Chapter IX

Comparison of Routes to Nuclear Material

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The previous two chapters described three routes for obtaining the fissionable nuclear material suitable for weapons, and the restraints on those routes. The route that would be selected by a particular nation or non-state adversary will depend on many individual factors:

1) Technological Capability: If its ability is high, a nation can consider any route. A low capability limits the proliferator to purchase or theft.

2) Availability of Nuclear Facilities: The ability of a proliferator to divert nuclear material depends on the type of facility it owns or can readily acquire.

3) Urgency of Need: If the proliferator must have the weapons on a short time-scale, it may have to openly abrogate safeguards on its own nuclear facilities or obtain weapons by purchase or theft.

4) Critical Resources: If a nation has large quantities of uranium, it would be less vulnerable to sanctions if caught diverting and less liable to be detected if it constructs a dedicated facility.

5) Political Relationships: Acceptance of safeguards or vulnerability to sanctions will force a nation to travel a route with the least chance of detection. On the other hand, alliance with a more advanced nation may provide an Nth country with the technology or resources for a dedicated facility.

6) Perceptions of Controls: If a nation perceives safeguards to be effective, it will be less likely to attempt diversion.

The interaction of all these factors with the Nth country's objectives will determine the optimal path.

One categorization of *objectives, as* identified in chapter VII, under "Diversion From Commercial Power Systems, " is as follows:

a) Nations desiring a major weapons force.
b) Nations satisfied with a smaller, perhaps less-sophisticated force.

c) Nations wishing the option of rapid development of nuclear weapons in the future.
d) Non-state adversaries limited to a few crude devices.

A major weapons program might be defined as one that produces at least 10 high quality weapons per year. Only a nation with a relatively sophisticated technological base can realistically consider such a program. That nation would not select a route as unreliable or intermittent as an illegal nuclear market. It could pursue either of the other two routes, but would probably be unable to keep its intentions secret for long. The diversion of sufficient quantities of nuclear material from a commercial nuclear power program would necessitate open abrogation of safeguards, unless the nation already had an unsafeguarded facility. Sanctions such as nuclear embargoes might effectively hamper a nation from continuing along this route unless it had its own uranium reserves and a natural uranium or fast breeder reactor. Construction of a plutonium production reactor dedicated to production of weapons material might have more appeal, in that it would be legal for a nation that is not a party to the NPT, and its production capabilities can be kept secret even if the existence of the facility could not.

The nation that wants a small number of unsophisticated weapons might procure the material from any of the three routes. If it needed the weapons quickly it could purchase the required goods on a black or gray market, if available, or might consider overt diversion from a reprocessing or enrichment plant. If its needs are not urgent, a country might be able to obtain the nuclear materials secretly. If it owned a reprocessing plant it could attempt to covertly divert sufficient material. The country might be unwilling to risk detection if it perceived safeguards to be effective. In that case it might construct a plutonium production reactor, especially if uranium were available. The reactor would be on such a small scale that it might easily escape detection. A final alternative, for a country that possessed a centrifuge enrichment plant would be to rework a portion of it into a high enrichment loop or to build a small “add on” to the existing plant.

The nation wishing only an option for future nuclear weapons development might build or acquire commercial nuclear power reactors. A reprocessing plant would be essential for it to extract the weapons material from spent reactor fuel. If it could not obtain such a facility, it might build one of its own to hold in reserve. A small reprocessing plant for weapons is far easier to design and build than a commercial plant.

The non-state adversary can obtain nuclear material either by black market transactions or by armed attack on shipments or stockpiles of plutonium from commercial power program. The non-state adversary would probably not be able to use material from other points in the fuel cycle because construction of the facilities required to convert the material to weapons grade would be most likely beyond the group’s capabilities.

This brief analysis indicates that all three routes are plausible under some conditions. The least predictable is purchase/theft. If such a route comes into existence, it could satisfy three of the four categories of proliferators. It might also serve the major force nation wanting a few bombs in hand to forestall the preemptive attack that might occur if its intentions became known before its program was complete. Hence, a high priority must be given to controlling this type of transaction. Diversion from commercial power systems can be largely controlled if Nth countries do not have their own reprocessing or enrichment plants. A reprocessing plant in particular provides instant access to any nation willing to abrogate its safeguards agreement and many opportunities for covert diversion by those that are not. The dedicated facility route is the least subject to control. Many nations are capable of this route because of ready access to sufficiently detailed plans and the availability of the modest resource requirements. One of its few disadvantages is that its cost which, while lower than that of a commercial power system, does not produce an economic return. More attention should be directed to possible means of detecting the efforts of nations who have embarked upon a dedicated facility route, and international responses prepared to deter them.

Control—including the manipulation of incentives and disincentives to proliferation —have been discussed in previous sections of this study (see chapter IV). Figure IX-1 summarizes the relationship between the routes available to the would-be proliferator and the major controls most appropriate to each route. Figure IX-2 describes three hypothetical Nth countries. Those national characteristics that would govern the choice of a preferred route and the controls most likely to be effective in each case are identified.

