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## **Human resource development for uranium production cycle**

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Nuclear fission energy is a viable option for meeting the ever increasing demand for electricity and high quality process heat in a safe, secured and sustainable manner with minimum carbon foot print and degradation of the environment. The growth of nuclear power has shifted from North America and Europe to Asia, mostly in China and India. Bangladesh, Vietnam, Indonesia, Malaysia and the United Arab Emirates are also in the process of launching nuclear power program. Natural uranium is the basic raw material for U235 and Pu239, the fuels for all operating and upcoming nuclear power reactors. The present generation of nuclear power reactors are mostly light water cooled and moderated reactor (LWR) and to a limited extent pressurized heavy water reactor (PHWR). The LWRs and PHWRs use low enriched uranium (LEU with around 5 % U235) and natural uranium as fuel in the form of high density UO<sub>2</sub> pellets. The uranium production cycle starts with uranium exploration and is followed by mining and milling to produce uranium ore concentrate, commonly known as yellow cake, and ends with mine and mill reclamation and remediation. Natural uranium and its daughter products, radium and radon, are radioactive and health hazardous to varying degrees. Hence, radiological safety is of paramount importance to uranium production cycle and there is a need to review and share best practices in this area. Human Resource Development (HRD) is yet another challenge as most of the experts in this area have retired and have not been replaced by younger generation because of the continuing lull in the uranium market. Besides, uranium geology, exploration, mining and milling do not form a part of the undergraduate or post graduate curriculum in most countries. Hence, the Technical Co-operation activities of the IAEA are required to be augmented and more country specific and regional training and workshop should be conducted at different universities with the involvement of international experts from leading public and private sector organizations involved in uranium exploration, mining and milling and mine remediation and reclamation. The Uranium Production and Safety Assessment Team (UPSAT) initiated by IAEA and tried first in the uranium mines in Caetite, Brazil, should be extended to more countries. The present paper summarizes the author's experience in IAEA and in India, highlighting the new courses that are required to be introduced at the post graduate level in different universities as part of education and HRD in uranium production cycle.

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