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Discussion notes with Director Ri Hong Sop, Yongbyon Nuclear Scientific Research Center, Pyongyang, DPRK. November 3, 2006.
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- Director Ri met Stanford University delegation (John Lewis, head of delegation, Siegfried Hecker, Robert Carlin, and Charles L. (Jack) Pritchard) at the Koryo Hotel. He was accompanied by Kim Chol Nam, Senior Officer; Kim Hak Son, officer and interpreter; Kyong Hwa Suk, officer (young woman who used to work for KEDO. She took notes on a Sony VAIO laptop). In addition, our hosts, Song Il Hyok and Kim Hyon Chol of the Ministry of Foreign Affairs were present and took notes. The meeting lasted approximately two hours. These notes based on John Lewis and Sig Hecker meeting notes.

- Director Ri started the conversation with greetings and that he was ready to answer my questions, within his authorization, of course.

- I told him how pleased we were to see him and how kind it was for him to come all the way to Pyongyang. I would have liked to visit him in Yongbyon, but we had been told that this would not be possible. I mentioned that the two previous meetings (Jan. 2004 visit to Yongbyon and Aug. 2005 in Pyongyang) were very helpful in reducing the ambiguities associated with the DPRK nuclear program. I asked him if he could give us an update of what has happened in Yongbyon since our last discussion in Aug. 2005.

- Director Ri said that it has only been a little over a year, so not much has changed. He stated that in Nov. 2002 the U.S. cut off the fuel oil shipments to the DPRK and we resumed reactor operation in 2003.

- Originally the Radiochemical Laboratory (reprocessing plant) was designed to make plutonium oxalate. We developed the normal, commercial fuel cycle processes to make plutonium oxide. Then, we changed the design to go from plutonium oxalate, to oxide, to plutonium fluoride (PuF_4), to metal, electrorefining, alloying, and casting. You touched the plutonium metal when you were in Yongbyon in 2004. We have now completed all the metal processing for weapons-usable material in the Radiochemical Laboratory. Since we have completed the process, we announced in Feb. 2005 that we have produced nuclear weapons.

- In August of last year, we were in the middle of reprocessing the second core. We completed that last year. We conducted two campaigns – the reprocessing in 2005 and the waste disposal in 2006. The radiation levels are higher than ever in the Radiochemical Laboratory.

- There are two reasons we could not have you visit now: 1) the radiation levels are high and 2) we have weapons-usable components (not clear if he meant components or material).

- We are preparing for the third campaign now. I asked him about the reactor operations. He said the 5MWe reactor is operating at full power now. We have been operating normally. I asked if it is operating now. He said yes. I also asked about periodic shut downs of reactor. He said: we have been operating the reactor at a bit lower temperature to get better weapons-grade plutonium. Otherwise operations are same as before. He said

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this is all I am authorized to say. When I asked how much the temperature was decreased, he said somewhat.

- I asked when they are planning to unload the current core. He said that "purely from a technical standpoint" they would do so next year, but there are other factors that he does not decide. The political situation may change. So, sometimes they unload the reactor earlier even though it is less favorable for us technically.

- I asked about his comment of running at lower temperature to get better plutonium. Why not just adjust the time in the reactor or run at lower power. He said that the power level has been the same at 25 MWth. The operators can decide themselves to adjust the temperature. The operators decide what is best for safety of the fuel rods. Lower temperature is better for the cladding. We do not want to lose time so we maintain integral power output.

- I asked him if they have done partial core unloading. Yes, he said we have removed damaged fuel rods a couple of times. In Aug. 2005, we were concerned about the rods. Practice showed that no problem with the fuel rods. The current load is OK. We have no cladding problems although these fuel rods were manufactured many years ago. We are now preparing for production of the next load.

- I asked if this third load was of lower quality because it was their last full load. He said that this load was from the IAEA inspected inventory. We have a process of examination in which we examined the current load of fuel rods before loading. We found that only a small number of rods had corroded and found replacement rods.

- I asked if they have had a lot of on and off cycles of reactor operation. He said there has been no cycling. When we need to examine the reactor and perform minor repairs, we lower the reactor power. We have a rule that we inspect the rods before we load them in the reactor and then also periodically. This the only time we have lowered the power. There have been no big fluctuations in power over the past year. We only did it during planned inspections. I said then you are happy with the reactor operations – you only had to do minor maintenance and lower the temperature. Ri said yes.

- I said that I am surprised you said you dropped the temperature to get better weapons-grade plutonium. For the times you have been operating you should have been able to run at 25 MWe for longer times and still have good weapons-grade plutonium.

