# Nuclear Power Growth and Safeguards 1975-1985*

# Nuclear Material - The Connecting Parameter

**In all safeguards agreements procedures are set forth to provide continuity of knowledge of the flow and inventory of nuclear material. Those agreements in connection with the Treaty on the Non-Proliferation of Nuclear Weapons define explicitly the objective of safeguards to be the timely detection of the diversion of nuclear material from peaceful nuclear activities.**

**This suggests that the magnitude of the safeguards work would seem to depend primarily on the inventory of nuclear material in the fuel cycle required to produce the nuclear electrical power. Evidently, the distribution of the nuclear material over the different facilities of the cycle, such as enrichment facilities, fuel fabrication and reprocessing plants, and the flow rate through or the hold-up in all these facilities have also a great influence on the safeguards work.**

**The long-term planning of the IAEA regarding safeguards is therefore based on forecasts of nuclear power production as well as on an evaluation of the future development of the entire fuel cycle with its nuclear material inventory and flow.**

## ANNOUNCED GROWTH OF NUCLEAR ELECTRICAL POWER, NUMBER OF FUEL CYCLE FACILITIES AND NUCLEAR MATERIAL INVENTORY

Summarizing the power production in the Member States of the IAEA of the officially and publicly announced nuclear power plants in operation, under construction and planned leads to the growth curve as presented in Figure 1. It is obvious that a high degree of uncertainty must be taken into account for the second part of the period covered by this forecast, the production growth in the first part of the eighties coming from power plants which are today in the planning stage and for which a firm construction decision is still pending.

* This article and the following articles on "The Technical Objective of Safeguards", "Systems of Accounting for and Control of Nuclear Material", and "Physical Protection of Nuclear Material" are written by: C.G. Hough, H. Kurihara, E. López-Menchero, Y. Panitkov, J. Rames, R. Rometsch, M. Ryzhov, B. Sanders.

