Colin Jones: And then you look at place like Saudi Arabia and that region of the world, which you would be surprised that they would be interested in nuclear, but they are. Obviously that they're very oil dominated, fossil fuel dominated. But I think that they've realized is that using oil for electricity supply, how effective is that right? Why are they using their own oil supplies to generate electricity when they could potentially invest in nuclear power and then have that oil to sell. So I do think that there is support for nuclear globally. It is going to be interesting to watch where the rest of the world goes.

Stephen Ludwig: Welcome to Inflection Points, a podcast series from Jacobs. I'm your host, Stephen Ludwig. That was the voice of Colin Jones, Vice President, Deputy General Manager of the Jacobs North American Nuclear Group. In our discussion, we talk about the development of nuclear energy in the United States, the cleanup of old nuclear contamination sites, the challenges and importance of those remediation projects and the future demand of nuclear energy, worldwide. There is a lot to learn from this great interview. The Jacobs Podcast is where we meet the people that help create solutions that deliver more connected sustainable world. With that, it's on with the podcast.

Colin, thanks so much for joining us today. Can you explain a little bit about your background and how you wound up into the nuclear energy area and how you wound up as Jacobs?

Colin Jones: Sure I certainly can. And thanks for this opportunity, Steve, I really appreciate the opportunity to get to talk about what I love doing every day. So I've been in this business for over 25 years. I know I'm dating myself when I say that, but, and it really is kind of a story of kind of, for me falling into, I've kind of fallen into this nuclear business accidentally. I'm from the UK originally, you might be able to tell from the accent.

Stephen Ludwig: I was curious about where that slight accent came from.

Colin Jones: Yeah, I've lived over here for over 20 years now, so it's kind of a quasi-American English accent. But, I was doing a business degree at the University of Humberside, the Northeast of the UK in place called Hull. I was doing a four year degree. In the UK, they do the degrees programs a lot differently. Usually the degree programs are three years but this was a unique degree program. It was four years and it gave you the opportunity in year three to take a year off from work in industry. So it was a great opportunity to get some real work experience. So, at the time, I [inaudible] my resume to a bunch of different places and I actually got recruited to work for a year with a company called British Nuclear Fuels. And then that was kind of the start of my career in the nuclear industry.

I worked for them for a year in their corporate marketing department. And after I was done with that 12 month placement, they said, "Once you've completed your final year view degree, we'd like you to come back and interview for a full-

time position." Which I did. So in 1994, September of '94 I started with British Nuclear Fuels in the United Kingdom. Again in that corporate marketing department.

I'd been there for two years and they sent me over to the United States. United States was a big growth market for them at the time. And it was offered to me as a kind of a career growth opportunity. Initially it was only supposed to be for two years, but as I just said earlier, it's been over 20 years. I came over here in October 90, 1996, and didn't leave. I was with BNFL for a while over here and then I bounced around a little bit. I went to work for a national laboratory in nuclear power, the Idaho National Laboratory. I actually got to work in the United States Senate for a couple of years. And then I actually did a stint the Department of Energy in their Office of Environmental Management and then came back out into private industry. And now I've been with Jacobs just coming on two years.

Stephen Ludwig: It sounds like a great accidental career. Like you've had a lot of twists and turns that turned out really well for you.

Colin Jones: Yeah, it is kind of interesting. You know when you at our business, nuclear is obviously it's very technical. I know I don't have a technical background but... It's kind of been, my career has been a little bit unique as kind of covering both the commercial industry side, where I started my career and going into Congress, which was an unbelievable opportunity. And you just get to see the world from a different vantage point in helping making the laws around energy policy, which is actually fascinating for three years, to be able to do that. And then actually to go work for the Federal Government in these programs? Which again is, there is so many differences between the Federal Government and how they operate and commercial industry. And then being able to kind of bring all those kind of experiences together and then use them day to day in the job that I have now in helping run the North American Nuclear Group for Jacobs.

Stephen Ludwig: Now, Jacobs does help climb around the world develop new nuclear facilities, as well as run existing facilities. But your work is focused a lot on working with the U.S. Department of Energy on environmental cleanup of old nuclear project sites. Is there a lot of nuclear ways to clean up in the United States? We don't talk about that very often.

