Decontamination of Pipes and Other Equipment from the Oil and Gas Industry (NORM) in the Desert Region - 11268

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ABSTRACT

Naturally occurring radioactive material (NORM) which contributes to background radiation can be found everywhere on earth, especially in deep geological formations and there are several ways through which NORM can be released (e.g. through the process of extracting material from the earth). In order to extract oil and natural gases from underground reservoirs, water and chemicals are used to simplify the procedure. This enables NORM to become soluble in the fluid and thus provides a way for NORM to be transported out of the formation. When liquid is transported from the underground through pipes temperature and pressure are changed and consequently NORM and other materials precipitate.

The project presented in this paper shows a special situation of NORM handling in the desert region of Northern Africa, where special and new challenges had to be met in contrast to other European sites (e.g. at nuclear power plants or research centers). The project has been the first project of pipes' and equipment's decontamination in this region. National laws and regulations do not exist which made the application of other standards necessary. In addition, an appropriate method of decontamination had to be chosen which fully meets the prerequisites and conditions of waste management and environment.

INITIAL SITUATION

sat. Kerntechnik GmbH received the inquiry for issuing an offer for the decontamination of contaminated production pipes and equipment components from the oil and gas industry at a site in the Northern Sahara desert region (Picture 1, 2).

The contamination was mostly Rn-220 and related nuclides which in the past remained untreated or handled by a high-pressure water blasting method leading to high amounts of secondary waste (ie. waste water which needed to be treated separately and with high efforts).



Picture 1, 2: Site with containers for decontamination plant

In detail, the inquiry included the decontamination of past flare systems with associated systems, pipes from the dismantling of flow lines and casings as well as gas pipes, drainage water pipes and complicated geometric structures. A detailed classification of pipes and equipment parts, from which a difference in handling the pipes and parts results, was already carried out and presented by the customer. With this classification an environmentally and resources-friendly waste management under consideration of conventional and additional nuclear waste management guidelines was intended. It is planned to collect the nuclear residues resulting from the pipe cleaning activities as secondary waste in drums and to bring it into controlled disposal, while the then decontaminated steel parts are re-used again in a normal material cycle.

The project foresees different stages which should first take place in Germany (technical preparation and engineering, mobilization and shipment of equipment) and then on site in the desert region (installation, operation, clearance measurement, handling of residues, disposal of material). In addition, two visits to the desert site by a team of our engineers were made in order to get a better understanding of the work and its conditions and to make adequate proposals which perfectly fit the needs for the engineering and the project work.

It is expected to have approx. 1.000 tons of material cleaned and cleared until the end of the first cleaning campaign (Picture 3, 4, 5).

Picture 3: Pipes and equipment for decontamination



Picture 4, 5: Pipes and equipment for decontamination

During the offer phase and the following planning phase several challenges had to be met with regard to the decontamination technique and method to be applied and additional conditions which had to be taken into consideration carefully.

Due to the existing climatic and environmental conditions (desert region) a dry (ie. water-free) decontamination method had to be applied. This method had to be robust and reliable too, in order to sustain operation and function at outside temperatures up to 55 °C and regional isolation. The team had to be well aware that external repair services, maintenance or constant technical support to keep the equipment running without failure or break-down cannot be performed easily under the given conditions.

To meet the technical specifications of the customer as noted the complete engineering was made with specially trained and qualified personnel. At the same time an adequate radiation protection concept has been developed which in general complies with the basic German laws and regulations. The necessary measurement instruments for control and clearance measurements of the material, positing systems and monitors were arranged for.

In addition, a logistics' concept needed to be set up to ensure the proper transportation of the pipe cleaning equipment to the site. The equipment developed was designed modularly; by this, it enabled the whole equipment to be packed in overseas containers and shipped to the site. Once on site the equipment was assembled again by a qualified team of personnel and put into operation finally. The required documentation for transport and import, including necessary authorisation and approval documents, and were provided in cooperation with the customer.

Furthermore, the logistics on site needed to be designed to be highly independently from outside supplies and deliveries. The equipment's design was planned for permanent operation (at least six months at 10 hours per day (ie. 1.800 operating hours per half year) with high reliability. Easy maintenance and repair with standard spare parts enabled the operators' team an uninterrupted operation in the set timeline. Spare parts were included as a part of the first shipment to the site to ensure permanent operation and to be independent from any time-consuming and expensive delivery and supply from outside which would have cost a loss in project and operation time.

