Radiation safety needs for the resurgent uranium mining industry

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Abstract. After many years in the economic doldrums the world's uranium industry is experiencing a resurgence of activity. The spot price increase for yellowcake since 2004 and the anticipated market shortfalls in supply of uranium are primarily responsible for this. There is now a rush of new activity: abandoned mines from a previous era are being re-examined for their potential to be re-opened or have their residues re-treated; planning for exploitation of previously known but undeveloped uranium deposits is proceeding in many countries new to uranium mining; and, finally, worldwide exploration activity for uranium is expanding with more than 500 companies now claiming to be involved in the uranium mining market. All of these activities have significant implications for the radiation protection profession. At every stage of the uranium production cycle, from exploration through mining and processing to remediation there are requirements for appropriate radiation protection procedures and regulation. The long period of reduced activity in uranium mining has meant that few young people have been joining the industry over the past 20+ years. There is now a shortage of trained and experienced radiation protection professionals associated with the mining industry that cannot be overcome overnight. The paper discusses the development of this situation and the various strategies that are being put in place around the world to improve the situation. In particular the International Atomic Energy Agency has been working with radiation protection authorities and uranium mining industry representatives from around the world to address the issue. The latest developments in this project will be described and the future plans described.

KEYWORDS: Radiation safety; uranium mining.

1. Introduction and background

The modern uranium mining industry was born in the heady days post-World War Two when the advent of nuclear weapons saw a great demand for uranium from the “super powers”. New mines appeared across five continents and production was of paramount importance. In some jurisdictions the concepts of radiation protection, for both the environment and the workforce, and waste management were barely observed whilst in many others such ideas were completely ignored. The initial rush slowed towards the middle of the 1960s with many mines closing down operations and creating legacy sites. The industry stayed at a relatively low level of activity then “boiled up” again in the late 1970s. This was a result of nuclear power being seen as the answer to the world’s growing demands for cheap energy to support industrial development.

Then a series of accidents and incidents changed the public’s opinion about the safety of this new power source and the politicians bowed to pressure from environmental and community groups and uranium mining - and the nuclear power industry - went into another very quiet period from about 1990 onwards. A further reason for the lower level of uranium mining activity was the end of the “cold war” in the late 1980s which meant that uranium stockpiled for possible use in weapons could be diverted to the commercial markets and used for power generation. Market prices fell and the industry had little attraction for younger professionals who considered that there may be no future in uranium mining. The existing professionals soldiered on but few replacement staff joined the industry. This notion was nowhere more keenly felt than amongst health physics professionals and radiation safety specialists. At the same time there were other attractions in the existing industrial, medical and power generation sectors which did show better possibilities and career paths. However, in some locations the trend away from employment in other aspects of the nuclear industries was similar. In Germany in October 2007, for example, a member of that country’s Radiation Protection Committee was reported in a magazine interview as saying that “there are practically no young scientists who are very well qualified in the area of reactor safety” and this was due to the perception that the nuclear industry had no future.

In May 2007 the British Nuclear Decommissioning Authority had a meeting with the title “Radiation Skill Strategy Workshop”. A major topic of discussion was a report entitled “Review of Health

Physics Resources in the UK Nuclear Industry" describing work carried out by Alex Rankine from the United Kingdom Atomic Energy Authority. This review found that over a number of years the demand for suitably experienced radiation protection professionals in all sectors of the industry has been greater than the number of qualified people available to take up jobs in the field. This same picture can be seen globally throughout the radiation protection industry.

Also in the 1990s there was also another change taking place in society whereby science in general, and the physical sciences in particular, became less attractive with generally fewer students taking these subjects at universities. In the United Kingdom, for example, it has been reported that less than 30% of current university graduates are in science and engineering fields; over the past 15 years the number of high school students studying physics has fallen by 35% although the student population has been growing. One authority in England estimated that the shortage of physics teachers was between 5,000 and 8,000 in 2008; the percentage of university undergraduates starting physics courses has fallen by 40% in 15years; and in the past 10 years up to 20 physics and chemistry departments at British universities have been obliged to merge to maintain critical mass. Similar happenings have been reported from around the world, although the change away from science may be less marked in Asia.