Colin Jones: Yes. It's a well kept secret. There's not a lot of people that really can understand. It's one of those, whenever you go to dinner party and you get asked a question, "Hey, what do you do?" And I can't... I explain to people what I do and what we do at Jacobs and-

Stephen Ludwig: And everyone asks, "Do you glow at night?" I'm sure that's the second, yah yah yah, yah-

Colin Jones: That's always one of the first questions. But a lot of people just don't have an appreciation. So the work that we do at North American Nuclear Group, we actually 10 major contracts that we manage on a daily basis. And that's nine of those contracts are supporting the U.S.Department of Energy. The majority of those are in the Office of Environmental Cleanup. We have one contract out in Nevada that supports their nuclear security work. And then we have an Office of Science Project Support in Argonne National Lab. And then the one remaining contract we have up in Canada, which is managing the Canadian nuclear laboratories. But as I mentioned, the lion share of our work is in nuclear remediation and cleanup. And this really kind of started in the 1940s during World War II. And it really was if you go back in that time, it obviously is... World War II was dominated in the global scene at the time but there was a real belief that the Germans and Adolf Hitler had access to nuclear technology.

And so that kind of created a race to be able to have the access to nuclear weapons technology in recognizing how important that is from a world security perspective. So that really started off in 1943, up at the Hanford Site which is based in Washington state. Is where you saw a real kind of national endeavor to go and actually create nuclear weapons. Over the years the country, the United States, has created thousands of nuclear weapons. At one point, they had over a hundred sites responsible for different parts of the nuclear weapons production program. So in about 1989, a lot of the states that were hosting these sites were started to get concerned about some of the environmental damage or the environmental mass that had been left behind as a result of this weapons making program.

So at that point, the Federal Government and the states decided that obviously the weapons program would continue as it was. But they would also create a separate environmental management program. So that's how we really got started, really focusing on cleaning up the environmental messes, if you like, that was left behind from the Manhattan Project. As I mentioned, this started back in 1943 or at the Hanford Site. One of the things that they needed back in those times, it was access to a lot of land and they needed water supply. And so as you look at the Hanford Site, which is 560 square miles, there was a few farmers and a few tribes on the land that the Federal Government displaced, but it had access to the Columbia River, which goes right through the Hanford Site.

So if you can imagine back in the 1940s, they had tens of thousands of people relocate to this part of Washington state and started building nuclear facilities, like nuclear reactors. So that they could process uranium based nuclear fuel, turn it into spent fuel so that they could mine plutonium from that spent nuclear fuel to put into nuclear weapons. The human feat that went into this, it truly is amazing. Back in those days, they were designing and building reactors in the matter of 18 months or two years. And obviously these were of smaller scale production reactors at the time. But just to kind of put that in context, some commercial utilities are building some new commercial reactors in the

state of Georgia right now and that's probably taken them 10 years to be able to complete the design licensing and construction of those reactors, probably more than 10 years. So just to kind of again put it in a little bit of perspective of what was going on back in the 1940s at a site like Hanford.

Stephen Ludwig: Now, talking about the Manhattan Project and World War II and that the Federal Government didn't really begin to look at these waste sites until 46 year years later in 1989, if they started in 43. What didn't they know about nuclear waste or what the dangers were that we about now, like, what would happen if we just left the waste there and left it alone?

Colin Jones: Right. These folks truly were pioneers and that they with the leading edge of their industry at the time. And there was a lot of stuff that they didn't know, but, and that's one of the things as you look across the DOE complex and you go from site to site, you see how that learning matured and how the technology matured. And you can actually, as you follow that technology maturation around the DOE sites, you can actually see how that held from a waste management perspective. Again, I'll go back to the Hanford Site. And the reason I keep going back there is because it is one of the most contaminated sites in the world with regards to radiological and chemical contaminants. And it really was one of the birth places of the nuclear industry as we know it today.

As part of this process in being able to mind plutonium from spent nuclear fuel, they use a technology that they call reprocessing. And back in the day, Hanford again, they were one of the pioneers. They tried out many different types of reprocessing technology before they selected the most effective technology. And so as a result of that, this process that they use is an aqueous process as they take spent nuclear fuel, which is a solid, put it through a chemical process so that they can extract the plutonium. You're left with a liquid effluent, which is contaminated. Millions of gallons of this contaminated waste was just poured in the ground or poured in cribs and trenches at the Hanford Site. It wasn't until a few years later that they thought, maybe we shouldn't do that. Maybe we should put them in underground tanks. And so as you look in the 50s and onwards, they actually ended up building 177 underground tanks, which now contain about 56 million gallons of radioactive waste.

Stephen Ludwig: Wow.

Colin Jones: Which is again, is just what is an environmental liability that not most folks really know about. And that is the responsibility of DOE using contractors like Jacobs, to be able to manage that waste.

