Interview with the head of the Waste Management department of a service provider specializing in the dismantling of nuclear facilities (July 16, 2024)
Length: 1:15h

PM:

Could you start by describing your activities and responsibilities at [company]?

Expert:

I am the head of the Waste Management department. Waste management means that we take care of the waste treatment of radioactive waste from operating facilities as well as facilities that are being decommissioned, and also the pure waste treatment of research facilities. We also take care of the decommissioning that comes before waste treatment and all activities involved in decommissioning. However, in recent years, our activities have been largely limited to a few decommissioning activities here in Germany.

PM:

Can you describe in general terms what projects you have had in the past? Which areas of decommissioning have you been looking at recently?

Expert:

I'll stick to the most recent projects related to decommissioning that we have actually carried out. One of the larger projects is the decommissioning of the steam generators at [nuclear power plant site] using wire saw technology. And the next largest project we had was the dismantling of the primary circuit at [nuclear power plant site]. This naturally included steam generators, pressure vessels, and other such items that we dismantled. Otherwise, we also had dismantling activities in combination with waste treatment facilities.

PM:

How long do these projects take? Are we talking months or years, and are there typical phases?

Expert:

The implementation of such dismantling projects, let's say [nuclear power plant site], certainly takes two to three years. This includes the planning phase, the manufacturing phase of the relevant facilities, execution, and then the clearance measurement. However, a primary circuit like this is not that big or that complex. I can remember another project involving the decommissioning of the research reactor in [location of a research reactor]. The execution phase took three months and the total execution time was over two years. This shows that the planning and approval phases can be very long, and only then does the execution phase begin.

PM:

This means that the actual time spent in the nuclear technology facility is significantly less than the total project duration.

Expert:

Yes, that is actually the shorter part. But it's also easy to imagine. The best example I know of is the replacement of steam generators in a plant that is in operation. The replacement of the steam generators takes 30 days. The planning time for this and the design phase beforehand took a good two years.

PM:

Who are the stakeholders in your decommissioning projects?

Expert:

We have the operators who issue the tender and award the contract, and we have the companies involved who carry out the work. In addition, there are the licensing authorities and the expert report. These are the four main parties involved in the projects. And if I go into more detail now, looking at the companies alone: there are people who do the general planning. Then there are those who go deeper into the technology, who plan technical or new equipment and new facilities, right down to the design draughtsman. We can also achieve a certain depth in-house.

PM:

Of course, it always depends on the size of the project, but can you estimate how many employees in your company are involved in a project in relation to the number of employees of the other stakeholders?

Expert:

For a planning task for the partial dismantling of certain plant components, we have internal project management and mechanical departments such as designers, draftsmen, and electricians. I would estimate that to be around 10 to 20 people. On the operator side, there are certainly no more than half that number involved in the planning, with the expert accounting for another quarter, and the authorities actually play no role at all because they are only involved in the approval process. That would mean 100% on our side, 50% on the operator's side, and 25% on the expert's side.

PM:

What do you see as the biggest challenges in planning the decommissioning?

Expert:

For us, the radiological data and thus occupational safety are the most important factors. We have to protect people during decommissioning. And that raises the question of what level of protection we need and how we can implement it. And the question of how much money we have to spend. My former boss used to say, "Decommissioning is a dead horse that no one wants to ride anymore." In that sense, no one wants to spend money on it. This means that, on the one hand, we have to promote extreme occupational safety, extreme environmental protection, and health protection, and on the other hand, we are not supposed to spend any money. These two things conflict with each other. And resolving this conflict in a reasonable manner is quite a challenge. Technically, we can handle everything; that's not a problem.

PM:

Since you say that you can handle everything technically, do you encounter things on site that you didn't take into account during planning? Or do you know the moment you walk in that you can really execute it 100% as you had previously thought and planned?

