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COMMENTS ON THE K-65 SILO SAND FILL PROJECT

05/19/89

OEPA DOE-FMPC
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COMMENTS

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Richard F. Celeste
Governor

May 19, 1989

Mr. James A. Reafsnyder
Site Manager
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P.O. Box 398705
Cincinnati, OH 45239

Dear Mr. Reafsnyder:

Attached is a list of comments and concerns relating to the K-65 Silo Sand Fill Project. These comments were prepared by our consultant, AWC Nuclear Services, and should be the main topic for discussion at our May 25 meeting.

Sincerely,

Graham E. Mitchell
Ohio EPA FMPC Coordinator

GEM/lal

Enclosure

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REVIEW OF PROPOSED SAND FILL PROJECT FOR THE K-65 SILOS AT FMPC

OVERVIEW

The purpose of the K-65 Interim Stabilization-Sand Fill Project is to install a four (4) foot thick layer of sand over the surface of radioactive residue material inside each of the two K-65 silos.

The advantages gained by such sand fill remediation would be:

1. reduction in gamma radiation by 75%
2. reduction of radon emissions by 95 to 99%
3. minimize the accidental release of radioactive particulates and radon gas/progeny if there were a catastrophic failure of the dome

INTERIM ACTION VERSUS FINAL REMEDIATION

The main question to be resolved is: Is it acceptable to allow the long-term storage or permanent disposal of the K-65 silo residues at FMPC?

If these radioactive residues are to remain at FMPC, the following concerns regarding the health and safety of both the on-site work force and the off-site population, as well as the protection of the off-site environment must be evaluated:

- radon/progeny emissions
- direct and "shine" gamma radiation levels
- leaking of the residues into the groundwater and/or surface waters
- the need for continued environmental monitoring of the effects of the K-65 residues

For the proposed sand-fill project, there is potential for reducing the radon emissions and lowering the gamma radiation level from the K-65 silos.

No data has been furnished regarding the leaching of radioactive materials from the K-65 silos; however, this important environmental issue must be fully evaluated if the residues are allowed to remain in-place.

Also, so long as the residues remain in-place, a comprehensive environmental monitoring network must continue to be maintained and all data scrutinized in a timely manner to indicate any release of radioactivity into the environment.

Therefore, before any interim action such as the Sand Fill Project is undertaken on the K-65 silos, the following information should be provided:

1. Documentation that there is no leaching of radioactive materials from the K-65 silos into the groundwater and/or surface waters. If no radioactive materials are being leached/released from the silos, then it would support leaving the residues in-place in the silos; otherwise, the residues may have to be removed.

2. The existing environmental monitoring data should be provided showing radon/progeny levels and the gamma exposure rates in the off-site areas with emphasis on locations inhabited by real people. If radiological conditions in off-site areas do not indicate levels in excess of regulatory standards, then interim actions such as the Sand Fill Project would not be justified.

Final remediation by residue removal must be considered unless there is sufficient documentation to prove that leaving the K-65 residues in-place will result in no releases of radioactivity to the off-site population above regulatory standards.

INTRODUCTION

This discussion is a summary of AWC, Inc's. review and conclusions regarding the proposed interim stabilization by sand fill of the K-65 silos located at FMPC, Fernald, Ohio.

This review is based on the four (4) documents provided by Ohio-EPA:

- Reference 1 - letter, DOE-400-89, J. A. Reafsnyder to B. G. Constantelos, "K-65 silos Near-Term Activities and Final Remediation Plan", dated January 10, 1989.

- Reference 2 - letter, DOE-628-89, J. A. Reafsnyder to B. Constantelos, "Request for Technical Information During January, 1989 TIE Meeting", dated February 21, 1989.

- Reference 3 - letter, DOE-712-89, J. A. Reafsnyder to R. Shank, "K-65 silos Interim Stabilization-Sand Fill", dated March 10, 1989.

- Reference 4 - letter, DOE-1009-89, J. A. Reafsnyder to G. Mitchell, "Ohio EPA Requested Information on K-65 Silo interim Remediation," dated May 4, 1989.

