium production. Obviously what was referred to was the vault under the reactor which contains the control rod drives (Fig. 2). In order to allow access to maintenance personnel, this vault is heavily shielded at the top by a thick concrete slab which in turn is lined with a heavy steel plate. It is obviously not possible to produce plutonium here.

A large beam of neutrons may enter another underground room, a long experimental channel. The possible plutonium production rate however is substantially below that of the arrangement described above. Moreover the capacity of this channel would have been assessed in the design verification to be made before the start-up of the reactor. If necessary, inspections of the channel would have been arranged.

We can conclude that due to the transparent design of the reactor and clear visibility of all substantial changes of its configuration, diversion according to either strategy would have been quickly detected.

No deficiencies in inspection

In view of the information presented here it is not necessary to dwell in detail on statements made by a former inspector who actually was never in Iraq. He had to agree that our approach to containing strategy 1 was efficient, but claimed that the inspectors would not have been in a position to uncover attempts to follow approach 2, suggesting that the Agency would not have upgraded its safeguards approach after further shipments of fuel. He was careful enough not to mention the necessary, drastic, and easily observable changes of the reactor configuration, and the strong dependence of plutonium production on supply of fuel by France. He forgot to mention that facilities in Iraq not yet submitted to safeguards would have come under safeguards when they first contained nuclear material; and that they are of no use without plutonium, which could only have been produced in Tamuz-1.

It has been argued that Iraq would not have agreed to an up-grading of the safeguards as the Agency intended for the time after the start-up of the reactor. Iraq, however, indicated its willingness to accept any approach which treated Tamuz-1 in a non-discriminatory

Figure 3. A view into the Osiris reactor pool: the interior of the reactor is clearly visible. The core is located inside the reactor coolant guide channel. **(Photo courtesy CEA)**

manner. The approach developed by the Agency and intended to be implemented after start-up of Tamuz-1 *is* non-discriminatory because, in other cases, similar approaches have been accepted by the country concerned and are implemented by the Agency.

In a statement on July 1981, the Director General concluded after a thorough presentation of the safeguards measures applied and foreseen, that there had been nothing wrong with the safeguards applied to the Tamuz reactors, and that there had not been any deficiencies in the inspection, schedule or procedures.

This should also have been clear to those who were concerned about the technical potential of the Tamuz reactor. Was the attack therefore really the result of disbelief in the effectiveness of Agency's safeguards? *

Detection is not enough

I am not going to speculate about motives and intentions. However, one lead could be found in a statement made by the outstanding Israeli physicist Ne'eman in an interview given to the Austrian journal *Wochenpresse.* He said "The mechanism of safeguards is good and reasonable as long as it is respected. The problem is that it can be abrogated unilaterally. Moreover a country can, according to Article X withdraw from the Treaty at three months' notice".

It seems therefore that there is an important lesson to be learnt from this sad episode: we should not only be concerned about the effectiveness of safeguards. Early detection is but one component of deterrence. It is the anticipated consequences of detection, the sanctions which the UN Security Council would be expected to apply, which would provide the main deterrent effect. Is the effectiveness of this punitive procedure comparable to the effectiveness of safeguards? This is a serious question which should be pondered well by those responsible.

* If the detection capabilities of the Agency are really perceived as insufficient, one has to ask why, e g. Israel is not prepared to put the Dimona reactor under safeguards.

Experience of the effectiveness of the system of non-proliferation agreements supported by nuclear safeguards has so far been encouraging. In the decade from 1945 to 1954 three States (USA, UK, and USSR) developed nuclear weapons, while only one nuclear power reactor went into operation. In the following decade (1955–64) two more nuclear-weapon States emerged (France and China), and another 35 nuclear power reactors were put into operation. Finally, the rate of proliferation has remained zero since 1975, and the number of power reactors in operation has risen to 253.

The IAEA has been applying its safeguards since 1962 and, so far, no anomaly has been detected which would indicate the diversion of significant amounts of safeguarded nuclear material, or of a facility, or of equipment for unauthorized purposes. This refers today to about 95% of the nuclear material and the nuclear facilities outside the nuclear-weapon States.

Safeguards as model for arms control

These considerations strongly suggest that IAEA safeguards have a role to play in shaping the long-term prospects for the survival of mankind. International safeguards are the first significant attempt in the history of our restless species to combine agreements on arms control with an objective and effective verification, within the territory of the parties, of how they are complying with the obligations stipulated in the agreement. Effective safeguards have not only the obvious advantage of helping stabilize and limit the current balance of power. They also provide a way of acquiring experience which can be invaluable in the establishment of future, more comprehensive, means to achieving general disarmament. Such general disarmament cannot, after centuries of mutual mistrust among nations, be conceived without controls. I suggest we look at international nuclear safeguards also as a prelude to general arms control. A further reason to support and strengthen them.