So the situation developed where there were fewer suitably qualified graduates and the uranium mining industry was perhaps the least attractive option for those seeking jobs. The majority of employees in the radiation protection sector were now an aging population with little new blood entering the profession as replacements, be it long or short term. There were generally sufficient radiation protection staff members to cope with the existing situation, although as the 1990s progressed it became more difficult for regulatory authorities in some countries to attract and retain staff in this discipline. Any vacancy in the private sector would almost always be better rewarded and so not only were there virtually no new radiation protection recruits to public services, but also the potential supply of new practitioners was continually diminishing.

Then the uranium mining industry took off again with a surge that began in 2002 and is now trying to stabilise itself with over 500 companies worldwide involved in the potential development of uranium resources. For example, the number of Australian companies claiming an interest in uranium exploration and mining in 2002 was estimated at 17-20, by 2004 this had risen to about 50. As the rise in the spot price for uranium oxide began to accelerate through 2005 and 2006 so did the numbers of "involved" companies appearing in the market place. By 2007 the number had risen to about 245. Many of these companies were trying to get uranium exploration programmes established. At the same time some of these companies were involved in major uranium resource development projects overseas. But this same situation was being played out in other countries to the extent that Australian, French and Canadian uranium mining associated companies alone totalled over 460 by the end of 2007. The level of exploration and development activity was also increasing amongst the established larger producing companies who had kept operating through the earlier, quieter times.

A recent report in the 2007 IAEA/OECD "Red Book" suggests that about 20 new uranium mines are anticipated to open before 2015. Each of these mines will require new radiation protection staff, all of whom will have to be sourced from somewhere. In addition there is likely to be a number of senior staff in the radiation protection industry who can be expected to retire over the same period. These factors will combine to create an acute shortage of staff for both existing and developing operations.

2. The competition for resources

Thus we have arrived at the situation we have today. A many-fold increase in uranium exploration and mining – activities that call for radiation protection measures in many phases of their operations – with an apparently declining supply of radiation protection professionals and support staff to ensure that these activities can be carried on whilst observing the required standards of radiation protection and safety. Adding to the problem is the increased competition from other sectors for these same, stretched, radiation protection resources.

The medical world has also been expanding the application of nuclear medicine in a variety of ways and these activities all require the involvement of radiation protection staff, both for oversight of the operation of the equipment as well as the regulation of the activity. Similarly the nuclear power sector has begun to look at increasing output with a number of power plants around the world being re-licensed or even re-started; and the plans for a number of proposed new power plats have suddenly been dusted off and brought up to date with serious plans for development and construction of several new power plants progressing rapidly towards implementation. Also industrial applications of nuclear science, such as borehole logging in the oil and gas industry, non-destructive testing in manufacturing industries and applications in agriculture and engineering are expanding as demand for their services and products increase. Again all these tasks need the involvement of radiation safety professionals at some point.

And finally even in the mining and minerals industry there is competition for radiation safety expertise between many operations dealing with naturally occurring radioactive materials (NORM). These include not only the oil and gas sector but also resource developments such as mineral sands, phosphates, rare earths and a number of metalliferous mines. In many of these situations the radiological risks may turn out to be low, but there is a need for radiological protection risks and requirements to be assessed and, where appropriate, radiation management plans drawn up and implemented. All of these processes require inputs from trained and experienced radiation protection staff to ensure the safety of the workforce, the public and the environment. Again the public and private sectors are competing for the same limited supply of human resources with the same outcome. Governments and public authorities have been made aware of the increased interest and public concern in NORM and so the demand for radiation protection professionals is put under stress from another quarter as regulatory authorities try to maintain adequate resource levels.

3. Recognition of the problem

Many of these issues had been previously recognised. In 1995 an article in the IAEA Bulletin observed that on an international level there was a marked shortage of radiation protection staff in many sectors, although it did not specifically mention uranium mining. The medical and nuclear power sectors dominated the discussion and the need for planning for future human resource requirements. As has so often been the case, the source of the material that underpins all these nuclear activities, the uranium mining industry, was out of sight, and to some degree, out of mind. Although there were plans to develop specialised training for the main sectors in the medical and power industries the mining sector was not mentioned. The mining industry had to try and obtain staff from other sectors, usually through offering enhanced financial incentives. However, most mining operations tend to be in remote locations and few people seemed willing to take up employment in such places, even when there was the chance for better pay, as life style issues for families are often considered more important. This is especially true when fly-in/fly-out operations are concerned. These involve working at remote locations and the workers are transported to the work sites where they stay in single persons' accommodation and work for periods of 2 or 3 weeks before travelling home for a 1-2 week break.