Stephen Ludwig: Now you mentioned Hanford's one of the worst sites in the country. There have been a number of, you mentioned, I think over a hundred sites that were being used at one point. And I think if I understand correctly, most of those sites have been cleaned up and remediated. Why is the remaining work on these remaining sites so difficult? What's taking so long and why is it so hard?

Colin Jones: So yeah, we started off with a hundred sites and now we're down to 16 sites. And I would say the 16 sites are some of the hardest sites left. And again, I think one of the big things is high level waste that we just talked about. That process I talked about, the 56 million gallons at Hanford. There's about 25 to 30 million gallons at the Savannah River Site. It's based out in South Carolina. And they actually have some smaller amount of high level waste at the Idaho Site.

That really truly is one of the big ticket items with regards to, as you look at the future cleanup and closure of these sites. It's some of the most challenging ways that they have to deal with, primarily because it's a liquid. Obviously liquid it's movable. And the process that we use, and we are using this as an industry, are using this process at the Savannah River Site to process that liquid waste into a glass fall. We call it vitrification. It's basically just using melters and glass frit, combined with a high level waste to make a glass block that can ultimately disposed of at a deep geologic repository one day. And obviously that makes sense in turning that liquid into a solid, makes it so much easier to manage.

Stephen Ludwig: What's a high level waste versus a low level waste? I don't, what's the difference there?

Colin Jones: Well that's a good question because there is, right now the definition of high level waste... the Department of Energy is looking at changing it. Historically, the high level waste definition is been based on the stage within which the waste was generated as it went through the cycle to become as part of the weapons program. And I know that gets kind of a little bit complicated. The department now is looking at saying, "Hey, why don't we look at it based on its radiological content?" Based on in layman's terms, how hot is it? Because depending on, there's different types of radio active waste, the high level waste being considered to be the most dangerous and requiring the most security safeguards and management. We have plutonium contaminated waste, which is equipment that has been contaminated with plutonium as part of the weapons making program.

Now that has a measured degree of units that are actually measured to dictate whether or not it's got a transuranic waste. And we actually have a disposal path for that kind of waste right now that goes to the Waste Isolation Pilot Plant, which is in New Mexico, which is an under the ground repository based in a salt formation, which has actually been operational for about 20 years now and is actually doing a pretty good job of being able to dispose of that kind of waste. And then we have low level waste. Low level waste for the most part is contaminated buildings and facilities. What we do with that is in a lot of places, we will build onsite disposal cells or there actually is some commercial disposal cells that can actually dispose of low activity waste. Each of the disposal cells will have something they call a waste acceptance criteria, which will dictate the range of waste that they can take and that can be disposed up in those facilities.

Stephen Ludwig: So you talked about turning the liquid waste into glass and then burying the glass. That's astounding technology. That's really interesting. But I'm curious about, I guess from a layperson's point of view, we kind of know that when stuff gets in the ground or ground water, it can move around. It sort of doesn't follow logically because I can't see it like a time lapse video, but why ground water and soil contamination, why is that so dangerous and how does it move in the ground? And so why do we have to pay so much attention to that?

Colin Jones: Well, and again, that is one as you look at the activities that we undertake as part of the cleanup program and in each of our contracts, you can really kind of bucket them into several areas. There's the high level waste that we've been talking about, there's facility demolition and decommission and deactivation. And these are nuclear facilities that in some cases have been operating for 30 years and have become highly contaminated. And we have to very, very carefully take those down. And so that our ability to be able to manage the contamination that is built into the concrete or the equipment that was contained in those buildings. And then there's the soil and ground water that we remediate. So those are kind of the three buckets, the soil and ground water. So for example, I talked about up at Hanford there, where in the early days that they were actually pouring waste just directly into the ground.

And there is a real science behind this. We've actually looked at how deep the soil pack is, when do you start... when do they hit water? Where does that water potentially travel to for the drinking source? And as a result of that, we are actually able to put in wells around those areas to be able to suck up contaminated water and then to clean it and re-inject clean water back into those areas. One of the things, again at Hanford, which is that Jacobs has been directly involved in now for over 10 years, has been the soil and ground water program there. As I mentioned again, as you've got those 177 tanks, some of those tanks have actually leaked. And again, as the contaminants, they go through the soil and they will eventually hit water which will then make its way to the Columbia River. The Columbia River is only 10 miles away from the Hanford tank farms.

Stephen Ludwig: So over a number of years, it could eventually leak. It could travel through the ground-

Colin Jones: Yes.

Stephen Ludwig: Into the river.

Colin Jones: Yeah.