FIGURE 1

FORECAST OF THE WORLD'S NUCLEAR ELECTRICAL POWER IN THE PERIOD 1975-85

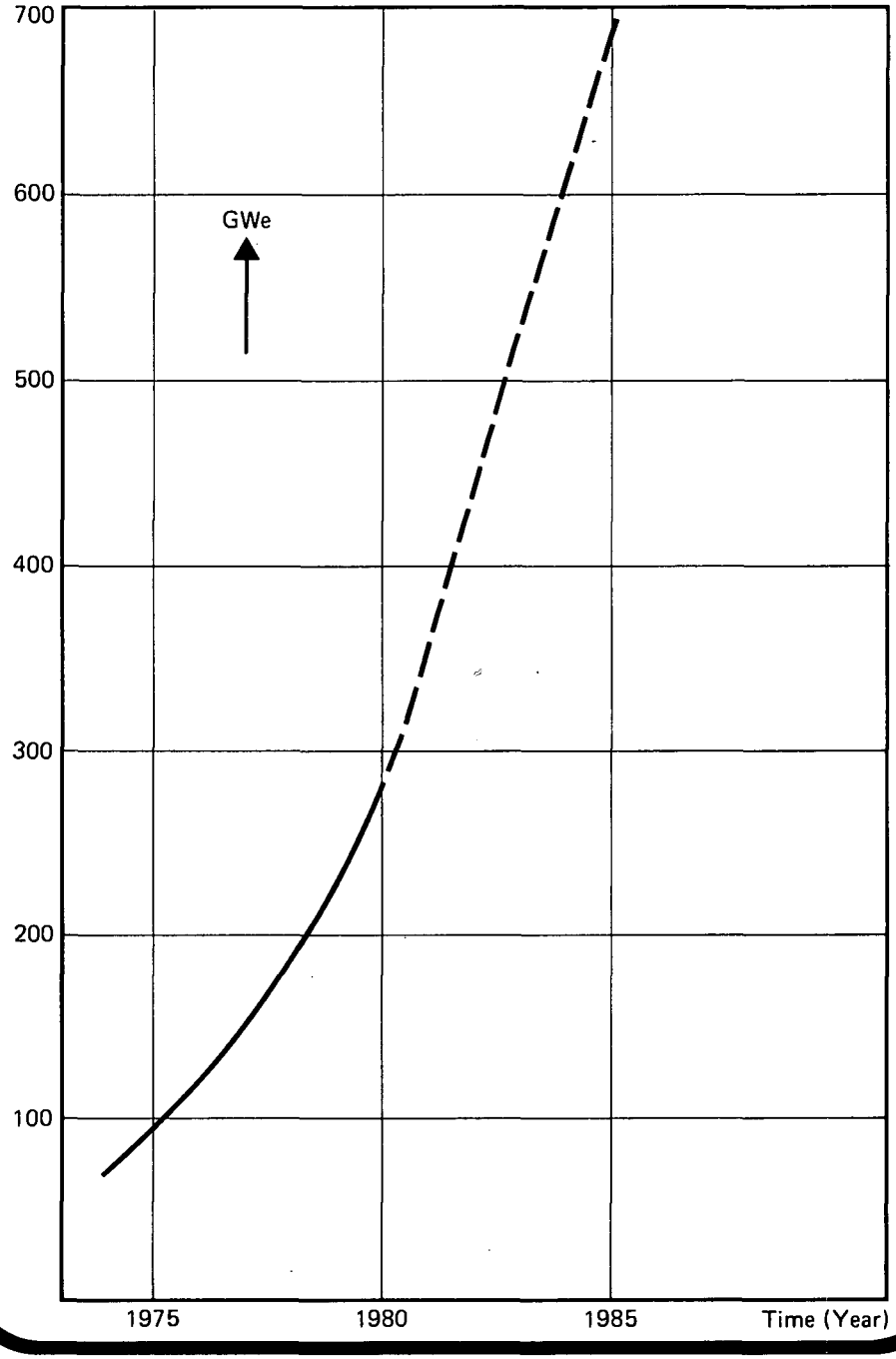


TABLE 1

NUMBER OF FACILITIES IN THE NUCLEAR FUEL CYCLE

| TYPE OF FACILITY | 1975 | 1977 | 1980 | 1985 |
|---|---|---|---|---|
| POWER REACTORS | 200 | 280 | 420 | 800 |
| URANIUM FUEL FABRICATION PLANTS | 24 | 28 | 36 | 55 |
| URANIUM AND PLUTONIUM MIXED OXIDE FUEL FABRICATION PLANTS | 21 | 23 | 26 | 30 |
| IRRADIATED FUEL REPROCESSING PLANTS | 6 | 8 | 12 | 17 |
| ENRICHMENT FACILITIES | 8 | 9 | 10 | 13 |

In the same way as for the nuclear power production, information has been compiled by the IAEA on the number of fuel cycle facilities to come into operation during the decade 1975 to 1985. The results are presented in Table 1. Again, for the second part of the period considered a higher uncertainty has to be taken into account.

For practically all the power stations mentioned in Table 1 the type of reactor to be used has been announced. It is therefore possible to calculate the nuclear material inventory used for their operation, as well as the plutonium production, based on the average values experienced today. Figure 2 presents the inventory of natural and enriched uranium in power reactors. Figure 3 presents an inventory of plutonium in thermal and fast reactors as well as cumulative amounts of plutonium in the spent fuel of thermal reactors.

## SAFEGUARDS EFFORT

It is expected that more than 80% of the nuclear power stations predicted for 1977 as well as a similar proportion of the nuclear material involved will be subject to the IAEA's safeguards agreements. This includes nuclear activities in the two nuclear-weapon States, which are the subject of voluntary offers by these countries.

A growth of safeguards activities is clearly inevitable. However, the safeguards effort and the corresponding expenditures by the IAEA are expected neither to increase proportionally to the nuclear electricity production, nor to the nuclear material inventory.

There are several reasons for this prognosis. The strongest lies in the structure of the world's fuel cycle constituted by the facilities enumerated in Table 1. They are related to each other by the one-directional flow of nuclear material through them. The different parts of