Later in the 1990s the awareness that there was going to be a problem grew, but only slowly. Since the rapid upsurge in uranium mining activity began in the latter part of 2003 the industry's managers have begun to better appreciate the situation in which they now find themselves. Apart from increased activity in countries and by companies who have been long associated with uranium mining, many new companies and several potential new producer countries have come into the scenario. Some of these countries may have been former producers who are looking to re-open old mines or re-treat residues from former, possibly less efficient operations. Some of the former Soviet Union republics in Central Asia fall into this category. Whilst they did previously have regulatory and radiation protection infrastructures the lack of uranium mining activity for 20 or more years has resulted in a degradation of facilities and ability through the failure to maintain and upgrade equipment, a loss of staff to other industries and a loss of institutional and corporate knowledge and experience that cannot be replaced or rejuvenated overnight.

Another example comes from the United States of America. It was estimated in 2005 that 57% of the then existing radiation protection professionals in the USA would be retired within 5 years. That same year the then US Secretary of Labor, Ms. Elaine Chao, announced a $2.3 million grant to the University of Missouri to develop training for radiation protection technicians to be implemented at community colleges nation wide. Although the emphasis was on the nuclear power industry the shortage of the radiation protection skill set was apparent throughout the nuclear fuel cycle, including the production phase i.e. uranium mining. The University of Missouri programme was designed to provide up to 200 new trained professionals in the radiation protection area. The first class of students was enrolled at several locations in autumn 2007. The four community colleges involved were in Virginia, Arizona, California and Texas. The first graduates from the programme are expected to obtain their associate degrees and radiation protection technician certification in the spring of 2009.

But in 2005 the USA was no longer a serious uranium producing country, having been reduced from an annual production of 16,810 t U in 1981 to only 943 t U in 2004. But then came the resurgence of the industry worldwide, and in the USA uranium production started to increase. By 2006 production had risen to 1,805 t U; but with a declining population of radiation protection professionals. Existing mines are expanding, new mines are being planned and abandoned mines are being examined for potential to re-open. All these are activities requiring radiation protection expertise to support safe operations, but the necessary skilled personnel are in short supply, and may be a limiting factor in some cases.

In fact the same shortage of skilled staff is being felt in all areas of the mining industry. In May 2008 BHP-Billiton announced that the staggered development plan for the expansion of the Olympic Dam copper-uranium mine in South Australia was due to "*a worldwide mining boom that has created greater competition among skilled workers and higher prices and shortages for equipment*". So it is not just radiation safety skills that are in short supply in the uranium mining industry.

The situation in the USA is a good example of how existing producer countries in some regions are hard pressed to maintain appropriate levels of staffing for regulatory oversight under the present levels of production. Some have been slowly developing the staff with the necessary skills and strengthening their regulatory institutions, whilst others are losing the skills through natural attrition. And then, in only a few years, both sorts of countries have suddenly found themselves pressured by a global industry that sees the need to develop resources to take advantage of the present market conditions. For those countries being newly brought into the uranium production business the situation is more acute. Economic growth for some of these countries is sorely needed and so the pressure on the governments concerned is real. In such instances local staff may be lured away from the government services, if they even exist,, to join the producers; this leaves the regulatory side of the equation even weaker, It is generally understood that a firm, fair and robust regulatory regime is in the interests of all stakeholders if the uranium mining industry is to have a sustainable future.

4. The Australian situation as a case study

The scale of the problem can be examined by looking at one country as an example. Australia is the world's second largest producer of uranium. The three mines operating in 2007 produced 10,145 tonnes U_3O_8 (8,612 t uranium). The radiation protection staff at the three mines have duties not only in the course of the routine mining operations, but also provide similar services to the on-going uranium exploration programmes that are understood to be underway at each of the three mining lease areas.

Australia's largest uranium producer, the Ranger Mine in the Northern Territory, is owned and operated by Energy Resources of Australia Limited (ERA), a company that is majority owned by Rio Tinto. The mining is undertaken an open pit and the operation produced 4,618 t U in calendar 2007. The head grade at the mill is 0.3% U_3O_8 and ERA currently has about 450 employees, the majority of who work at the mine site. The radiation protection staff in 2007 comprised one Radiation Safety Officer (RSO) assisted by two technicians and one trainee technician. In 2006 ERA announced that recent changes to the mine plan as a result of increased ore reserves being assessed have led to the mine's operational life being extended to 2020.