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EVALUATION

The following evaluations of the sand fill project were performed with emphasis on the overall protection of the public health of the off-site population. However, there must be some consideration of the radiation dose commitment to the on-site workers for completion of this project in order to derive a balance-of-risk assessment, and to assure compliance with applicable radiation protection standards and the concept of exposures being As Low As Reasonably Achievable (ALARA).

1. Minimization of Effects of Dome Failure

The documents furnished for this evaluation did not go into any details of the potential for the catastrophic failure of the silo's dome. Apprehension still exists that such a dome failure accident may happen in the future, and that the resulting uncontrolled releases of radioactivity would subject the off-site population to exposures which could be prevented if the interim sand fill project is completed.

The addition of a four foot thick sand cover over the radioactive residue materials in the silo would provide a physical barrier which would minimize the release of radioactive particulates in the event of a dome failure. That is, the dome structure would cave-in on top of the sand rather than falling directly on top of the residues thereby releasing some concentration of long-lived radioactive particulates such as radium or uranium.

Information was not provided in the reference documents to indicate any increased deterioration of the structural integrity of the dome itself, nor that there is immediate concern that dome failure could occur in the near future. In fact, Reference 1 reports that previous work, such as the center protection caps and the polyurethane foam coating, have been effective in maintaining the structural integrity of the dome.

The sand fill project would be an advantage to minimizing the release of radioactive particulates; however, it would only apply if a dome was to actually fail and cave-in.

2. Reduction in Gamma Radiation

Reference 1 reports that computer modeling computations indicate that a potential reduction of 75% in gamma radiation is attainable from the addition of a four foot thick layer of sand. Reference 2 provides two of the computer codes used for the generation of the gamma exposure rate graph (see Attachment 3 - Gamma Reduction from Reference 1). 000004

The important point here is that all of these computer modeling computations provide the gamma exposure rate directly on top of the surface of the dome. Therefore, the effect of reducing the gamma radiation exposure rate by adding the four foot sand cover would apply to on-site workers who were on top of the dome or perhaps in the nearby vicinity. Reference 4 reported the expsure rate currently on top of the domes to be 125 to 150 milliRem/hr; and that it is anticipated that the sand cover will reduce this to about 20 milliRem/hr. The significance of "sky shine" from the silos is also mentioned in Reference 4, and is estimated to be about 0.04 milliRem/hr for the on-site workers. The effectiveness of the sand covers to reduce "sky shine" is estimated to reduce on-site exposures by 30 to 90%. In any event, adequate protection can be given to any on-site workers who may have to work on top of the silos through the established FMPC Health Physics program.

Reference 1 states that computer calculations performed by Oak Ridge National Laboratories showed the maximally exposed off-site individual would receive a whole body dose of 17 milliRem per year as a result of total FMPC airborne emissions prior to any remedial work on the silos. Reference 1 also states that the present exposure rate is twice the background level for the neighbors adjacent to Paddy's Run Road. The only actual environmental radiation measurements or dosimetry monitoring records which were provided indicates that there is an area along Paddy's Run Road at about 8 microR/hr above the background level (Reference 4, Attachment 3). For full-time occupancy at that location, this elevated gamma radiation would result in a total dose of 70 milliRem per year assuming there are real people there all the time.

Computer extrapolations of the off-site gamma exposure rates resulting from the sand fill operations were not provided in any of the references; and it is not practical nor necessary to complete such complex calculations at this time. Because of the ground level geometry of the off-site areas with respect to the elevated silos, and the radiation shielding provided by the existing earthen berms surrounding the silos, the proposed sand cover at the top of the silos will probably have minimal effect on reducing the actual off-site gamma exposure rate. In addition to the Paddy's Run location, all other actual environmental measurements/dosimetry monitoring data should be evaluated to determine whether the off-site population's annual dose limit is being exceeded given the existing status of the silos. If the off-site (real people) population's annual dose limit is being exceeded, the proposed sand cover could be justified.

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3. <u>Reduction of Radon Emissions</u>

Reference 1 states that calculations and laboratory tests for three types of sand fill would reduce radon emissions by 95 to 99%. References 2 and 4 provide the reports of the laboratory measurements and computations of the radon flux attenuation factors for the three sand types. This data was used to generate the graphs showing radon attenuation versus various sands and thicknesses - computer calculated and from testing (see attachments to Reference 1). From this information, the four foot depth for masonry sand was determined to be the optimum thickness to practically eliminate radon emissions from the silos.