Figure IX-1 Control

Route	Detection	Deterrence	Limit Opportunities	Political Climate Conducive to Nonproliferation
(Covert Diversion	Safeguards	Sandions Political pressure curses, spells & incantations	Export control Spent fuel return Technological measures (e.g., nonproliferation readers) Multinational Fuel Cycle Facilities Guaranteed fuel supply International management of the fuel cycle	Weaken incentives Strengthen security of Nth countries (e.g., Securuty guarantees, military assistance, etc.) Reduce prestige of nuclear weapons (e.g., arms control) Resolve intenational disputes strengthen potitical disincentives Icrease the political posts strengthen domesic anti-proliferation forces
Overt Diversion	Not needed	Sanctions Poitical pressure curses, spells & incantations	(except G.F.S.)	Strengthen NPT Improve ber Enhance rol in internatio Link aid a Expand U
Dedicated Facilities	Intelligence	sanctions Political pressure Curses, spells& incantations	Secrecy for new developments Exports controls	r new developments Nuclear Free Global and regional arrangements (e.g., MNFCFS)
Purchase/Th	Safeguards & Intelligence	International coordination of police	Physical security protection (e.g., PAL) Tecnological measures (e.g., coprecipitation)	Moderate grievances

SOURCE: OTA

Figure IX-2

Country Case Study I

Salient Characteristics

1) Technological capability: Large, economically strong country with moderate to high technology.
2) Nuclear facilities: LWRs on stream providing high fraction of total power supply. No reprocessing or enrichment facilities.
3) Urgency of need for weapons: No specific, critical need, so an orderly sustained program is feasible.
4) Critical resources: Significant deposits of uranium and other materials used in nuclear fuel cycle.
5) Political relationships: Relatively independent—no patron, but also no immediately threatening rival. Not a party to the NPT, but safeguards agreements on imported reactors.
6) Perception of control: Safeguards believed to be effective and international response to illegal diversion expected to be strong.

Objective

This nation would probably not be satisfied with less than a major weapons force: perhaps 50-100 deliverable weapons.

Route

The dedicated facility route — a large plutonium production reactor and reprocessing plant — would probably be the most probable. Covert diversion is very unlikely, and overt diversion would necessitate the construction of the full commercial fuel cycle, which would be more expensive than the dedicated facilities. The international response to the legal construction of dedicated facilities is likely to be less severe than to covert or overt diversion, even if the tatter is technically legal.

Controls

Control over the acquisition of nuclear weapons by such a country will be difficult. There are no obvious, effective levers should it decide to build dedicated facilities. Influencing incentives and disincentives and gaining a nonproliferation commitment by the nation maybe the best hope. Export controls and sanctions may have some utility particularly if the country is still dependent on some nuclear imports (e.g., reactor fuel), but it would be difficult to maintain supplies units in the face of legal proliferation,

Country Case Study II

Salient Characteristics

1) Technological capability: Small country with low to moderate technology.
2) Nuclear facilities: Two LWRS on stream and several more expected. High economic dependence on availability of nuclear power. No reprocessing or enrichment facilities.
3) Urgency of need for weapons: Looming security threat implies urgent, but not frantic, program.
4) Critical resources: Small, noncommercial deposits of uranium. High dependency on imports for many resources,
5) Political relationships: Party to the NPT: patron of uncertain reliability.
6) Perception of control: Safeguards effective, and international response could be overwhelming.

(cue study II contlnued)

Objective

A small force of about 10 weapons and an unsophisticated delivery system would suffice.

Route

Secrecy and cost would be overriding considerations. The purchase/theft route would be most desirable. If this is not available, a small dedicated facility would be the next choice. Covert diversion of spent fuel would be possible, but quite difficult and would still require the construction of a reprocessing facility.

Controls

incentives and disincentives provide the most effective means of control. Improved physical security for materials and weapons can limit puchase/theft opportunities. Enhanced safeguards and intelligence work can improve the chances of detection. The threat of sanctions can at least limit the nation to routes most likely to be kept secret. Tecnological measures, international management of the fuel cycle, or multinational fuel cycle facilities can limit opportunities for diversion.

Country Case Study III

Salient Characteristics

1) Technological capability: Medium size country with moderate technology.
2) Nuclear facilities: Several LWRs on stream and more under construction which will constitute a high fraction of total power supply. Centrifuge enrichment plant and small reprocessing facility.
3) Urgency of need for weapons: Sudden crisis introduces very urgent need.
4) Critical resources: Small commercial deposits of uranium. High dependency on imports.
5) Political relationships: Party to the NPT patron of uncertain reliability.
6) Perception of control: Safeguards effective. Subject to considerable non-nuclear international influence.

Objective

The primary goal would be to obtain several weapons quickly and more later. Sophistication of weapons and delivery systems is not a major consideration.

Route

Since speed is the prime requirement, overt diversion would be most attractive. Purchase/theft also offers a quick route but is unlikely to provide weapons in the required quantity. Plutonium stockpiles from the reprocessing plant would be rapidly assembled into crude weapons. The enrichment plant would allow independence from international nuclear embargoes in the long term.

Controls

Little can be done to deter a country in such a situation. Any plausible sanctions would appear less dangerous and further removed than the immediate threat, and the means are aleady at hand to procure the fissile material. The most effective controls would have been to previously defuse the political situation, provide credible security guarantees, and prevent the acquisition of sensitive facilities.

SOURCE: OTA