Expert:

Unfortunately, that's an illusion. That's precisely the goal you're pursuing with your project. That's exactly the point: the documentation is certainly more or less incorrect. In this respect, it's clear that surprises will be encountered on site. And then you have to replan. It becomes difficult when certain spatial conditions don't fit. It is not always possible to measure the spatial conditions on site with 100% accuracy, so that you can draw everything one-to-one in advance and try it out. Sometimes it actually ends up being too tight. That's why so-called "mockups" are made for certain things, in order to reproduce the situation realistically in the workshop in some way and then test it. We are quick to replan, yes, but there are always surprises.

PM:

You just mentioned things related to geometry—i.e., spatial dimensions—which make you realize that certain dimensions don't quite fit. Are there also surprises when it comes to the material properties themselves? For example, are there areas where you notice that the radiation is higher than expected, so that you have to replan your protection concepts?

Expert:

Of course, we have had cases where the radiology did not fit. That means that somewhere there was stronger activation than predicted. We actually had this surprise during the dismantling of the biological shield of the research reactor at [name of a research facility]. There were so-called offset parts in the reactor, which are steel components that were hidden somewhere in the biological shield. And because we had beam pipes through which neutrons were sent, these were reflected into the Biological shield, including around the beam pipe, and activated parts that we didn't know were activated. You then have to respond appropriately to the activation in areas that were previously considered non-activated or low-activated. This is mostly a licensing issue, not a technical one. In most cases, you have a license for this or that area that you are allowed to work on. And if you then have to dismantle much more, you need a license.

PM:

When you notice such surprises on site, how does that work organizationally? Do you first talk to the operator, or how do the communication channels work?

Expert:

First of all, the operator is the second person we talk to. The first thing we do is talk internally. We have identified the problem and then, of course, we have to look at what the problem is. And the question is always: Is the permit we have affected, yes or no? And then you also have to look at how to communicate that. In any case, when there is a change, it is always good to think about it yourself first—this is the situation we have, what solutions do we have? And then I can approach the operator, the authority, or the expert.

PM:

Does claim management also play a role? I know from our experience in traditional civil and environmental engineering that it is no longer possible to earn a decent living with the fees that have actually been negotiated, and that negotiations take place at the negotiating table. Is it similar in Nuclear technology?

Expert:

Yes, of course. The additional expense. That's why you're tempted to weigh up the scope of delivery and services as carefully as possible in the offer. And if it's larger, then of course you have additional expenses. If I look at the example of [name of a research institution] again, I think we had to do seven more core drillings instead of one large one. That's quite a lot of extra work.

PM:

Back to dismantling in general. When you are commissioned to dismantle certain components, what kind of information do you generally need for this? Both geometric information and information relating to semantics, knowledge, or documents.

Expert:

When we draw up a work contract, the level of detail should of course be sufficient to give us a really well-developed concept that allows us to identify the scope of the dismantling work. It should be possible to use this concept to determine which team, which tools, and how much time will be needed to complete the project. In other words, I actually want a concept that allows me to glean precisely this information. Of course, I need radiological data for this, which then tells me how I have to protect people. It may also be that I have to replace people due to the limitation in the collective dose. When it comes to the biological shield, it depends on which method or demolition technique I use. It also depends on the request: Is it very precise or is it open to different techniques? If it is open to any technology, I naturally need to know what material I have, including its density and properties. With concrete, it's not quite as bad as with other materials such as zirconium: zirconium changes massively under neutron irradiation, and you can hardly break it with normal saws and cutting tools. You have to take a different approach there, with a completely different technique. And when it comes to neutron embrittlement in particular, you need precise data or test pieces to be able to test whether the tool is suitable or not. Then we clearly need the activation curves to know where we can work and how, i.e., remotely or at a distance with shielding, or perhaps even directly by hand. Not with the Biological shield, but with other mechanical components or a reactor, the question arises as to how the parts are assembled: Are they bolted or welded? The aim is to dismantle the whole thing in the same way it was assembled. But if, for example, a bolt has been screwed in and then secured with spot welding and you don't know that, you'll have problems. The remaining questions about what information I need all come up when reading the request.

PM:

You mentioned many material properties. Where do you get this information? In most cases, tenders from operators contain general information and then it is usually stated that further surveys may be carried out or that more detailed information will follow. Where do you ultimately get the information you need for your concept?