Review of the basic laboratory data (see Table 2 - Radon Flux Attenuation Factors, from Reference 2 - Attachment II) indicates that the moisture content of sand is more critical for controlling radon diffusion than the type of sand cover and its thickness. For example, a four foot thick cover of masonry sand has a radon flux factor of 0.73 for a moisture content of 4.2% versus 0.39 for 9% moisture. That is, doubling the moisture content of the sand cover results in an appreciably lower radon flux (47% lower in this example). The references do not state what moisture content was used to prepare the radon attenuation graphs. Therefore, the selection of the most effective moisture content of fill sand is extremely important to minimizing radon emissions from the silos.

Over time, the installed sand cover may "dry out" due to evaporation and saturation of the atmosphere within the dome's void space, or by seepage into the underlying residues. In order to assure the continued effectiveness of the sand cover to reduce radon emissions, the optimum moisture content of the sand fill itself will have to be monitored and maintained. This may require active maintenance by periodically wetting down the sand cover inside the silos.

Reference 3 describes the mechanical spreader/ broadcaster type system which would be used to install the sand within the silo. This appears to be the best method for the sand fill operation. Sand specifications are discussed; however, only the particle size distribution (sieving of grab sand samples) will be checked. The moisture content of sand should be specified and checked daily to assure that the sand meets the required specifications for the project.

Two other problem areas are not addressed in the sand installation work plan:

1. obtaining the maximum density (i.e., compaction) of fill sand

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2. obtaining a good, tight "seal" around the silo's walls

Both of these factors determine the cover's capability to inhibit the diffusion of radon gas through the porous sand particle matrix. Since the use of a spreader/broadcaster system cannot by itself compact the sand fill, and the restrictions of the dome openings may limit other mechanical techniques for compacting the fill sand, the resultant sand cover will probably achieve minimal density. The optimum sand compaction density was not provided in the references; but usually, the maximum density and moisture content (i.e., saturation) of cover material is selected to minimize radon diffusion.

Attachment 3 to Reference 4 states, "exact optimum moisture content of the sand material will be determined upon final selection of the sand conveying and spreading system." This means that the expected reduction in radon emissions may not happen in reality because the fill sand is at a lower compaction density, and moisture content, than the optimum parameters as used for the laboratory tests.

The question of obtaining a good, tight seal between the sand fill and the walls of the silo is critical. The radon gas emanated from the underlying residues would most likely take the path of least resistance by migrating along the sand/residue boundary and then diffusing upwards along the wall's surface.

Attachment 3, Reference 4 concludes that the fluid nature of the fill sand will result in a "self-healing" effect; but how this relates to compaction of the sand and obtaining a good, tight seal with the walls of the silo is not clear. Without a good "seal" between the sand and the walls, radon emissions from the sand filled silo will probably be no different than the present rate of emission from the silos. The information provided in Reference 4 does not clarify the concern for achieving an optimum fill sand moisture and compaction density within the silo; nor the ability to obtain a good, tight seal between the fill sand and the silo's walls.

Reference 1 provides some results of the FMPC radon monitoring network during 1987 and 1988. For example, the FMPC site boundary stations had an average radon concentration of 0.8 pCi/1 (including natural background) for the first half of 1988. The allowable radon gas level in off-site areas occupied by the general public is 3.0 pCi/1 above background levels (see NRC's 10 CFR 20, Appendix B, Table II, Column 1 - Maximum Permissible Concentrations in Unrestricted Areas for 168 hour per week exposure). Therefore, existing environmental monitoring data indicates that the present radon emissions from the K-65 silos are 000007 well within the allowable regulatory limit. This environmental monitoring data should be reported and evaluated to determine whether radon emissions from the K-65 silos are a real problem.

No data was provided for the nine off-site radon monitoring stations. Such data should be reviewed and compared to the FMPC site boundary fence sampling locations to determine if there is indeed a significant difference between the present on-site radon levels versus the off-site levels attributable to radon emissions from the K-65 silos. Unless it can be shown that elevated radon levels exist in the off-site areas surrounding FMPC, and there should also be a real population at risk, the need to further reduce the present radon emissions from the K-65 silos is not required by any regulatory standard.