Stephen Ludwig: Okay.

Colin Jones: Yeah, obviously that has actually happened. But what we've done is we've been able to create a series of wells around the tank farms and in the locations from,

based on our science and engineering, to be able to give us the best opportunity to be able to prevent that from happening. And we actually treat billions of gallons of water each year, which is just, again it's just fascinating that we're able to pull that much water out of the ground, treat it and then push it back in again to be able to protect the environment. And I would say obviously that this has been going on for a number of decades right now. And as you look at the state of the Columbia River it's obviously much cleaner today than it has been previously in the past. And we've done an excellent job being able to clean up that river and be able protect that natural resource.

Stephen Ludwig: That's amazing work. Now I'm going to shift gears a little bit on you. So ever since the Three Mile accident in the United States in 1979, nuclear power really went out of favor in this country. But there's currently about 60 nuclear power plants operating in the U.S. and they're all getting kind of old. As with any facility, there has to be a natural lifespan to these things. What happens when these old nuclear plants come to the end of their natural life and need to be shut down?

Colin Jones: Yeah, that's a great question. Obviously, electricity supply and clean electricity supply is very important. There's a enormous debate about security of supply, climate change. All those things are very important topics. Just to be clear what our focus in North American Nuclear right now for Jacobs is on the cleanup. We're actually not directly involved today in the United States on supporting any of the commercial nuclear plant work. Our colleagues overseas though, at Critical Mission Solutions International, are the folks, the team in the UK. They are involved in some nuclear projects, new nuclear projects over there where we're going to be helping out as a program manager in helping build new nuclear capabilities in UK and the rest of Europe.

But specifically in the U.S., you're right. There's actually about a hundred operating reactors today. They generate about 20% of our electricity supply, clean. There's zero emissions. And actually the reliability of the nuclear reactive fleet is absolutely fantastic. From a reliability perspective, they're well in the 90% range which means that they're basically pumping out, they're create electricity on a daily basis. As you can tell, I'm a big proponent of the nuclear industry. You know, I think Three Mile Island was... did change the industry significantly at this time about that time, all the reactors had been built, but it really did put a halt on reactors. And that's had a number of different impacts on the nuclear industry.

I think we lost a lot as a nation from a nuclear development perspective on reactor technology. Also from a supply chain perspective too, as you look at the nuclear supply chain in the United States, it isn't as strong now as it was back in the 60s and 70s when we were building all those reactors. Those reactors are starting to come towards the end of their life. The Nuclear Regulatory Commission, they license reactors, their original license would've been for 30 or 40 years. And actually a lot of react have gone through what we call life

extension programs. So they have to prove to the Nuclear Regulatory Commission that they can maintain safe operations of those reactors. So what you see at each of the individual reactors through their maintenance programs, you will see a lot of the reactors today don't look the same as they look like 20 or 30 years ago when they originally became operational.

There's been a lot of updates with regards to the reactors and the safety of those reactors from the operational that they've gone to digital technology now. There have been leaps and bounds in the reactive technology and they've been able to incorporate those new technologies into the actual reactors that we have today.

Stephen Ludwig: You would think with the push for clean energy, people would be more enthusiastic about nuclear in North America but it's not coming back. Are there various market forces that it are blowing against that?

Colin Jones: Yeah, I think there are. I think some of it is significantly related to cost, right? I mean, we talk about the two reactors that are being built in Georgia right now. Plant Vogtle, there's been scheduled delays and cost increases. We're talking 10 plus billion dollars to build a reactor. And depending if you're a regulated utility or deregulated utility, your ability to be able to raise that amount of funds or have your shareholders agree to be able to invest in a technology like that can vary. And the other thing that nuclear is competing against right now is natural gas. As everybody has heard of the fracking technology and the significant increase in natural gas. I mean some evidence that we have over a hundred year supply of natural gas. We're exporting natural gas right now, that we have such an abundant supply and you're looking at a natural gas [inaudible] plan that can generate electricity that you can build for a couple of hundred million versus tens of billions of dollars for a nuclear plan.

Obviously, as investors look at that, that will obviously play into utilities decision making. I'm a firm believer in an all of the above strategy, right? I think there's a place for nuclear, for renewables as a nation that we need to be looking at all those available technologies, especially the clean ones. And recognizing the impact on the environment and the climate and how important that is for the future.

Stephen Ludwig: Yeah. I think most people don't know that in 2017, I looked this up, the United States did become the world's largest natural gas producer, which I'm sure would surprise a lot of folks. Now for a number of reasons that you shared, nuclear has lost favor in the United States but you mentioned earlier that part of Jacobs internationally is helping clients around the world with nuclear facilities. How do you see that global market for nuclear facilities?