The second largest Australian uranium mine at Olympic Dam in South Australia is owned and operated by BHP-Billiton Limited (BHP-B), who are perhaps the world's largest mining company. This operation is host to the world's largest known uranium ore body. The operation is underground and is primarily a copper mine with uranium, gold and silver as co-products from the mixed-metal ore body. The 2007 production was 3,400 tonnes U and the mine has a permanent workforce of around 1500 persons. The radiation safety staff in 2007 comprised four RSOs, two physics graduates who are being trained to become RSOs and seven technicians, who also have responsibilities with respect to general industrial hygiene. The underground mining operation does require that the radiation safety staff have additional knowledge and experience in relation to the specific radiation safety issues when workers are in enclosed spaces, surrounded by the ore body and exposed to higher levels of radon than their counterparts in an open pit operation. This last consideration does call for close cooperation between the RSO and the Ventilation Officer. In some smaller underground mines these two posts may be combined if a suitably qualified person can be found.

BHP-B has recently begun a two year feasibility study into the expansion of the Olympic Dam mine and its conversion into an open pit operation. This would raise the annual production of uranium to around 15,500 tonnes by 2015 and extend the mine life by about 60 years. It has been indicated that although the operation would expand by more than two fold, the radiation safety staff would increase but probably to less than double the present complement.

The third uranium mine in Australia is owned and operated by Heathgate Resources Pty. Limited and is located at Beverley, South Australia. The company has a work force of around 100 persons, most of who work at the mine site. The 2007 production was 638 tonnes of uranium but plans are in place to expand this to about 1,280 tonnes uranium per year from 2009 onwards with the expected mine life of about 30 years. There have been recent applications by the company to expand their lease are and exploration is ongoing throughout the existing lease. The radiation safety and protection resources on site in 2007 were one RSO and two technicians.

There are a number of prospective mines elsewhere across Australia with at least 85 significant uranium deposits already identified. Not all of these deposits will become mines and not all of those new mines will develop in the next few years; but some development and expansion of the uranium mining industry is inevitable. It is relatively easy to see a doubling of demand for radiation safety staff in the uranium mining industry over the next five to ten years as estimated by some authorities. This could mean having to find 30-40 new personnel when retirements and natural wastage are taken into account.

Uranium exploration operations also have requirements for radiation protection staff. The number of exploration companies in Australia expressing an interest in uranium has been estimated at over 200 with more than A$181.4 million being spent on uranium exploration in 2007, greater than twice what was spent on the same activity in 2006!

Each uranium exploration operation has to have somebody who is responsible for the radiation protection aspects of the work. This is usually a regulatory requirement set out in the exploration licence. Most exploration operations cannot justify a full time RSO on site every day and so the usual situation is that there is an identified technical person on site with responsibility for radiation safety. Where the exploration is undertaken by an existing uranium mining company, access to the required expertise can be arranged from within the organisation. In the case of the many smaller companies, the scenario may be that experienced part-time RSOs provide consulting services to several different companies. Even in Australia there are relatively few persons who can provide such services and many of them are approaching retirement.

Another aspect to all of this is that the mining and exploration operations described require regulatory oversight and so there is also a need for experienced and qualified RSOs in the relevant regulating authorities in each jurisdiction where uranium resource development is being undertaken. Whilst this is an issue for the few staff in those areas where there is existing activity, it could be a major constraint

in jurisdictions where there is no uranium exploration or mining at present. Add to this situation the possible impact of other industries requiring RSOs (such as mineral sands exploitation) and the need for the rapid introduction of training and accreditation programmes is even more evident.

5. What is happening today?

So currently the situation is approaching a critical point. As uranium mining and exploration activity expands so does the radiation protection requirements, which are being met by a relatively small number of people. In many cases these people acting as Radiation Safety Officers (RSOs) are often semi-retired, certainly many of them are in the twilight of their careers. These people may work for several companies as the radiation protection issues during exploration are frequently relatively straight forward. A common strategy is for the expert RSO to prepare the radiation safety management plan together with all the necessary permit applications (for instruments, sealed sources, etc) that may be needed for the exploration operation. At the same time the expert RSO will usually prepare the material and documentation necessary for staff training. In addition, this individual will usually be responsible for actually undertaking the basic radiological safety and awareness training for all staff members prior to the field operations commencing. Finally, in many instances such a "part-time" RSO will also make regular visits to the operations to audit the performance of the system on site and provide any necessary support to the site staff.