Expert:

If I stick with the biological shield, then of course I get the information from the operator. Sometimes they don't have it. The Biological shield of a nuclear power plant is relatively uncritical. The Biological shield of a research reactor is always something else. It makes perfect sense to carry out a preliminary sampling program. And I can continue with this sampling program because then I have the exact properties. There are many different types of concrete, and this can only be done with a sampling program. Then I can also test the tools. For example, if I now have concrete that has been enriched with iron ore, as is currently the case at [location of a research reactor] – or vice versa, the iron ore has been enriched with concrete. It had a density of 4.6 [t/m³] and was magnetic, so you could hold a magnet to it. It can be drilled quite easily. But if you try to dismantle it with a hydraulic chisel, you won't get anywhere. Then you have concrete like the one at [location of a research reactor], for example. It contained loose metal parts from the casting process. You can forget about any cutting methods with that. But you can only find that out by taking samples.

PM:

Do you also regularly receive information from the operator about the operating phase? When you dismantle a component, you see it for the first time. But the operator has, in the best case, decades of experience with it. Is there any kind of exchange of experience?

Expert:

No, not at all. No matter what I've gathered from my own experience so far, when the project starts, you begin searching through drawings and other documentation. It doesn't matter whether these are applications from the past or something else. The current status is certainly not very well documented in terms of drawings. Then you have to see where something has been changed. For example, have rooms been covered with a new coating? Is the coating toxic or not? You can only find out these things if you really dig deep. Maybe there's a colleague somewhere who still knows. This is the knowledge that is, so to speak, at the bottom of the iceberg [meaning the "knowledge iceberg"]. Only when you ask specific questions will you find out this kind of information.

PM:

Interesting. One might assume that it would also be advantageous for the operator if the contractors knew what was involved. And the more information you receive, the more likely it is that everything can be carried out on time and within budget. Or does the operator have a different understanding?

Expert:

The operator writes things down as an object description. He says: "Please rebuild a piece of bioshield for me. This long, this wide, this high, and our Archive is open for any further information. Once you have the order, you can look it up there and then rebuild the whole thing as you wish. But please at a fixed price." So you're not supposed to have any recourse. That means the operator either has no interest these days or doesn't know any better. He knows he doesn't know much about . He hands over all responsibility to the contractor and then cheekily says, "You're the experts." That's how it works these days. It's pretty much the opposite of fair.

PM:

I think that in the end, it creates stress for everyone involved and for the operator if they know better but don't want to share their knowledge.

Expert:

He doesn't know better. There are certainly some people who know better. But communication is certainly not as it should be.

PM:

How do you initially assess the spatial conditions when you start planning a project? Do you have the opportunity to visit the site and take a look at everything while you are writing your concept, possibly even before you get the "okay" for the job? Or on what basis is the decision made?

Expert:

The drawings play an important role. Here in the office, we can of course plan very intensively based on the drawings and also identify critical areas that need to be remeasured on site. We have also worked with 360° photos and point clouds. These allow us to remeasure some things and find out a lot of information. We haven't been able to use this for ourselves yet. Certainly not for the research facilities. In [nuclear power plant location], there was image material, but [also] this "real" 3D measurement with reference points? Perhaps it was still in its infancy. We have never really succeeded in transferring it to a 3D model and then working with it.

PM:

So even the operator has no interest in learning from you on site how you proceed. Planning is done purely on paper and is approved by the operator.

Expert:

Yes, of course. It's paper, obviously. You could present it better in the simulation. And if there are images, that's the basis for approval. We receive approval based on the paper documentation.

PM:

Do you think this paper level is sufficient?

Expert:

Yes.

PM:

Do you prepare documentation during the dismantling process? Is this agreed upon in the contract? During normal operation, regular inspections and maintenance take place, and if you have a project that takes several months to complete on site, then you also have some insight into the history . Apart from the pure dismantling work, are there any documents that you pass on to the operator?