5. <u>Radon Releases During Sand Filling Operations</u>

Reference 3 provides detailed work plans for the sand fill operation (see Work Plan for the K-65 Storage silos Interim Stabilization Project - Installation of Sand Layer). These work plans appear to provide adequate safety and radiation protection considerations for the workers associated with the sand filling operations.

An area which is not addressed in these work plans is how to control the release of radon/progeny from the silo when the manways (dome openings) are uncovered to permit the sand fill operations. Section 3.6 of the subject work plan discusses radon sampling of the silo; but only the criteria for authorizing the opening of a manway is provided - "under no circumstances will the silos be opened to the environment when:

- the radiation dose rate on the silo surface is above 100 mRem/hr, or
- the expected release of radioactivity is more than 4 Curies, or
- the radon concentration inside the silo is greater than 3×10^6 pCi/l

After a manway or sounding pipe is opened, there will be no method to control the release to the environment of potentially high activities of radon/progeny. Working Level grab samples will be collected next to the open manways, and this information will be used to determine the required respiratory protection for the on-site workers. The continuous radon gas monitoring network at the K-65 fenceline will be used to monitor radon releases. An action level of 1500 pCi/l has been established which will require that the manway covers will be reinstalled and secured. 000008

The radon treatment system will be periodically operated to reduce the radon concentration inside the silo, but this system probably cannot be run continuously during the sand filling operations. If some mechanism can be designed to filter out the heavy dust load during the sand filling operation, the radon treatment system could be run longer and perhaps a "negative pressure" could be maintained within the silo thereby minimizing radon/progeny releases while the manways are open.

6. Sand Radwaste Volume

The reported K-65 residue volume is 7,200 cubic yards (or 194,400 cubic feet). The addition of the proposed four-foot thick sand cover would add an additional radwaste volume of 40,205 cubic feet. This represents an overall radwaste volume increase of 21%. This radwaste volume (40,205 cubic feet of fill sand), would result in extra time, manpower, radiation dose, and costs to remove, package, and dispose of such sand should a subsequent decision be made to remove the underlying K-65 residues. For example, if this volume of fill sand was to be repackaged in 55 gallon drums for disposal, at least 5,361 drums would be required, and 107 trailer trucks would be needed to transport just the fill sand.

Reducing radioactive waste volumes should be a goal of any FMPC site remediation activity. If the K-65 materials are to be eventually removed, additional radiation doses will be accrued by the workers during the removal of the sand covers. Increasing the overall waste volume of the silos could be justified only if there is a positive reduction of dose commitment (i.e., the dose reductions to the FMPC work force and the off-site population during the time period of interim stabilization should be greater than the real dose received by workers installing, and subsequently removing the sand fill).

7. Other Considerations

Approval of the proposed sand fill project should be based on increased protection of the public health and the environment. This should also be a consideration for minimizing on-site worker's exposures to radiation and radon/progeny emissions from the K-65 silos. With respect to such radiation protection activities, the applicable federal regulations/standards should be clearly stated. Then, a comparison could be made of the expected benefits for completing remedial actions and for the final solution to be certain that any proposed action would result in compliance with such standards.

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For example, U.S. EPA regulations are specified in 40 CFR 190-192, "Environmental Radiation Protection Standards for Nuclear Power Operations". These standards contain limits for the radiation doses received by members of the public in the general environment as a result of operations which are part of the nuclear fuel cycle. These EPA standards specify that the annual radiation dose equivalent to the off-site population should not exceed 25 milliRem to the whole body. The U.S. NRC regulations are contained in 10 CFR Part 20 and Part 61. In particular, Part 61.41 specifies an annual dose limit of 25 milliRem to the whole body from land disposal of radioactive waste. These standards for the off-site population should not be confused with the 100 milliRem dose discussed in Reference 1 which deals with "radiation protection standards for public entering a controlled area" [see DOE 5480.11 (12/21/88)]. Therefore, it should be stated whether or not the goal of remedial activities at FMPC is to achieve an off-site radiation dose limit of 25 milliRem per year.