Once the initial training has been delivered and the expert RSO is satisfied that an adequate level of awareness and understanding of radiological protection has been achieved, the day-to-day radiation protection may be left in the hands of a radiation safety technician. Such people usually come from a professional or technical background with several years experience of the exploration operation and a good understanding of radiological protection issues. The exploration crew members need to be aware of what the radiological risks are in relation to their work. Ideally this knowledge should be presented in conjunction with regular safety training so as to reduce the "hype" associated with radioactivity. Safe working practices, good housekeeping and normal standards of industrial hygiene will go long way to reducing some potential radiological exposures. Examples are dust control and use of appropriate personal protective equipment (PPE) when working on duties like dry drilling or core sectioning; also the use of basic clean room procedures when changing from work clothes, or eating meals etc. All of these activities are good practice anyway but they also have a positive impact on reducing potential exposures, such as through the ingestion or inhalation pathways.

The on-site radiation safety technician will usually have received some additional basic radiation safety training from a responsible person or organisation. The important consideration is that the training is relevant to the real risks and situations that will be encountered at the exploration site. Such training courses are available in several countries and usually vary in duration from 2-5 days. There seems to be no standard course with international accreditation as yet, and this is an area where producer organisations or international agencies may wish to consider combining their efforts to establish the correct levels of competence for radiation safety technicians to work on uranium exploration sites. This could perhaps, in future, even extend to some form of accreditation for courses that are specific to the uranium mining industry's needs.

The uranium industry and authorities in Australia are approaching the problem through the activities of a working group that has been established within the Uranium Industry Framework (UIF). The UIF, sponsored by the Commonwealth Government's Department of Resources, Energy and Tourism, was set up in 2005 with the objective of identifying "opportunities for, and impediments to, the further development of the Australian uranium mining industry over the short, medium and longer term while ensuring world's best environmental, health and safety standards". The UIF is composed of experts from all facets of the uranium industry in Australia including mining and exploration companies, the Australian producers' lobby group (Australian Uranium Association-AUA), the governments of South Australian and the Northern Territory, other interested parties from industry and other stakeholders.

In a major report published by the UIF Steering Group in September 2006, 20 recommendations were made in relation to the future of the Australian uranium mining industry. Three of these are of particular interest to the radiation protection aspects of the industry's future:

> *"Recommendation 2*
> *The Australian Government, Sate and Territory governments and industry, in consultation with relevant educational institutions, should develop a course on mining-related radiation safety and protection to meet the needs of mining operators and regulators, including accreditation of coursework and related industrial experience and the development of a national certification process for radiation safety officers.*
> *Recommendation 3*
> *Industry in partnership with the Australian Government and relevant Sate and Territory governments will work with educational institutions to develop strategies aimed at attracting current personnel from industry into relevant established courses, where available.*
> *Recommendation 12*
> *The Australian Government should work with relevant State and Territory governments to establish cooperative arrangements with industry to ensure that permanent records of the radiological dose history of uranium industry workers are collected, maintained and retrievable*."

The first two recommendations follow the thrust of much that has been expressed in this paper and elsewhere in the global industry in relation to the acute shortage of skilled and trained radiation safety and protection workers in the uranium mining industry. The third point (Recommendation 12) is another area of concern in relation to radiation safety which has not been properly addressed in many locations. Workers in the mining industry are often nomadic as the mines they work in open and close often over relatively short time spans. Several new uranium mines in development may have projected lives of 10 years or less. This could result in a worker moving to 2, 3 or even 4 mines over a working lifetime. In the interests of ensuring the highest standards of radiation protection to workers it is important that any previous dose history is known before new workers are placed in some areas. Even though projected dose rates at a given work location may be well below the regulatory limit the operator's duty of care requires that they take all reasonable measures to ensure that worker will not be exposed to a dose in excess of the limit. This requires that the workers' previous dose history is known. Such a national registration system has been practised in some countries previously and currently, but is only now coming into force in Australia. Best practice safety management would now require operators to be aware of all previous radiological exposures of their work force so that they can be sure regulations are observed and safety standards enforced.