Expert:

We have a tender, the tender documents. A concept is developed on this basis. The machines, equipment, and systems are then developed or selected. These individual devices are, of course, clearly documented. The dismantling concept is described in more detail in the work flow. These very detailed work flow descriptions contain certain checkpoints that are included as test steps. These test steps are used to document the dismantling process. Furthermore, the equipment, devices, etc. are subject to preliminary testing. This means that you have to plan them and the documents are submitted, prechecked, and then approved. There is a Supervisory process for the machines, and all test steps are already carried out within this Supervisory process.

PM:

How do you document on site? Do you do it analog or digital?

Expert:

It's all on paper.

PM:

What are the reasons for this? Has it always been this way, is it easier for you to archive it, or are the hurdles too high to switch to digital?

Expert:

What can I expect from digital?

PM:

For example, PDF forms that you fill out on site using mobile devices. Or that you have on-site access to a central document management system where filling out and creating a document also clearly defines where it belongs? So not like a loose piece of paper where you first have to look for where to file it.

Expert:

I think the only interface that is virtually electronic is waste tracking, but that's purely on the operator side. Otherwise, the general problem is that the operator has its own electronic environment. It has its network and it has its computers. If we wanted to do something electronically now, we would have to set up our own network. I think that's a relatively big hurdle, because we're definitely not allowed to work in the operator's network. Maybe others do it, but I don't know.

PM:

By network, do you mean information models or the internet, for example?

Expert:

No, not even the internet, but the intranet. The network has central document storage that we access. Take test steps or construction test sequence plans, for example, where you have a workflow: test steps have to be entered, and then you could track them digitally on tablets or similar devices, click on them accordingly, and work with them. To do this, you would have to access the operator's network. I'm not familiar with that.

PM:

That means all file exchange is bundled. You may agree on a shared file storage system with the operator, but it is clearly isolated from the outside world.

Expert:

Indicates placing a folder on the table Inspection folder — there you go. *Laughs*

PM:

OK, so it's analog. How is communication with the operator generally? Sure, it probably varies depending on the job or project, but is there such a thing as a project team? How is communication handled, for example, is there a regular meeting?

Expert:

That depends on the phases. What we always have are regular project meetings. Depending on the phase, these are sometimes monthly, sometimes weekly. The status is reported there. Sometimes there are agreed, clear structures for what such a progress report should look like. As we get closer to execution, there are of course all the acceptance tests for the equipment and facilities here in our workshop. Then there is relatively close communication with the operator. Next week, for example, we have acceptance tests where the operator often wants to be present, as does the expert report. Discussions take place on site almost daily. Every morning there is a construction site meeting; scaffolding, fire certificates, or other items must be registered. You need work approvals for certain things.

PM:

To what extent are the contractors monitored by the operator in their work?

Expert:

They usually have a representative from the operator on site who is permanently present. That's how I know it.

PM:

You said that when you encounter surprises, you first discuss them internally. But at that point, the operator is already aware of the situation.

Expert:

You're right about that, yes. *Laughs* We then communicate that we will take care of it first. You have to see whether the work needs to be stopped or not. And as soon as you enter a work stoppage, you must of course inform the operator immediately. Depending on the problem, you also have to weigh things up a bit. If I can continue working, I don't necessarily need to inform the operator . If I have to stop, then I clearly need to inform the operator immediately.

PM:

Do you have any insight into whether BIM or information models in general play a role in the operator's environment?

Expert:

With existing facilities, there are certainly ideas here and there to map them in a BIM model. I am familiar with these 3D images in some way, which you can use to start working on a BIM model. But that's about it, I think. No one has really thought it through to the end. For new plants, such as those currently being built [in a certain country], everything is mapped in the BIM model. But that's just for new construction.

PM:

Yes, I also think that this definitely makes sense for new buildings. But have you ever seen a BIM model being created specifically for demolition? Would that even be feasible?

Expert:

No, I'm not aware of that.

PM:

Can you imagine that demolition or demolition planning would be simplified in newer facilities where a BIM model is available from the outset?

Expert:

Yes, definitely. There is a general obligation to plan plants in such a way that they can be dismantled. And that means that operators today actually have to build a BIM model. That is certainly very helpful. If you can then incorporate the material properties [into the model], then we are already well on our way.