FIGURE 2

INVENTORY OF NATURAL AND ENRICHED URANIUM
IN POWER REACTORS

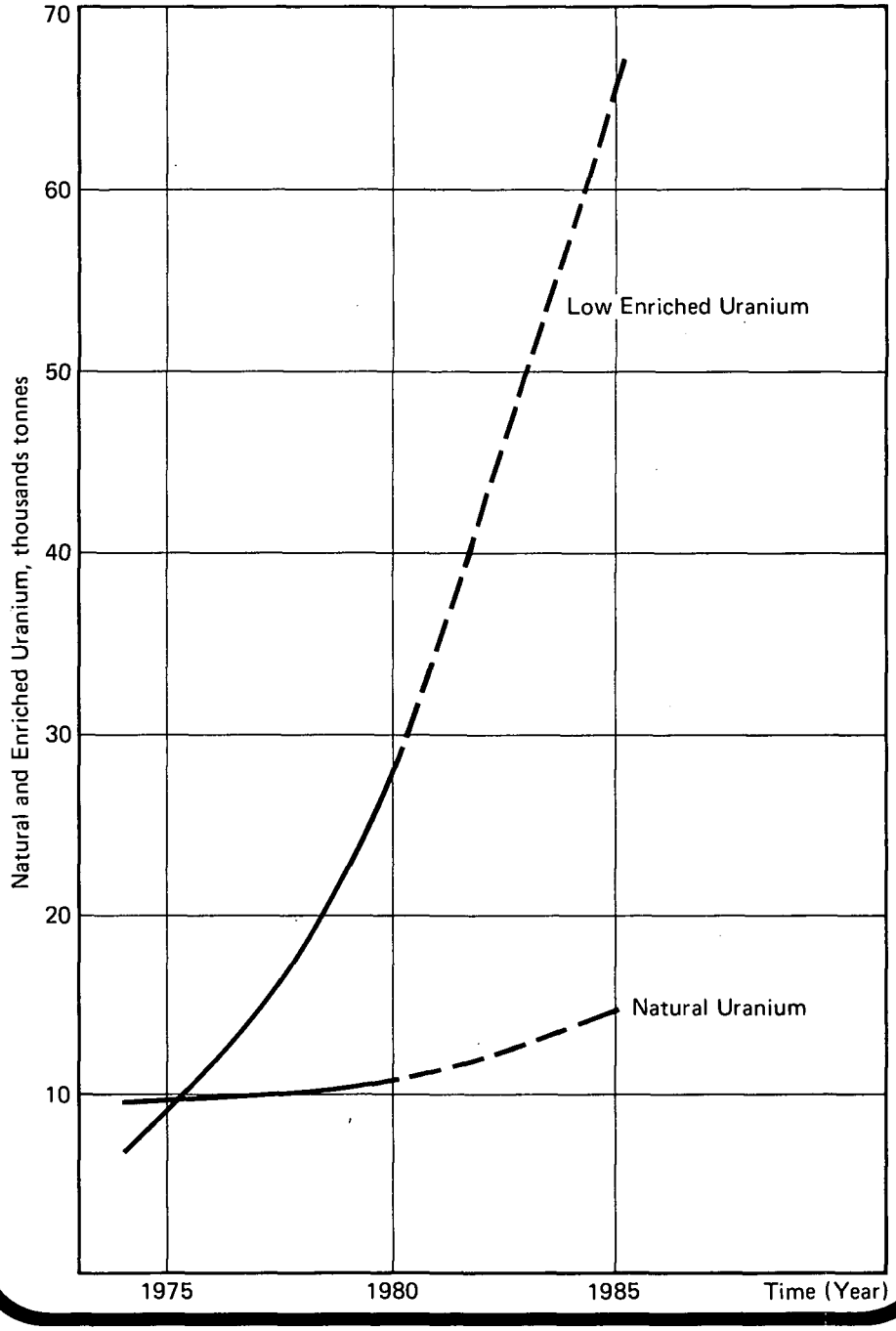
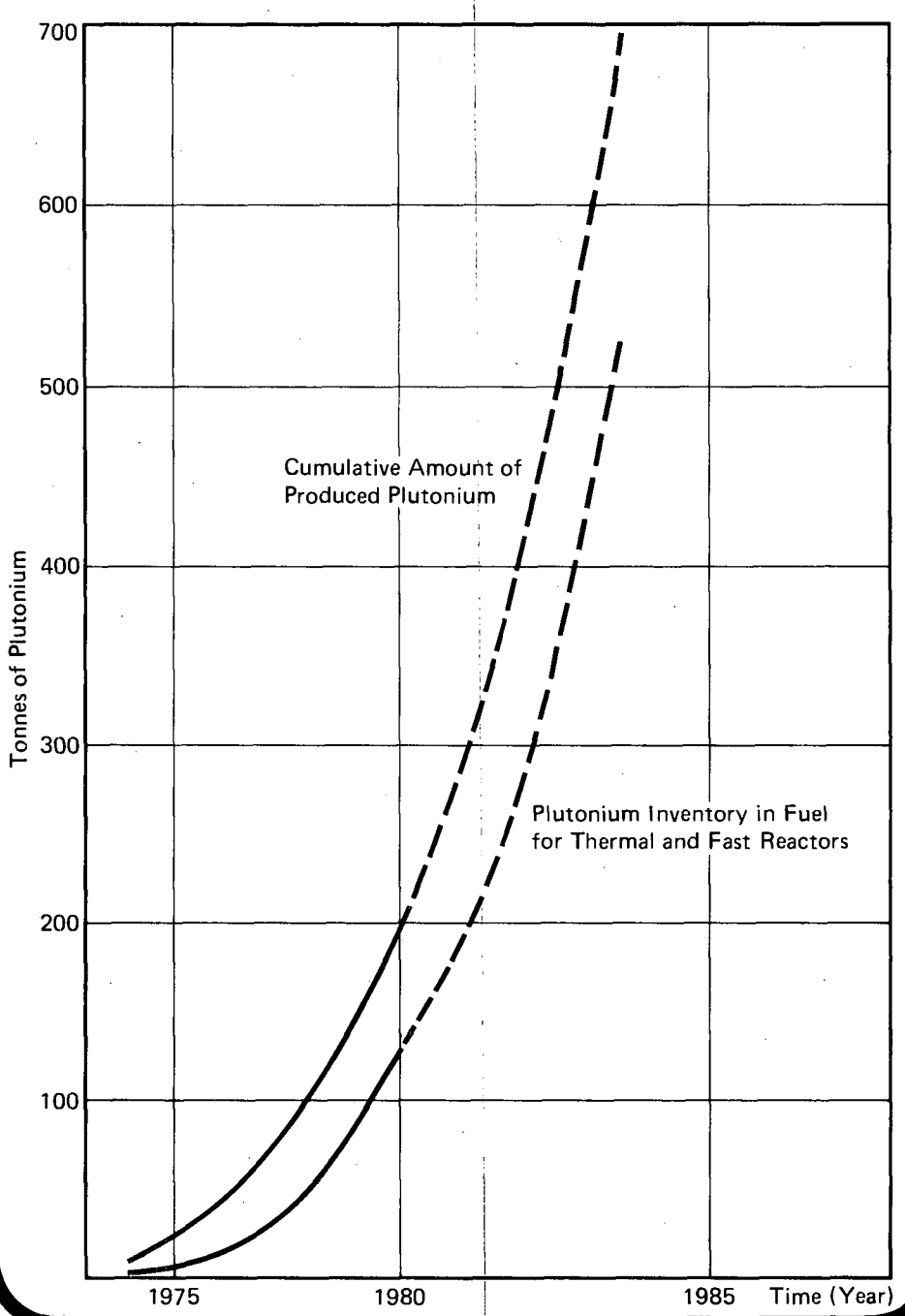