- Ri said, yes your opinion is correct. There are two reasons why we did this: 1) Better plutonium and 2) avoid cladding failure. I asked about the decreased temperature. He said we used to run the output temperature at 350°C, but we experienced damage to the fuel rods. Now we lowered the temperature to 300°C, but this is worse for electricity production. So, it's a tradeoff between efficiency and cladding failure.

- I asked him about the refurbishment of the fuel fabrication facility. He told us in Aug. 2005 that they were completing it and would produce fuel rods in 2006. You said that you were preparing for a new fuel load now. What is the status of the facility?

- We are finalizing facility preparations now. I said that he indicated before that the fluorination line had corroded, has that been finished? Ri said that the original line had collapsed. They are in the final stages of refurbishment. I asked when they will be ready to make new fuel. Ri said they will start next year (2007). I asked how long will it take to fabricate an entire core. Ri said it is possible to finish one core load in one year. They are not in a hurry. They still have spare rods from the old inventory; not enough for a full

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load, but they can replace rods as necessary. When we shut down the reactor, we would then have a load ready to go.

- I asked if they would reload the reactor with a new charge. He said yes, we will. He said that they have a couple of ways to go. They could do a partial reload and replace the rods in the center first. Or they could replace the entire core. It depends on the situation. We have enough rods for a partial load now. As we produce new rods, we can replace them later. Again, they are not in a hurry.

- I asked next about the Radiochemical Laboratory. You told me last year that you had made improvements to increase the efficiency by 30 percent. I believe you told me that you replaced the mixer-settler tanks with pulsed columns. I want to make sure that I got that correct. Ri said that is correct. They replaced the mixer-settlers for the co-precipitation line only with pulsed columns. He said that if they could do it all over again, they would replace all mixer-settlers with pulsed columns. But for now, it is difficult to make all these changes because of the serious problem of the radioactive environment, so they decided it was not necessary to replace them all. We did get an efficiency increase of 30 percent.

- I told him that my colleagues in this business said that this type of change is very difficult to make, so I am surprised that you did it. How did you manage it? Ri said, yes, but we did it. It was difficult. Maybe it shows that our technicians may be more advanced than yours. He said that the mixer-settlers had problems with surfaces. (In general the interpretation was poor, and here it was very poor. Not sure of what he said next, but he appeared to say that had problems with clogging passages). At any rate, he said they have no such problems with the pulsed columns.

- I asked how they managed to make this change in place since it is a big deal to make it in an existing facility. Ri said yes, but because of the nuclear threat we had to do this in spite of the risk. Making changes in the fuel fabrication facility is simpler because it is accessible to people

- I asked if the DPRK had all of the materials it needed for the fuel fabrication refurbishment, or do you need to purchase externally. I asked about materials such as specialty stainless steels. Ri said yes we have all the materials we need, including the specialty steels. We can produce the corrosion-resistant steels here. These must resist nitric acid. I asked if they have all the chemicals for the reprocessing operations also. He said yes, all the chemicals are from their own supplies, including the tributyl phosphate (TBP). They can all be produced here in the DPRK.

- I switched to the 50 MWe reactor. What is the status now? Last time we were here you told us that the workers were ready to go back. Ri said we are now in a stage of partial preparation – not in full swing. I asked what specifically are you doing – are you working on site or off site? Ri said that they are recovering the original state of the equipment. For example, removing rust from the steel. The main problem is the preparation by the other industries – recovery in other factories, not on site in Yongbyon. This is not a simple job, nor a small job. The problem is in outside industrial facilities.

- I asked if they had everything they needed within the DPRK? We must do everything ourselves. It is difficult to import, so we must do everything ourselves. It will take longer. I asked when they expect to resume full operations. He said that the decision to go from

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partial to full preparation depends on a decision by his superiors. I later asked specifically about when they expect to restart the 50 MWe at Yongbyon. He said that he has sent a schedule to the higher level, but has not yet received instructions. He expects to get instructions soon.

- I subsequently asked about the status of the 200 MWe reactor. Ri said that nothing new. You can understand the sequence – first the 50 MWe reactor, then later we do the 200 MWe reactor. The decisions can be sequenced.

- I asked about plutonium metal. I said that I am still puzzled by the shape of the plutonium that I held in Jan. 2004. Could he explain exactly what it was? Ri said that the piece was just a remaining part from the mold. We showed you only the top part of the casting. I drew him a picture of the thin-walled funnel and asked why it was thin-walled. I said that I would have expected it to be a solid piece if they were casting a hemi-sphere. I asked were you casting a thin-walled part? Ri smiled and said I can't tell you what we were casting. He said he was not in a position to tell me what shape they were casting. I said, well, I didn't think you could, but I thought I'd try anyway.