PM:

This principle of "decommissioning by design" is also a frequently used buzzword at scientific conferences. Even before a new reactor is planned, consideration should be given to how it can be dismantled as easily as possible later on. What distinguishes a reactor that can be dismantled easily from one that is more difficult to dismantle?

Expert:

At the end of the day, we usually have a space problem. This is often due to the logistics of decommissioning. This means that you need to have enough space or buffer areas available for decommissioning to temporarily store waste before it is cleared or further processed. [A larger facility leads to higher investment costs.] Access for certain tools is also difficult. Ultimately, we have dismantled all facilities that were not planned according to this premise. When you consider the problems that have delayed dismantling, there were a few spatial issues, but actually there were problems in radiology, such as contamination or insufficient buffer areas. In other words, the drainage to the rear was not suitable. How can I make something like easier to dismantle? By storing residual waste next door so that I have a large buffer area. In the plant itself, perhaps a little more space for dismantling from a technical point of view. I don't see much else.

PM:

Do you have any experience with reactors where there were deviations from normal operation, e.g., incidents? What does that imply for decommissioning?

Expert:

That's actually exactly what I just said. Incidents mean: Where do I still have contamination? At the end of the day, we want to release the plant from the German Atomic Energy Act (Atomgesetz � AtG). That means we have to bring a plant below the contamination limits. And that means I have to remove or remove contamination. If the contamination has now penetrated into any cracks or crevices, I have to do something to the building. If I dismantle something for this purpose, it may result in the whole structure no longer being as stable. And then I have to take structural measures to prevent it from collapsing. The other problem, even in Chernobyl, is that I have activity in rooms where I can't get to. To get there, I have to do something additional. Those are the issues, I think.

PM:

When would you say this premise arose that reactors should be designed and built in such a way that they can be dismantled as easily as possible?

Expert:

I think it's been around for decades. Do you know for sure?

PM:

I don't know either, that's why I'm asking.

Expert:

It's definitely been decades. It's just that no one thought about it.

PM:

It started in the 1960s with the German power reactors. I believe the premise already existed back then, but perhaps in hindsight we wouldn't recognize it that way now.

Expert:

The only one that is really extremely difficult, the [specific experimental reactor], is completely different. It's the nuclear research reactor that was built like a submarine. So it was certainly not easy to dismantle.

PM:

You said earlier that documentation on site is mostly done analog. You also mentioned that there are digital approaches to waste tracking. What does that look like?

Expert:

There is the ReVK, the Residual Material Tracking and Control System (Reststoffverfolgungs- und Kontrollsystem, ReVK). This is a program designed specifically for this purpose. For waste documentation that comes after Konrad [meaning the Konrad repository], the operator must declare exactly what is in it and where it comes from. This means that when I dismantle a component, it goes into a mesh box or a crate. This crate must be clearly labeled with the material it contains. In addition, certain barcodes or printouts are placed on this crate. The material is then further processed, shredded, or repackaged during the waste processing stage. At each step, it is clearly documented what happens to the piece that was dismantled. That's what waste tracking is for. And there is a central server and workstations in the plant where people are trained to make the appropriate entries so that the waste is properly tracked.

PM:

Can you also see where the piece is located in this waste tracking software? Or is it just a matter of matching the barcodes or QR codes on the container with the information about what's inside?

Expert:

The purpose of waste tracking is to say exactly that this component, e.g., a piece of piping, has exactly this activity and this mass, possibly—I don't know exactly—has these dimensions and is in this box that goes into this Konrad container. I need to be able to trace exactly that the part was dismantled there and then put into this Konrad container. Whether they have a tracking system to show where the part is currently located is possible, but I don't know.

PM:

That sounds reasonable. A system that all parties involved can actually access.

Expert:

Yes, ReVK can do that. NIS used to do that in Hanau, but they now belong to Siempelkamp.

PM:

What is your last point of contact with the plant? Are you finished, have you packed your things in these mesh boxes, taken your equipment, and left? Or how do you complete the work on site?