Available environmental monitoring data should then be reviewed to determine whether the public's allowable dose limit is being met under the existing status of the K-65 silos. If the dose limits are presently being exceeded, then it is justified to consider remedial work or more importantly, a final solution for the K-65 silos. In any case, the expected reductions in radiation exposure rates and exposure to radon/progeny emissions should be compared to the allowable dose limit to justify completion of proposed work.

Also, a comparison should be made between the committed dose to the workers to complete a proposed interim project versus the reduction of dose to both the on-site and off-site populations if the project is completed. For example, in the case of the proposed sand fill project, numerous on-site workers will receive substantial whole body dose while working on top of the silos or nearby the radon gas treatment system. Workers and off-site populations may be exposed to higher radon/progeny levels during the sand fill project due to the radioactivity releases while the manways/sounding pipes are open. These committed doses should be compared to the dose saved by both the on-site and off-site populations resulting from the reduced gamma exposure rate (direct and "sky shine" radiation) and lower radon/progeny levels due to the sand cover in the silos.

Although the occupational radiation exposure of the on-site workers should be adequately controlled by the DOE and its site operator to be within the permissible federal radiation protection standards, it is this on-site population which is most at risk from the presence of the K-65 silos. Therefore, any proposed interim or final remediation of the K-65 silos must fully consider all 000010 radiation exposures received by all "real people" in both the off-site as well as the on-site populations. Afterall, even workers go home.

SUMMARY

This review of the sand fill project for the K-65 silos indicates the following:

Positive Findings

- The sand cover is expected (via computer modeling) to reduce gamma radiation exposure rates by 75% on top of the silo.
- The sand cover is expected to reduce radon gas emissions from the silos by 95 to 98% based on laboratory analysis of radon diffusion through samples of fill sand.
- In the event of dome failure, the dome structure would fall on top of the fill sand rather than falling on the radioactive residues; therefore, there would be no accidental release of radioactive particulates.

Negative Findings

- The sand fill at the top of the silos is not expected to appreciably reduce the direct gamma radiation exposure rate at ground level for the off-site population.
- The sand cover is not expected to be able to achieve the desired reduction in radon emissions unless the optimum moisture content and sand compaction, as used in the laboratory tests, are maintained within the silos.
- Without compaction, there is no means of obtaining a good, tight seal between the fill sand and the walls of the silo; therefore, radon gas will most likely migrate around the sand fill and be emitted at a rate comparable to the present release rate.

RECOMMENDATIONS

1. Establish the applicable off-site radiation dose limit; e.g., 25 milliRem whole body dose per year to any member of the general public.

2. Review available environmental monitoring data to determine if the applicable off-site dose limits are presently being exceeded.

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3. If the off-site dose limits are being exceeded, determine the most effective method to reduce radon/progeny emissions and/or the gamma exposure rate in order to achieve regulatory compliance.

4. There should be a consideration of the dose "saved" to the actual on-site and off-site populations versus the actual dose received by the workers to complete such an interim, remedial project.

CONCLUSION

The proposed sand fill project for the K-65 silos should be completed if:

1. It can be shown that applicable regulatory off-site dose limits are presently being exceeded; or

2. That upon completion of the sand fill project, the estimated dose commitment to the on-site workers and to the off-site population will be significantly reduced and will be As Low As Reasonably Achievable (ALARA); or

3. That the reduction in committed dose (i.e., dose saved) to the FMPC workforce and the off-site population over subsequent years would be greater than the dose received by workers to complete the sand fill project.

FINAL REMEDIATION

The ultimate, permanent solution to eliminating radon/progeny emissions and to reduce gamma exposure rates from the K-65 silos would be to dig up and remove all of the residues. This residue removal would obviously eliminate any potential leaching of radioactivity from the silos. Also, if all radioactive residues are removed, the comprehensive radon and progeny environmental monitoring network would not be needed.

Hopefully, such final remediation will be fully addressed in the forthcoming RI/FS Record of Decision scheduled for November, 1990. At this time, it seems imprudent to complete the proposed sand fill project of the K-65 silos unless it can be shown that such interim work will result in compliance with the applicable off-site dose limits and lead to an overall reduction in dose commitment to both on-site workers and off-site populations.

18 May 1989
Date

Gregory G. Eadie
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Health Physicst

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