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ACCEPTED MANUSCRIPT

Machine Learning Techniques to Repurpose Uranium Ore Concentrate (UOC) Industrial Records and Their Application to Nuclear Forensic Investigation

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Abstract – The discipline of nuclear forensics has emerged in response to the illicit trafficking of nuclear materials and aims to determine the provenance of intercepted materials by comparing them to a database of samples of known origin. One of the major challenges of this approach is the availability of reliable inventory data for the various radioactive materials that may be intercepted. Analysing the representative samples is a lengthy process and it can be difficult to obtain data from legacy materials. Therefore previous nuclear forensic studies have often been based on datasets of very limited size. We propose an approach to repurpose pre-existing quality control inventory data from Uranium Ore Concentrates (UOCs) such that it can be exploited for nuclear forensic investigation. Furthermore, it is demonstrated that pattern recognition techniques can be used to successfully utilize this data to reliably infer the country and deposit group of material origin. We have also demonstrated methods for overcoming the issues associated with quality control records; missing data and data represented as less than values.

Key Words – Nuclear Forensics, Uranium Ore Concentrate, UOC, Deposit, Missing Data, classification, visualisation, feature selection

1 INTRODUCTION

The discipline of Nuclear Forensics is relatively immature; the need to examine illicit nuclear materials began in the early 1990s when the first cases of "Nuclear Smuggling" were reported in Switzerland and Italy. Between 1993 and 2013 the IAEA have recorded 2,477 incidents of radioactive materials outside of regulatory control. Furthermore, 424 of these recorded incidents involved unauthorised possession and related to criminal activities[1].

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