NORM training: increasing awareness, reducing exposure

Richard van Sonsbeek

RTD Radiation Protection Services, Röntgen Technische Dienst bv, The Netherlands

Abstract
At the request of a major oil company in Africa, RTD has developed a NORM training for operational personnel. A distinction was made between Radiation Protection Technicians (RPTs), and Radiation Protection Supervisors (RPSs).
The training consists of a theoretical and a practical part, and is given "in house" at the production locations. This makes it possible to do practical exercises at the workplaces of the students. Both the RPTs and the RPSs learn how to perform and interpret radiation measurements. In addition, the RPSs learn how to inspect, and supervise work involving NORM independently, including the necessary measures to be taken to protect personnel from getting internally exposed to ionising radiation, and the ways in which dispersal of radioactive material into the environment can be prevented.
Our experience shows that with relatively little effort, and low cost it is possible to increase the awareness of operational personnel for the hazards of NORM. In this way a reduction of occupational dose and an increased protection of the environment can be achieved, even in countries that do not have as developed knowledge infrastructures for radiation protection as in the western countries.

1. Introduction: NORM in the oil and gas industry

The oil and gas industry is one of the industries that is faced with the problem of naturally occurring radioactive material (NORM). The production streams contain radionuclides of the ^{238}U series and the ^{232}Th series. The formation water contains cations of calcium, strontium, barium, and radium dissolved from the reservoir rock. The radium isotopes ^{224}Ra, ^{226}Ra, and ^{228}Ra thus appear in the water co-produced with the oil and gas. Pressure or temperature drops can lead to the formation of sulphate and carbonate scales on the inner walls of a production installation, and in sludges. Very thin films of Pb-210 occur as the result of the decay of ^{222}Rn that is generated in the reservoir rock and travels with the gas-water stream. ^{210}Pb also appears in sludges resulting from the direct mobilisation of lead from the reservoir rock. The parent nuclides ^{238}U and ^{232}Th are not mobilised from the reservoir rock.
For radium isotopes in sludges and scales activity concentrations ranging from 0.1 Bq/g up to 15,000 Bq/g are reported. The activity concentration of ^{210}Pb can be as high as 1,000 Bq/g. Taking into account the large volumes of scale and sludge that can be present in production installations, it is clear that care should be taken when work is performed on such installations. The workers should be protected against the harmful effects of these radioactive materials, particularly against internal contamination. They should perform their work in such a way that also members of the public, and the environment are not exposed to ionising radiation due to uncontrolled release of radioactive materials and contaminated objects. Further the work should be performed in such a way that the volume of radioactive waste that is generated is limited, because the disposal thereof can be a problem. More information on NORM in the oil and gas industry can be found in Safety Report Series No. 34 of the IAEA [1], and the references mentioned in that publication. In this paper we describe the way in which an oil company operating in a less developed country dealt with the NORM problem, with an emphasis on the training of its workforce.

2. Case history

In 1995 RTD Radiation Protection Services performed a NORM survey for a major oil company in African Country. During this survey NORM contamination was found at various installation parts, that were either still in operation or were supposed to be disposed of as scrap metal, and it became clear that the oil company had a NORM problem.
The Radiation Advisory Committee (RAC) of the oil company reacted to this problem by developing NORM procedures with the aim to implement the policy of the oil company to protect its personnel, the environment and the public against the hazards of exposure to ionising radiation due to its activities. There are no specific regulations on ionising radiation and radioactive material in the African country where the company operates, let alone regulations on NORM. However, being one of the operational

companies of an international group of companies, the oil company has to comply with the group regulations as stated by the group management.
Since the oil company is of Dutch origin, these group regulations are partly based on Dutch regulations and practices. This means for example that material is classified as radioactive material if its total activity concentration (calculated according to a specified rule) is higher than 100 Bq/g, as in the old Dutch regulations. In the field an action level is set at three times background radiation level for materials that are suspected to be radioactively contaminated, which is the same action level as applied by Dutch oil companies. Sample have to be taken and analysed for a final classification.