The team operating the equipment consists of experienced and qualified employees of sat. Kerntechnik. Additional support is given by local staff from the customer. For the German operator team, additional logistical requirements of entry regulations, visa application and granting and (in the country to work in) the provision of desert passes by local staff who is employed at the customer's company were encountered. In parallel, a back-to-back team has to be established and prepared to enable fast actions in case of unexpected situations (e.g. illness, accident, etc.).

THE APPROACH

On the basis of the company's long-term experience in the nuclear sector in Germany and Europe, a decontamination facility based on the "abrasive grit blasting" method has been designed.

The abrasive grit blasting offers an advantage in comparison to previously applied methods, such as a high-pressure water blasting method, because of the environmental aspect and the reduction of secondary waste. Both methods mentioned clean the pipes and equipment parts from contamination, but the high-pressure water blasting method results in high amounts of contaminated liquids to be collected in water tanks or basins with additional necessity for treatment and handling and might also lead to carryover of contamination to the environment.
The customer's request for consequent waste management under consideration of environmental protection, technical reliability and economics was also taken into account for choosing the most efficient and effective cleaning method.

The customer's requirements included the dimensioning of the facility to pipes of up to 10 metres length (approx. 32.8 feet) and diameters between 6 and 30 cm (approx. 2.36 to 11.81 inches) for decontamination of inner surfaces (inner surface decontamination).

Significant achievements by using this method have already been made and can easily show the advantage of no radioactively contaminated water remaining, but only dry secondary waste quantities which can be collected and packed in 200-l-drums and stored in an interim storage.

The dry abrasive blasting is used in a wide range of industries for many difference purposes, including the removal of contamination in pipes, especially for very resistant scales. In this method compressed air is used to propel the grit material (corundum, steel grit, steel shot) from a blast pot through a blasting hose to a nozzle that is manually controlled by the operator. In automatic and closed systems, the hose is fitted to a lance of approx. 12 metres with blast head that is maneuvered by a lance trolley. For the cleaning of inner pipe surfaces, the lance is inserted into the tube up to the rear end, which is connected and tightly sealed with the collection adapter of the abrasive recovery box. Due to the vacuum prevailing in the collecting adapter, the abrasive material is recovered and conveyed to the reclaim unit. The produced waste (dry scale debris, dry smashed grit) is collected in a disposal drum. By applying this method, the quantity of grit material, and therefore secondary waste, can be reduced to a minimum.

In total, secondary waste can be calculated at approx. 2,5 tons at a decontamination of about 1.000 tons of pipes and geometrically complicated structures which means about 5 drums of 200 litres each.

The facility designed was produced, initially assembled and tested in Germany. After a presentation and test run with the customer, the final technical acceptance procedure took place. After that the facility was disassembled and packed in eight oversee containers of 40 feet, shipped and than transported by truck to its final destination. The containers' design provided for their use in the desert as workplace. Therefore, the facility was assembled again on site in the

containers and put into final operation (Picture 6, 7). The same team took over main responsibility for usual operation and the pipe cleaning process. Some support is given by local staff from the customer's company, mainly concentrated on the handling of the pipes before and after the pipe cleaning process, but without any radiation protection or special technical experiences.


Picture 6, 7: pipe cleaning facility

CLEARANCE

After having completed the pipe cleaning work, the team member responsible for radiation protection and clearance carries out the control and clearance measurements for the cleaned parts (Picture 8, 9). This procedure enables the customer to fully release 100 % of the cleaned parts for re-use or recycling.


Picture 8, 9: clearance measurement

Clearance measurements for material suspected and classified as uncontaminated is performed by experienced staff of sat. Kerntechnik; the final acceptance is performed by an external expert who is appointed by the customer. If the area specific β-activity turns out to be above the defined clearance limits, the material will be classified as contaminated and returned to the cleaning cycle.

The measurement methods in general, as well as the clearance limits are clearly defined by the customer and form the indispensable prerequisite for all works on site. Due to the large volumes of contaminated pipes and parts, a measurement procedure combined with a statistical method for

the assessment of the results has to be applied. The compliance with the derived limits for the β-count rate has to be proven. The measurement points are to be marked and the results of the clearance measurements are to be documented and delivered to the customer on a regular basis. For quality assurance the customer is entitled to check the results of the clearance measurements by its own measurements of the residual surface contamination for a certain percentage of randomly selected sampling points. Any defaults are reported immediately to the operating team and further defined actions need to be taken in order to reach full compliance with the clearance limits as defined. In addition, full documentation in accordance with German laws and regulations is made on site by the team in cooperation with the external expert under close surveillance by a radiation protection responsible from sat. Kerntechnik.

