

3.1 Determination of the total inspection effort required.

3.2 Allocation of inspection effort among states.

3.3 Allocation of inspection effort within a state (against declared or undeclared sites).

(The technical analysis of these models is confined to the Appendix.) Section 4 contains some general conclusions about whether and how much the IAEA can improve its NPT safeguards programs through careful allocation of its inspection effort.

It is hoped that the answers to questions raised above will focus the attention of policy makers on the crucial determinants of cost-effectiveness for NPT safeguards programs, and in other arms-control arenas. A study like this one is timely, in view of recent events and the impending NPT Extension Conference. But its ultimate goal is to contribute toward increases in effectiveness, and reductions in costs, for all forms of arms control.

2. Basic Modelling Assumptions

In this section, the assumptions that form a basis for the subsequent analysis are introduced, explained, and justified. Some terminology used throughout will also be introduced.

All of the modelling of inspection effectiveness below is based on the analysis of decisions. It is assumed that decision makers use their full knowledge of the situation they face, and make choices that are in their own best interests. The formal methodology is called Decision Theory; when the outcome depends on the choices of two or more concerned decision makers, the branch of Decision Theory called (Non-Cooperative) Game Theory is invoked. Good background references are [4], [6], and [10].

As an illustration, consider Figure 1a, which provides a very simple model of the situation facing a state when it considers violating a treaty. In this vastly simplified model, the state's only choice is whether to violate or not — all details, such as how, where, or how much to violate, are suppressed. If the choice is "Violate," then the eventual outcome depends on a further event, whether the violation is "Undetected" or "Detected." In this model, the state sees this latter bifurcation as uncertain, and out of its control. On the other hand, if the state chooses "Comply," the outcome is completely determined; there are no intervening random events.

The state makes its choice based on its assessment of the values it could receive contingent on each of the three outcomes that could arise in this model. Here, and below, a state's