3. The radiaton protection organisation and the role of the students

The oil company uses Radiation Safety Experts of RTD Radiation Protection Services to perform the tasks of a Radiation Protection Advisor (RPA). The tasks of the RPA are to make policy proposals and, after these have been adopted by the RAC, monitor the implementation of the policy, and to provide expert advice for all matters concerning ionising radiation. The oil company also uses the expertise of other radiation experts in the group of companies.
According to the oil company's manual on ionising radiation a Radiation Protection Supervisor (RPS) shall perform measurements and supervise work involving ionising radiation. One of the RPSs is appointed as focal point, and will act as representative on behalf of the RPA, and directly report to the RAC. A RPS can be supported by several Radiation Protection Technicians (RPT), e.g. maintenance operators. A RPT only needs to measure the count rate when a specific part of an installation is opened and report this to the RPS. A RPT will have to follow the instructions given by the RPS. In table 1 the tasks and responsibilities of RPSs and RPTs are summarised.

The RPS shall:	The RPT shall:
- inspect and supervise work involving ionising radiation - ensure quality assurance of radiation protection - organise the required monitoring and sampling - qualify waste with respect to radioactivity - ensure that radioactive waste and NORM-contaminated equipment is stored, packaged and disposed off in compliance with regulations and procedures	- measure count rates whenever no data are available on installation parts to be opened - register and report the results in compliance with relevant NORM procedures - notify the RPS if count rates exceed the agreed standard, i.e. 3 times background - supervise routine NORM jobs

Table 1. Tasks, and responsibilities of Radiation Protection Supervisors and Technicians.

To fulfil his job a RPS shall be trained in basic radiation safety, and specifically in the handling of NORM. The RPS shall have knowledge of the company's manuals and procedures on ionising radiation and NORM. Next to attending a course he should also have gained some experience by assisting another experienced RPS at non-routine jobs with respect to NORM.
A RPT shall be trained in using available radiation monitors to measure NORM. A RPT shall have knowledge of the company's NORM procedures concerning the registration and reporting of measuring results. He shall have assisted a RPS at routine jobs with respect to NORM.
At request of the oil company RTD Radiation Protection Services has developed a NORM training both for Radiation Protection Technicians (RPTs) and Radiation Protection Supervisors (RPSs).
The fact that an independent institute provides the training can be an advantage because in that case the credibility for the employees is larger than when the employer himself provides the training. After all, radioactivity and ionising radiation can be emotionally charged subjects.

4. Objective of the training

The main objective of the training is to create a general awareness of the risks of NORM because it means a hazard for the workers, the environment , the local population, and in the end the world population. Think of the transport of contaminated objects to workshops and of contaminated scrap metal.
Giving these training courses reduces directly the first risk, i.e. the sanity of the workers because these persons are taught in a direct manner how to deal with and to handle NORM. It may be

expected that the awareness of these risks will diffuse from the directly addressed group of lower and medium level technical employers through the entire company, and perhaps even into the society. The workers unions will be very helpful in the process.
In addition to the reduction of the risk of exposure to ionising radiation, more knowledge of the subjects "radioactivity" and "(ionising) radiation" can be reassuring because they often cause agitation amongst non-educated workers.

5. Main elements of the course

The training consists of a theoretical and a practical part, and is given "in house" at the production locations. This makes it possible to do practical exercises at the workplaces of the students. Students can directly ask questions concerning their own risk.
Both the RPTs and the RPSs learn how to perform and interpret radiation measurements. In addition, the RPSs learn how to inspect, and supervise work involving NORM independently. They learn about the necessary measures to be taken to protect personnel from getting internally exposed to ionising radiation, and the ways in which dispersal of radioactive material into the environment can be prevented.
The population of students is a mixed population with regard to culture, education, and work experience. Most students have no background in physics, and therefore some of the physical background of radioactivity, and ionising radiation must be treated.