Colin Jones: I definitely think that as you look at China has really embraced nuclear technology, and then you look at places like Saudi Arabia and that region of the world, which you would be surprised that they would be interested in nuclear,

but they are. Obviously that they're very oil dominated, fossil fuel dominated. But I think that they've realized is that using oil for electricity supply, how effective is that right? Why are they using their own oil supplies to generate electricity when they can potentially invest in nuclear power and then have that oil to sell? So I do think that there is support for nuclear globally. It is going to be interesting to watch where the rest of the world goes.

The other big component in nuclear right now, too, is up until this point we've had these 1,000 megawatt kind of reactor types, even up to 1,600 megawatt reactor types. There is a big push now to look at what we're calling small module reactors. And that is one area where we have a number of U.S. vendors that are trying to play in that area. And so you're not looking at making such a large commitment and building a 1,000 or 1,600 megawatt reactor. Maybe you can build a 50 megawatt reactor. Maybe that's more helpful in more remote regions. Maybe you can make it more modular as you can just kind of add in on 50 megawatts at a time. And there is some safety benefits. I'm no expert in the small module reactor technology but they tout safety benefits as well to the small module reactors.

Stephen Ludwig: It's interesting when you say modular, I always think of like the Lego building block approach to building but I get it's far more complicated than slapping some Legos together.

Colin Jones: No, but that's what the principle is based on though. And again, this is not a particularly new technology because when you think of, again... the Naval Nuclear Program plays a very big part in our industry. And you look at nuclear submarines, right? They're powered by a nuclear reactor on a submarine. That is of the genesis of small module reactors. But no, that's how the small module reactive vendors will tell you it is just like Lego blocks, adding one with another and making it modular.

Stephen Ludwig: Interesting. So I'm sure we could talk for another few hours about all aspects of environmental cleanup for nuclear, running a facility and doing that safely. This new modular conversation we're having is super interesting and how there's a lot of areas we didn't touch on and how nuclear energy and nuclear ideas are used in industry, as well as the military. But beyond all those things, is there anything I didn't ask you about that you'd like to mention?

Colin Jones: You know, obviously I've been doing this for 25 years and will do this for the rest of my career. No doubt. I would just... is highlighting the people, what an amazing mission this is. In recognizing the historical importance of nuclear weapons technology and how it helped end World War II. How it helped prevent the Cold War with the standoff between the United States and Russia. The political implications it's had, we're now playing our part. And we have done for the last over 20 years and been able to clean up the environment that resulted from the creation of those nuclear weapons. So to me, it's such a vital and important mission. I like to talk about as being environmental superheroes.

And again, it's not a mission that not a lot of people know about. There's over 20,000 contractors working in this environmental cleanup business.

And I can't stress enough the importance of the people. At Jacobs were very lucky to have some of the most talented people in this business. They've been working in this business for a long time. Some of which would've gotten their start in the nuclear weapons program mining and milling plutonium pellets. I mean as you could imagine doing that for a job and now being responsible for being able to clean up the liability that was left behind from manufacturing those nuclear weapons. Our people really are top notch. And, one of the driving principles and one of the most important factors for us is safety. As you can imagine, the environment that are people working, the people who are on these sites, they're facing radiological hazards, chemical hazards, not to mention your normal industrial type hazards of being on a construction site. Because that's what it's kind of akin to.

Even though we're decommissioning and demolishing these buildings, they are kind of like construction sites. So you've just got to kind of think about all those hazards and the lengths that we go to to keep our people safe in recognizing how important they are. Our mantra is that any individual that comes to work every day, they're going to leave. They're going to leave at the end of the day in the same great physical condition that they came to work at the start of the day. So I can't emphasize enough with regards to the people that we have supporting our business and putting Jacobs in such a good place to be able to go and execute this business for the Federal Government and for the Department of Energy on such a crucial mission.

Stephen Ludwig: That's great. Where can people find more information if they want to find out more about what you're doing?

Colin Jones: They go to Jacobs at jacobs.com. We have information there about the work that we do throughout the United States.

Stephen Ludwig: Great. Colin, thanks so much for joining us. This was a terrific interview.

Colin Jones: Thank you, Steve. I appreciate it.

Speaker 3: Thank you for listening to Inflection Points, a podcast series from Jacobs. To find out more, please visit jacobs.com. Jacobs, challenging today, reinventing tomorrow.