Expert:

Normally, the handover is made to the operator. The goal is to release residual waste as much as possible. The mesh boxes that are there are pre-measured. If they are eligible for release, they go to the clearance measurement system. After the clearance measurement system, they go to the next buffer area and wait for clearance from the authorities. They carry out random remeasurements and give their approval. And then there is the other route for residual waste, especially those that are packed into the Konrad containers. The handover takes place before the Clearance measurement system because it is usually not within our scope. However, there are other approaches where this is included. The pre-measurement actually completes the process. Then we know which materials are eligible for release and which materials should go into the Konrad container. And then there are orders where we pack the material into the Konrad container and then close it, which completes our task. Now I'm complicating the whole thing. By now, we know how to deliver it to Konrad. It may be cemented or filled with construction waste and then sent to Konrad. That can also happen with us, depending on the situation.

PM:

Let's conclude the topic of dismantling and move on to the theoretical level, to knowledge management. My working hypothesis for my imagined information model is that knowledge is most accessible when it can be anchored spatially. Do you think that in the nuclear technology field, a lot of knowledge is actually anchored spatially?

Expert:

I go to the archive when I want to know something, so it is spatially anchored. *Laughs* Maybe we should talk about this spatial anchoring. How do we do that? There are colleagues, there are projects, and we have an archive where you can look things up. And now you can also look things up on the server. There are lots of things we store there. How do I search in an online Archive? I never find anything there, that's the problem.

PM:

That might be the hook. What are you looking for? Do you think in terms of time periods, do you think in terms of specific components? What are your search criteria?

Expert:

Let me start the other way around. How do I organize my files? I organize my files according to plant. That means if I'm talking about [nuclear power plant location], [nuclear power plant location], or another plant, then I know I have to go into these [plant designations]. Of course, I have the link in my head. I know which projects were there. And you have to know that. Otherwise, you don't stand a chance; even assigning them by state won't work. For us, it only works on a plant-specific basis. There is also a parallel filing system where, knowing that you are dealing with a decontamination plant, for example, or high-pressure cleaning systems, you can find what you are looking for under that term. If someone has found something about high-pressure cleaning systems that is unspecific or not specific to a particular plant, then it is listed under the plant. I can also find something under terms such as machine, band saw, or wire saw. But that's about it. We actually have this link here, where I enter something in a database and then start searching, but it's difficult to use.

PM:

So that means that in order to find your way around such an analog or digital archive, you need a certain amount of prior knowledge to find the actual source of knowledge?

Expert:

Exactly, otherwise it's difficult.

PM:

My idea is that you don't have a separate, central [knowledge] Archive, but that you combine it with geometry. If we imagine a new reactor, where there is a BIM model and this is made available to you as the executing company: Would it be attractive for you to attach virtual documentation or knowledge modules to individual components?

Expert:

"Attaching knowledge modules" is a good keyword. Let's not stick with your example, but with what I said. We have ten reactors that we have decommissioned, then another ten where we have supplied waste treatment plants, and now there is another waste treatment plant that may be new, e.g., the IAEA is writing something new. I would like to include this information. But where do I put it, how do I link it? I don't want to make the link myself anymore. The next time I go into the search—I'm lazy, after all—how do I do it on Google? I want to enter two or three keywords and get all the results for them. That's how I do it everywhere, including on Google, or I continue my search. That's how I imagine it. So that means I take a piece of information, put it somewhere, but I can always access it. I don't have to search for it systematically anymore. As we said, with prior knowledge, you can find what you need, but that requires a certain systematic approach. And we end up searching unsystematically. And your question was, is that interesting? Yes. I just have to be able to pin it down. How the links are created—I have no idea. That's the main problem.

PM:

My question is mainly about the granularity level of the knowledge modules and documentation. Could you really always assign them spatially, even fictitiously? So that, for example, in the primary circuit, when I dismantle something, I would know that a module is attached to this pipe, and the next pipe, one room further on, has this module attached to it. Can you really subdivide it that finely? Are there elements where we say, yes, you could assign it that way, or is the current documentation situation such that thinking is more coarse and general?