The course consists of the following elements:

- basic atomic and nuclear physics: atoms, molecules, isotopes, radioactive decay;
- ionising radiation: the distinct properties of alpha-, beta- and gamma radiation;
- interaction of ionising radiation with matter;
- dose and dose rate, annual limits;
- external, and internal radiation exposure, contamination;
- origin of NORM in the oil and gas production;
- detection of NORM (portable monitors)
- interpretation of measurements;
- the specific hazards of NORM;
- protective measures to be taken during work on NORM contaminated installations
- implementation of NORM procedures

The training is provided in English or in French, and each student receives a syllabus in one of these languages. At the beginning of the training a number of challenging questions are given on paper. Usually these questions cannot be answered by students that have no prior knowledge on radiation protection. However at the end of the training these students will notice that they are able to answer the questions, provided of course that the transfer of knowledge was effective. This method has been given the name “Test your knowledge”.
During the practical part each student can learn to perform measurements on some NORM contaminated objects. On request the group can also perform measurements at one or more workplaces indicated by themselves (reassurance).
The duration of the training for RPS is three days, and for RPT one and a half day.
Each student has to do a short exam at the end of the training. After passing the exam the student is provided with a certificate. The purpose of the exam is motivation of the students to pay attention during the training as well as feedback for the trainers.

6. The trainers

The trainers are radiation experts of RTD Radiation Protection Services that have broad experience themselves operating as RPS during NORM jobs at oil and gas production installations. They are used to communicate with the people on the shop floor. From the results of the training we provide in the Netherlands, we know that this has a big advantage, in spite of the fact that they are not professional trainers. The score of students with lower education is relatively high during formal exams.
During a trip the same radiation experts also perform radiation surveys in the production fields of the oil company. Therefore they can also inform the students on the extent and magnitude of the NORM contamination of the installations on which they are working.

7. Discussion

NORM is a world-wide problem. NORM contaminated objects can potentially be transported from one location to another location at another side of the world. Therefore the awareness of the hazards of NORM at the location were the NORM problem first occurs, either an oil and gas production location or the location of another type of NORM industry is of great importance. From our experience in the Rotterdam harbour, which is one of the world's biggest trading places for scrap metal, we know that the majority of the loads of scrap that are intercepted by portal detectors because they show enhanced radiation levels contain NORM contaminated objects.

Unawareness of NORM therefore also leads to a risk for oil companies to be hold liable for the consequences resulting from the transfer of contaminated equipment and scrap metal to other companies and other countries. Such incidents may also result in bad publicity. Increasing the awareness of NORM through training can prevent these unwanted incidents from happening. Training on NORM is relatively inexpensive, compared to the potential cost resulting from not taking the NORM problem serious. Most students are very motivated, because it directly concerns their own daily workplace. Sometimes the students who have been employed by the oil company for a longer period of time can provide valuable information regarding work performed in the past on NORM contaminated installation parts, i.e. before the NORM problem was known, and what was done with contaminated objects or waste.

NORM training is even more valuable because it creates awareness among the local workers, who in general will have longer contracts than the ex-patriots have, and who are expected to do most of the communication to the local society. Considering the trend of internationally operating oil companies to more and more make use of local workers instead of ex-patriots, it becomes even more important to train this group.

This year RTD Radiation Protection Services will provide the training for the fifth time.

References

[1] IAEA, Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry, Safety Report Series No. 34, Vienna, Austria, 2003.

Corresponding Author:
Richard van Sonsbeek
Röntgen Technische Dienst bv
RTD Radiation Protection Services
Delftweg 144, P.O. Box 10065
NL 3004 AB Rotterdam
The Netherlands
T: + 31 10 2088229
F: + 31 10 4158022
e-mail: r.van.sonsbeek@rtd.nl