FIGURE 3

CUMULATIVE AMOUNT OF PRODUCED PLUTONIUM AND INVENTORY OF PLUTONIUM IN FUEL FOR THERMAL AND FAST REACTORS



the inventory presented to us in a dynamic way are inherently correlated, thus permitting one to focus the safeguards verification on those parts of the cycle where material appears in bulk form. The number of facilities where this is the case is much lower than that of power reactors. Therefore, concentrating the verification activities based on measurement of nuclear material on those facilities and validating the measured data through the power reactors and material stores by balanced use of containment, surveillance and identification of items, will enable the increase of safeguards costs, in spite of the impressive growth of installed nuclear power, to be limited.

A number of other elements also influence the future safeguards effort. For a given nuclear power installation programme and a pre-determined effectiveness of safeguards its cost will essentially depend on:

The degree of optimization of the industrial activities in the international nuclear fuel cycle,
- having the minimum necessary number of bulk facilities for a determined number of power stations, and
- minimizing the transport of nuclear material in bulk form by co-location of facilities reprocessing material in this form.

Gradual reduction of the relative number of inspections by optimization of the inspection design concept and use of rapid, non-intrusive, non-destructive measurement and surveillance techniques.

Promotion of the development of effective States' systems of accountancy for and control of nuclear material.

Maximum use by the Agency, in its verification activities, of effective States systems of accountancy and control.

All these measures together will permit a high degree of optimization of safeguards cost-effectiveness. They require co-ordination among the IAEA, the States' systems and nuclear industry for which a network of good relations is being established.