Expert:

I'm not a fan of this level of detail. Personally, I can work with raw information and go into the details myself to see what it looks like in detail. You come from a slightly different angle and say that you can present a much greater level of detail. But can I process this level of detail? Let me compare it to order processing. What happens in order processing? In order processing, I set up a project structure and a corresponding project structure plan. This project structure plan requires a certain level of intelligence or specific thinking. Others have to follow the structure because one person is working on the topic and has to build on it. How successful is that? The whole thing is successful if you have three numbers in a project structure plan. If you have more than three, there is always something wrong with the assignment. And that's where I see the danger. The question is, what can the intelligence of the system do better so that I can track this level of detail? I really have my reservations about levels of detail. I think the example with the project structure plan illustrates this a little. People are lazy. "Do I have to pick out ten numbers again? I'll write them down—oh, I'll write everything down on one. Case closed."

PM:

But wouldn't it be advantageous if you could imagine putting on your VR glasses, going through the facility again, and being able to add information virtually on site? That would also be an easy way to enter things and possibly also more accessible th ly dealing with a clever idea that I have right now and that could help with the next project. What should I do with this idea? If I write it down on a piece of paper and bring it to your Archive, you know where it goes, but I can't find it again afterwards.

Expert:

When I attach this information, I have to decide where it makes sense and where it doesn't. For example, when we're at the primary circuit, we have the pressure holder, and on the pressure holder we have the so-called surge line. And this is almost always quite heavily contaminated. Now you have a shift in these high activities, keyword "fuel system decontamination." This is, of course, important information that can be pinned to the right place. "Attention – before system decontamination, the highest activity was here at this point and afterwards at that point." These are things that could and should be pinned in detail. And elsewhere, someone else has to decide whether it is important or not.

PM:

Do you think that in retrospect, i.e., for "lessons learned," people would be more willing to engage in detailed work because they would be more likely to see the added value?

Expert:

Yes.

PM:

How do you currently approach the topic of "lessons learned"? How should I imagine this when a project comes to an end? Do you sit down at the table again and document what is said? Who sits there?

Expert:

There is indeed a topic called "Lessons Learned." We deliver our lessons learned to a central location, which essentially manages them. You just have to read them. Of course, you need that initial knowledge of where the lessons learned are and that you can search for specific topics in the "Lessons Learned" folder. It would be interesting if you could filter by project. Otherwise, we already do a round with this iceberg knowledge [meaning the "knowledge iceberg"] here at our company. That's because we have daily discussions here, for example. Colleagues talk about what they are doing, and in this context, you can give advice. This is again feedback from experience, which is exactly what lies beneath. The ideal situation would be to have everything recorded, including electronically. But we still have a way to go.

PM:

I have researched a lot about implicit and explicit knowledge. The ideal scenario, of course, is to turn this implicit knowledge into explicit knowledge, i.e., make it accessible to others. But there are many studies and authors who point out that our brain is still the best information storage device for implicit knowledge. This naturally raises the question of how much I promote formats that encourage exchange between different people. Because, of course, other people can't look inside my brain, which is the disadvantage. But for a person on their own , experiential knowledge is already stored quite well in the brain. It is only through collaboration that the question arises of how I can best pass on this knowledge.

Expert:

Add a few more sensors and it'll work. *Laughs*

PM:

Can you give some examples of experiential knowledge from your decommissioning projects? What could be possible knowledge building blocks, smaller building blocks that accumulate?

Expert:

Ultimately, it's always about duration. What is always queried are Cutting times and non-productive times or setup times. And everything is based on that. A band saw, for example, cuts an area in a certain amount of time. That is the pure cutting time. Then you need setup times: you have to bring the band saw there, you have to position it, and so on. And with those two times, you have roughly the activity time on site, which is then influenced by masks and other difficulties, perhaps at height. Then you have the access times to the Controlled area or from the Controlled area boundary to the work site and everything else that makes up the work process. These times add up to a certain total time for execution. These are the things that are always asked about. And that's how we calculate all the issues, for example.

PM:

So you have empirical values from individual preliminary projects and then consider together how much these can be applied to a new project?

Expert:

Exactly. Earlier we talked about bioshelter. What pieces will it be cut into? Then you know what the pure cutting surfaces are. And with that, you know roughly how much cutting time I need. Can I do everything with the wire saw or do I have to drill, etc.? Then you have to see what technique you use. But for each process, there is a certain amount of time that you need.