Within the UIF the Skills, Training and Education Working Group (STEWG) examined the Australian national training situation for skills in the uranium mining industry and produced a draft report late in 2007. One of their findings was that the situation in relation to the availability of trained radiation safety staff was poor enough that it could become a constraint to the industry's future development. The main recommendations of the report are that there should be consideration given to the creation of a specialist training programme for RSOs. Such a qualification could be achieved as a one semester stand-alone course but would most likely be best acquired as an addition to an existing qualification or degree in physical science. Similarly radiation safety technicians could be trained through the introduction of a one week course which would need to include both classroom and field teaching sessions. The importance of hands-on training in such a course cannot be emphasised enough. Consideration should also be given to the preparation of an industry-wide basic radiation safety course that could be offered to all potential employees in the uranium mining industry. Such a course need be little more than an expansion and consolidation of the basic radiation safety briefings that are given to all new employees at existing uranium mining sites.

Apart from the direct training of all the staff it is equally important to provide access to mentors and networking connections to fellow professionals so that newly engaged, trained and appointed radiation safety staff can discuss issues arising from their site specific situations. Wherever possible the use of secondments to working operations as an integral part of training should be investigated. The interchange of staff between sites and between regulators and operators can greatly improve working

relationships when each side has a better understanding of the requirements and practices of the other. Such opportunities should be followed up as much as possible. It is important that regulatory staff have some field experience to be able to better perform their tasks in overseeing all the radiation safety aspects of uranium mining operations.

Another potential problem is that in some jurisdictions, especially in countries new associated with the uranium industry, there may be little previous experience of uranium mining or exploration, and so any training has to undertaken outside the home country, or perhaps even out of the region. Additionally, the current high level of activity in field operations has left few people free to undertake training in addition to their regular duties in mining companies or regulatory bodies. Academic training facilities can help to make up some of the shortfall, but these facilities often have no access to working sites and so lack the ability to show students examples of real field conditions. The importance of the practical element in training for field operations should not be underestimated. Working conditions in the field require a different approach to that used in the comfortable surroundings of a classroom, a laboratory, or a factory environment.

As previously stated the potential for the shortage of skilled radiation protection staff to constrain future uranium mine development is not just confined to Australia. Other current and future producer countries have expressed similar concerns and raised the idea that there is a global need for suitable training that needs to be focussed on the immediate problems of fining enough radiation safety specialists. The IAEA does support some short course training of this type, usually organised through the organisation's own Technical Cooperation programme (TC). This may be done as either a regional or national initiative, depending on the demand and the local situations. Nominees from Member States may also be supported through TC to receive specialised training in countries other than their own. This does add to the knowledge and experience base for the future RSOs. However, as stated previously, the capacity available to provide the training is nowadays often exceeded by the demand, especially in areas of the world where uranium exploration is developing and becoming very active. A joint effort by industry and governments, perhaps coordinated by an international organisation of industry body may be the best solution, if resources can be made available to support such an initiative. Certainly the possibility of standardising the training and subsequent qualifications would ensure that acceptable international standards were being maintained in this most important area.

In a resolution passed during its General Conference in 2003, the IAEA General Conference re-emphasized the importance of education and training in establishing and maintaining an adequate radiation protection and nuclear safety infrastructure. The IAEA has developed training materials for use by Members States, including post-graduate courses in radiation safety. Other examples of the activity the IAEA is currently involved in can be seen in TC projects being run at the present and in the plans for the future programme, due to run from 2009-11. In the former Soviet Republics of Central Asia the IAEA has been running a Regional Project on remediation of uranium mill tailings and associated legacy sites since 2005. One objective in the programme has been to enhance and upgrade existing environmental monitoring and surveillance services, including radiological monitoring for workers at remediation sites and the communities in nearby settlements. The programme has included field training, workshops, scientific visits and fellowships and the introduction of international safety standards. The workshops were designed around IAEA Safety Guides and Safety Reports, which were also used as basic texts throughout the project. It is hoped his project may be expanded to cover more European nations in the new cycle starting in 2009.