- I asked him about electrorefining – were they now able to make high-purity plutonium metal? He said yes, we have mastered this process – it can be done by us, not only by you.

- I asked if they do plutonium research at their facility in Yongbyon. He said we have done the research necessary to go from plutonium oxalate to metal for weapons. I asked if they have also done plutonium properties research. He said that most of their efforts have gone into the oxalate-to-metal process. They have developed the metal casting techniques. They have done extensive studies of the uniformity, density and purity of the plutonium metal. We do not conduct extensive properties tests for plutonium. Those properties are well known.

- I asked if the plutonium components for the test device were made in Yongbyon. He said that this was not his responsibility. He is not in a position to comment on this. They made the gross metal shapes – only what I saw. I asked if the casting is done at Yongbyon or elsewhere. Ri said that they make the metal, but don't do the final casting. I asked if other organizations are co-located at Yongbyon, or is everything at Yongbyon under his direction. Ri said everything at Yongbyon reports to him, but he did not say that the casting for the test device was done at Yongbyon, as noted.

- I switched to the nuclear test. I said that it is typical to do an underground drill-back to the collect debris and do a radiochemical analysis to get an accurate yield of a nuclear explosion. I asked them if that is what they did. He said, he agrees that this is the best method. However, the test itself and what was done is not his responsibility. This is not within his authority. It is separate from him. I asked if the test samples would come here to Yongbyon to be analyzed after the drill-back. Ri said that the radiochemical analysis is separated from him. I asked if he went to the test site for the test. He said he did not.

- (I had previously asked the Ministry of Foreign Affairs to talk to the technical people who had responsibility for the rest of the nuclear program and the nuclear test. I was told earlier in the week that “we heard your request.” However, they never delivered.

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- I asked about neutron initiators or other parts of the device. He said that is not his responsibility. He said that the security situation is very tense. There is no link between the different sectors because of the security considerations.

- I asked about the the IRT research reactor. Have you run it and are you making radioisotopes? He said there was no change. Yes, we have run it some and made some I-131. As you know it is used for thyroid cancer treatment.

- I mentioned that in Aug. 2005, at the request of Vice Minister Kim Gye Gwan, we had a long discussion about the LWR reactor and comparison of proliferation concerns for it and the graphite-moderated reactors. As you know the LWR project through KEDO was terminated (I jokingly mentioned that now my colleague Bob Carlin is out of a job). Bob said that when they shut down KEDO, there were approximately 100 young technical people out of a job. Have any of them found jobs at Yongbyon. Ri said, no – we have enough workers at Yongbyon. (Ri told us in Aug. 2005 that Yongbyon had nothing to do with the KEDO LWRs and that those workers were under a totally different department.)

- If there were an LWR project would there be a role for his center? I mentioned that they have experience with uranium metal fuel. Could they translate that to oxide fuel and either stainless steel or zirconium cladding materials? First, he said that stainless steel is better. He said this question is too advanced (meaning too hypothetical) because one must enrich the fuel for an LWR and they don't have the enrichment capabilities. We would not be thinking about doing this.

- I said that I understand that. What I was interested in is to see if under such circumstances it might make sense for Yongbyon to carry out the uranium processing to the point of turning over the oxide or yellow cake to another country (such as Russia), then getting the enriched uranium (to LWR levels) back, and making the oxide fuel at Yongbyon? Ri said that all depends on the price balance. One would have to see what is more favorable – to buy it from other countries or to have the DPRK involved. I asked if they would need new facilities for oxide fuel fabrication. He said that they could use existing buildings, but would need new equipment.

- I asked about the back end – the reprocessing. Would you send the spent fuel rods back to where the fuel was made or enriched? He said that all depends on the nature of the agreement between the governments.

- Lewis mentioned that they previously discussed what it would take to dismantle the facilities at Yongbyon if an agreement was reached. Would that be different now because of the nuclear status? Ri said this is up to the political people, not for me to decide.

- I asked how things are at Yongbyon today. How do the people feel? Ri said the more the work, the better for our people.

- I invited him and his colleagues to lunch, but Director Ri had another engagement.

Overall comment:

This session was more formal than the other two. Ri answered the questions that were within his jurisdiction. However, we did not find the warmth and sense of humor we found during our visit to Yongbyon in Jan. 2004. Of course, the venue was not ideal. We had four people there and two MFA people were there in addition to the young woman taking notes on the laptop. It must have felt like an inquisition to him. Nevertheless, he did remarkably well. He was patient, professional, and courteous.