PM:

Do you just have these times in your head, or is it written down and stored somewhere?

Expert:

We've written it down in tables so that we know how much time we need.

PM:

How do you train your own employees—especially those who carry out the work on site? Is it more a case of "learning by doing," or does familiarizing them with previous projects also play a major role?

Expert:

That depends on what qualifications we're talking about. The project manager or site manager has certainly done other projects before. And ideally, a younger colleague joins them, working alongside them and learning as they go. Ideally, the person who wrote the concept also works on site. That way, you already know what you're doing. And the people who operate the machines are mostly experts in the machines. If it's a new machine, we do training and mockups here. And we also test it here beforehand. The people who do this are pretty good experts. We do a lot of new things, and sometimes it's actually trial and error.

PM:

Yes, well, there are many unique projects, so there are always new situations.

Expert:

Yes, that's true. But as I said, they are good specialists who can handle it well.

PM:

Do you feel that the targeted transfer and application of knowledge is rewarded in your company or in Nuclear technology in general? What about the exchange with other people? Or does that tend to fly under the radar?

Expert:

When you say "rewarded," what exactly do you mean?

PM:

It doesn't necessarily have to be more money. But perhaps there is a culture in which people are specifically encouraged to share their knowledge on a regular basis. The transfer of knowledge could lead to social validation and fundamental recognition.

Expert:

There are various formats in nuclear technology, whether it's KernD [Kerntechnik Deutschland e. V.], KONTEC, or conferences such as AiNT [Aachen Institute for Nuclear Training]. At conferences, there is this exchange, which is also networking. The whole thing is rewarded in a small circle. When I take young colleagues to such conferences, that in itself is a form of recognition. And that's what it is, that people are sent here and there to attend one conference or another and have a look and listen. But it's also often in people's own interest to do so. A network is always a good thing.

PM:

At the lowest level, i.e., the actual performers, what is the situation there? I don't know if you take them to conferences too...

Expert:

Not those at the lowest level, no. But there is actually a monetary advantage if projects go really well, if they have really "stretched" themselves. Then there are bonuses.

PM:

That would be a secondary reward, I would say. So not directly when knowledge is exchanged, but it's probably an important factor in ensuring that things run smoothly overall. What is the general situation regarding the culture of error in nuclear technology? Nuclear technology is a very sensitive area. How openly can you talk about mistakes there? I ask this mainly because experiential knowledge is often based on what didn't go so well, but where individuals may feel a certain amount of shame or reluctance to contribute such knowledge, even though it could be beneficial for future projects. How openly is this discussed?

Expert:

You have the whole spectrum. From concealment and blame to a completely open culture. It depends on who you are communicating with. Here in my circle, I have the same culture as the airlines. The error culture of airlines is phenomenally good. Errors are addressed, they have to be spoken about, and then the error is discussed and how it can be avoided. For me, that's the only sensible way to deal with errors. I have that too. We currently have a project where, if we as a company make a mistake and the project manager or one of the people involved comes to the construction site, to put it mildly, I think they'll be nailed to the wall first. That's the other side of the error culture. We have the whole spectrum. It depends a bit on who the customer is. Some operators are not known for being good customers.

PM:

Do you notice a difference when you are working in a reactor, depending on whether it is a test reactor, i.e., financed by the public sector, or owned by a private operator? Are there differences in terms of communication and perhaps also in the willingness to give you information that could be helpful for you to complete the project?

Expert:

That depends on the operator; not all operators are the same. We have operators who are extremely communicative. I have at least two examples where, when we go there and say, "This is the problem," we set out together to find the information. In the public sector, there is a certain inertia on the part of civil servants who don't know something or don't feel like looking it up. I wouldn't want to generalize that. There are all kinds. There are differences between operators' facilities; I can go from one facility to another and experience one thing at one facility and something else at another. And between operators and research facilities, it depends on the individual contact person.

PM:
So it's not the parent organization that's in the foreground, but the individual?

Expert:
Yes, you can't generalize.