extracting and reprocessing plutonium from irradiated reactor fuel. The radioactivity is only that from natural uranium, which is relatively minor. There are also nuclear-criticality aspects of the final production stages, associated with some enrichment techniques and also with the handling and storage of highly enriched kilogram quantities of the final product. Nuclear-criticality problems are also associated with kilogram quantities of the other weapons-grade fissile isotopes.

Potential acquisition via smuggled material is included under the undeclared facility category, as this source cannot be discounted. While there has been no confirmed evidence of undeclared (clandestine) international shipments of high or weapons grade uranium or plutonium, this type of scenario is now considered quite plausible, [3] with particular regard to the current situation in the states of the former Soviet Union and the large quantities of weapons-grade fissile material now available. Smuggled material is here defined as being clandestinely obtained from non-indigenous sources by either undeclared purchase(s) or theft. The latter could potentially occur from materials in storage or materials being transported between facilities. There have, for example, been a number of recorded cases internationally of undeclared natural and depleted uranium shipments. [4]

A very large number of processes can in principle be used to separate and hence enrich uranium with the U-235 isotope. Only techniques known to have been demonstrated to at least a pilot-plant stage have been included in the diversion path analysis tables. For completeness, in the overall facility risk rankings all other techniques that are either at the R & D stage, considered either obsolete or at the possible-in-principle stage, have been grouped together, see Figure 2 (*R & D Stage* labelled box). A general discussion and listing of these techniques is provided in Krass, [1983]. The laser isotope techniques (molecular and atomic vapour), chemical exchange techniques and aerodynamic techniques are separated in the tables, as these have reached advanced stages of development in some states.

4.2.2 Plutonium-239 Route

Tables 1.2 and 2.2 list the various facilities relevant for the Pu-239 acquisition route for declared and undeclared facilities respectively. The key items for this route are reactor irradiation of, primarily, low enriched or natural uranium, [5] followed by extraction of plutonium from the spent reactor fuel using a plutonium reprocessing plant. The main features of the route then require a power/production or research reactor and a reprocessing facility, the latter of which involves the handling and storage problems of highly radioactive liquid wastes. The extraction of plutonium, while involving highly radioactive materials, is considered to be technically much easier than uranium enrichment, although a reactor to produce irradiated fuel

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[3] An attempted clandestine sale in 1993 of Russian weapons-grade Plutonium has recently been reported [Economist, 25/12/93, p.67], and a 1993 theft of 1kg of HEU (subsequently recovered) from a Russian site was also reported [Time, 18/4/94 p.31]. The extent of this particular risk was highlighted in a recent editorial [Science, Vol 263, March 18, p.1543, 1994] and also in detail in: Capitol Hill; Congressional Testimony, June 27th, 1994, of T.B. Cochran before the Committee of Foreign Affairs Subcommittee on International Security.

[4] Nuclear Materials Management, 34th Annual Meeting, Scottsdale, Arizona, July 1993, p.305.

[5] Conversion of U-238 to Pu-239 using neutrons obtained from high-current proton accelerators, as an alternative to reactor irradiation of uranium, is also quite feasible [Accelerator Production of Tritium, Executive Report, Brookhaven and Los Alamos Laboratories; BNL/NPB-88-143, March 1989], but is discounted for this study as demonstration accelerators for this purpose have not yet been built.