



IMPLEMENTATION OF THE ADDITIONAL PROTOCOL: VERIFICATION ACTIVITIES AT URANIUM MINES AND MILLS

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The mining and milling of uranium is the first in a long chain of processes required to produce nuclear materials in a form suitable for use in nuclear weapons. Misuse of a declared uranium mining/milling facility, in the form of understatement of production, would be hard to detect with the same high level of confidence as afforded by classical safeguards on other parts of the nuclear fuel cycle. For these reasons, it would not be cost-effective to apply verification techniques based on classical safeguards concepts to a mining/milling facility in order to derive assurance of the absence of misuse.

Indeed, these observations have been recognised in the Model Protocol (INFCIRC/540): "the Agency shall not mechanically or systematically seek to verify" information provided to it by States (Article 4.a.). Nevertheless, complementary access to uranium mining/milling sites "on a selective basis in order to assure the absence of undeclared nuclear material and activities" (Article 4.a.(i)) is provided for. On this basis, therefore, this paper will focus predominantly on options other than site access, which are available to the Agency for deriving assurance that declared mining/milling operations are not misused. Such options entail the interpretation and analysis of information provided to the Agency including, for example, from declarations, monitoring import/export data, open source reports, commercial satellite imagery, aerial photographs, and information provided by Member States.

Uranium mining techniques are diverse, and the inventories, flows and uranium assays which arise at various points in the process will vary considerably between mines, and over the operating cycle of an individual mine. Thus it is essentially impossible to infer any information, which can be used precisely to confirm, or otherwise, declared production by measuring or estimating any of those parameters at points within the mining/milling process. The task of attempting to verify uranium production at the mine site *per se* would be both extremely difficult and time consuming. In any case, access to all parts of an underground mining operation could not be guaranteed during a short notice visit. Verification is feasible only at the last stage of the process where the uranium is present in a relatively pure form. Accordingly, on-site activities suggested in this paper focus on confirming consistency between declarations and likely production (to the extent that that is possible) at the product end of the mill, which is much the same for all technologies.

The extent to which the Agency can have confidence in the production declared may depend on the degree of independent information available to corroborate production figures. While corroborating evidence may not verify production *per se*, it does provide an additional level of assurance that the information contained in a declaration is reasonably accurate and complete, provided the information comes from an independent source.

Environmental sampling techniques (eg detection of gamma emitting radionuclides of uranium/thorium decay daughters, perhaps in tails) could also prove useful during on-site visits, particularly when inspecting those operations which may, for example, mine for six months of the year and mill for the remainder of the year. Absence of comparatively short-lived decay products in effluents would be indicative that the daughters had not been in recent contact with the parent, and thus that the mill had not been in recent operation. Th-234 (a daughter in the U-238 decay chain), with a half-life of some 24 days, would seem an ideal candidate to look for in determining whether a mill had been in recent operation. As an aside, it should be noted that environmental sampling could also prove a useful technique in providing to inspectors an additional level of assurance that undeclared nuclear activities, such as conversion or enrichment, were not being carried out clandestinely in the vicinity of the mine site.

Clearly the effort to comprehensively verify the absence of undeclared nuclear material and/or activities at mining/milling operations has the potential to absorb substantial IAEA resources. With this in mind, this paper advocates the use of options other than site access which are available to the Agency for deriving assurance, including analysis of both open-source reporting and information

provided by States. However, in those cases where on-site access is considered necessary, it is suggested that the Agency target verification effort towards the final stages of the production process. An audit of production records coupled with an estimate of potential throughput capacity of the mill should provide the best opportunities for inspectors to verify consistency of declarations. Under certain circumstances, environmental sampling could also prove a useful tool in verifying the absence of undeclared production.