With regard to the clearance criteria, the countries in the Northern African desert region do not have an explicit law or set of regulations for the clearance procedures, methods and limits. Until the project started, decontamination was made only to remove surface contamination, but not to have the pipes and equipment parts to undergo a fixed clearance procedure. The complete clearance procedure was defined by the customer in dependence on the German regulations of the Radiation Protection Ordinance with its demanding and strict clearance handling. In detail this means that the surface contamination of inner and outer surfaces of the pipes is not allowed to exceeed 0,05 Bq/ cm α-activity.

The works and services performed and the external expert on site are generally based on German laws and regulations. The German Radiation Protection Ordinance is fully applied and has to be respected at any point in time by all people working on site, the external expert and the additional customer's support staff without any exception.

SAFETY

During the operation activities and within the framework of the project the company takes the general accident prevention regulations (i.e. fire prevention, emergency scenarios, etc.) and the radiation protection regulations into consideration. The radiation protection actions fully comply with the valid German Radiation Protection Ordinance.

The decontamination facility is located in a separate and specially labelled area ("radiation area") with warning notices.

Occupational radiation protection measures and general HSE measures with respect to the staff are performed and controlled. Potential emissions of radioactively contaminated dust/ mist from the exhaust of the cleaning facility into the environment are monitored and solid radioactive residues are collected in appropriate drums.

It is only possible to access the containers by passing a positing system. Wearing personal protective clothing is obligatory and, of course, includes the personal dose meter including the required analysis by German authorities for proper record.

Besides the already described vacuum system of the facility as a closed system, the containers themselves are equipped with a constant air stream and a dust filter, as well as a person's measurement system (i.e. for hands, feet, clothing, etc.). This also mitigates the risk for distributing radioactivity into the environment. For emergency cases a safety shower system with an automatic water-collecting system is installed, too.

The containers shall only be accessed by trained and qualified personnel and it is left up to the decision of the responsible radiation protection team member in each single case to grant or refuse access for people who are not directly involved in the regular cleaning activities.

ADDITIONAL CHALLENGES

In the course of the project, it turned out that not only pipes are contaminated, but also smaller equipment parts, pipes with complicated geometric structures and pipes' outer surfaces.

For the above mentioned parts, special cleaning solutions needed to be established to ensure a cleaning and clearance quota of 100 %, too.

For smaller parts a blasting box or cubicle is used (Picture 10), which was already implemented and operated by sat. Kerntechnik in Germany in some other projects and nuclear power plants. With the help of the blasting box the team is able to clean smaller parts fast and effectively.

Picture 10: blasting box for small parts

The parts of complicated geometric structures (Picture 11, 12) are pipes with angles and turns, valves or fittings. A direct cleaning in the existing cleaning facility or in the blasting box cannot be carried out in most cases, because a cleaning result of 100 % cannot be reached at once. However, for including these parts into the cleaning and clearance processes they are cut and sawed into smaller pieces with standard cutting tools, such as band saws, angle grinders or keyhole saws, and then inserted into the cleaning facility or the blasting box. Afterwards the control and clearance measurements can be made within the defined limits.


Picture 11, 12: complicated geometric structures

For cleaning the pipes' outer surfaces, a facility extension was designed and installed for the existing equipment. The pipe cleaning is made by using a specially produced vacuum cleaning heads which enables a fast and efficient cleaning (Picture 13). The blasting grit and scales are returned to the cleaning facility during the cleaning process; scales and blasting grit are separated from each other the in the facility. The scales are collected in drums and marked in accordance with defined standards and regulations, while the blasting grit is returned to the cleaning process.

Picture 13: outer surface cleaning of pipes

CONCLUSION

The project's participants have faced several different requirements and challenges in the various phases of the project. For example, during the planning and production phases, climatic and local conditions had to be taken into consideration, besides the standard criteria for cleaning contaminated pipes. In addition, unexpected events, such as changes to the initially planned installation process or sudden undersupply (e.g. of electricity) had to be considered, planned and calculated. For the operating period of pipe cleaning, the quantity of spare parts and consumables had to be considered and provided for.

In general, the planned and expected, as well as the unexpected events could and can be met with high flexibility from all parties involved and the project's first decontamination campaign can be completed and finished at the satisfaction of all participating parties by the end of December 2010.

In this project, large experiences in the field of decontamination have been proven. And the company has shown that nuclear know-how can be applied globally within the framework of responsible environmental protection and will have to be applied in many more projects in the near future. Different departments of sat. Kerntechnik GmbH (e.g. radiation protection engineers, mechanical engineers and operating staff) have closely cooperated with great success!

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