The IAEA is currently organising two other TC regional projects specifically aimed at strengthening institutions in the regulation of uranium resource development in Member States in Latin America, which is current, and Africa, which will run in 2009-11. The issue of radiological protection and safety for the workers as well as the environment and the public is an integral part of the agenda in these projects. The plan is for these projects to include an overall assessment of the strengths and weaknesses in regulatory systems in participating countries and then target common areas of activity where upgrading can be implemented through a combination of regional training courses and topic specific training such as fellowships. In addition there will be a number of scientific visits organised for selected participants which will allow them to see first hand how radiation protection and other

regulatory activities are being managed in existing uranium mining operations. In Member States where there is little or no existing regulatory infrastructure, additional national TC projects may be implemented to accelerate the establishment of necessary services in specific situations. The IAEA is also liaising with other international agencies working in Member States on development projects where there are opportunities for synergies in delivering technical assistance that will enhance radiation safety.

In a further initiative the IAEA is working with an international group of uranium regulators and, in association with the World Nuclear Association (WNA), many of the major uranium mining companies to help develop strategies and processes and guidelines for improved levels of safety in all aspects of uranium mining, including radiation protection. Whilst the IAEA already publishes an extensive range of Safety Standards and Safety Reports related to radiation and waste safety that are applicable to the uranium mining industry, the work with WNA has led to their publishing a document in 2008 "Principles for Managing Radiation, Health and Safety, Waste and the Environment". This is the first output from a joint IAEA/WNA process, begun in March 2007, with the aim of providing industry-specific guidance materials to augment the existing resources, including the IAEA range of safety standards. The plan is to assist newcomers to the uranium mining industry to improve safety performance through the introduction of best practice, be they regulators or operators. A further meeting for this project is scheduled to be held in Vienna in October 2008. One outcome from that meeting is hopefully going to be the development of improved contacts between the major players in uranium mining and some of their new colleagues from both sides of industry.

6. Conclusions

In June 2008, at a uranium mining conference held in Adelaide, Australia, the question of radiation protection staff shortages was mentioned during discussions held in the context of overall shortages of skilled human resources. A senior industry manager responded by saying the situation had been the same in the 70s and the solution then was to hire scientific staff away from other industries and recruit young people with the basic hard science education required. The implication was that the same solution would be the way to resolve the same issue today. Sadly the situation is very different in the 21st century. Fewer young people with physical science qualifications and many more industries seeking to employ them mean that the competition for the staff is now much more intense. The global mineral resources sector generally is expanding its activity so rapidly that the competition for specialised staff is extremely intense. Uranium mining is an industry that has a vital part to play in the provision of future energy supplies for the world as well as supporting a number of other essential activities such as the medical and industrial areas to say nothing of its possible beneficial effects in the battle to reduce greenhouse gas emissions.

But this industry cannot be sustained or develop without an adequate supply of RSOs and suitably qualified support staff who will ensure that the industry has sufficient resources to operate in a safe and effective manner that is protective of the worker, the public and the environment. The existing supply of radiation safety personnel is being stretched to its limit; and the aging of this valuable group means that replacements as well as new members of the radiation safety workforce need to be obtained soon and a future new supply assured for the future. The increasing demands for RSOs from the minerals industries, the medical field and other areas of industry where nuclear science has such important applications, further exacerbates the current staff shortages. The uranium mining community, both regulators and operators, and the radiation protection community need to work together to provide a suitable and sustainable response to this situation.

One solution may be for the regulators and operators working in the uranium mining industry to work together and with educational and training institutions to encourage new entrants into suitable courses of study that would lead to qualifications as radiation safety workers at the various levels required. Such encouragement may include scholarships or perhaps "sandwich courses" with periods of industrial training interspersed with the academic semesters. These activities could be organised on a regional basis. This would ensure some degree of consistency in regions and facilitate international

accreditation schemes. Such programmes ought to result in a steady supply of new, trained professionals with both academic and practical knowledge upon taking up employment.

Without doubt there is a global shortage of suitably qualified and experienced radiation protection and safety workers. As with many sections of the nuclear sector, the rapidly expanding international uranium mining industry is likely to need many more of these staff than are available at present, especially over the next five to ten years. There is also a need for a longer term assured supply of personnel as replacements for the inevitable retirements associated with the present aging workforce. All these people will be needed to staff not only the existing mines but also those new uranium mining projects that seem likely to develop over the next 10 to 20 years. Only through the training, development and involvement of these radiation safety professionals can we be assured that uranium mining will be developed in a safe and secure manner.

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