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28 Nov 77

MEMORANDUM FOR: COMMANDER, FCDNA

SUBJECT: Chairman's Report - Conference on Runit Cleanup, 4-5 October 1977

1. Subject conference convened as scheduled. Summarized minutes of the conference are attached (Encl 1).

2. Conclusions: Based on the discussions and agreements during the conference, the chairman concludes that:

a. The radiological data presently available does not permit an accurate refinement of the scope of work involved in the cleanup of Runit Island.

b. Additional data, both soil profile and in-situ survey, are required if the estimate of the volume of soil to be excised is to be refined with any degree of accuracy. The greater the density of the data obtained, the greater the accuracy of the refinement of the estimate.

c. Great expenditure of resources solely to define the scope of work in Runit Island cleanup is not warranted. Such an effort would be self-defeating.

d. To a very large extent the effort expended to definitize the scope of work in Runit Island cleanup can be done in such a manner that it will directly contribute to the effort required for certification of Runit Island. Such effort would be necessary in any event and can serve dual purposes.

e. A coordinated program should be established and conducted to simultaneously define the scope of work involved in Runit Island cleanup and contribute data required for eventual Runit Island certification.

f. Plowing and/or mixing are not desirable or suitable techniques for meeting cleanup criteria. Both could be used after cleanup but must be carefully considered and justified.

3. Recommendations: The chairman recommends that the following program outline be transmitted to Commander, JTG for execution generally in the sequence listed, although some actions may be performed concurrently based on availability of assets.

a. In coordination with ERSP, establish, survey and mark, a 50 meter grid for the northern half of Runit.

b. Utilize FRST, other resources, and portable field instruments to search out and remove very small "hot spots" and plutonium chunks on or near the surface. This effort should initially be confined to the FIG/QUINCE area, concentrating on the areas shown as D level or higher concentration on the YVONNE (Runit) June-July 1977 aerial survey. This effort is visualized as a locate-and-measure and shovel-and-bag operation. It is not intended to excise extensive areas of surface contamination. Its purpose is to attempt to pick up milligram and larger particles of plutonium concentrated in very small areas, generally less than one meter square. Removing such very high contamination level spots should reduce the size of the areas which in-situ survey will characterize as greater than 400 pCi/g, thus reducing the volume of surface soil to be excised. This effort should be carefully monitored and if it appears unproductive, should be stopped. Location, amount excised, and estimated activity for each excision should be recorded. Excised soil should be stored for crater containment. If the hot spot extends deeper than about 25 centimeters the area should be treated as in f below.

c. If resources are available, the effort outlined in b above should be tried in the Cactus crater vicinity. The test should be in the vicinity of USAF-RHL sample sites 9, 10, 27, 31 as shown on the Runit data map (previously provided). This effort should not be extensive. The Cactus crater area does not exhibit the same characteristics as the FIG/QUINCE area. The effort will probably not be productive in the Cactus crater area, but potential gain justifies a limited experiment, provided sufficient resources are available not to interfere with other operations.

d. Using an IMP, conduct in-situ surveys on the established 50 meter grid, to define the size of the areas contaminated to levels greater than 400 pCi/g PU 239/240. In order to minimize risk of contamination of the IMP, this need not include a detailed survey of the area within the 400 pCi/g isopleth. However, data taken should be directly contributory to the full survey required for cleanup and certification. This effort should be confined to the FIG/QUINCE area and the Cactus crater area as indicated by the contamination isopleths on the YVONNE June-July 1977 aerial survey data.

e. Using backhoes, FRST, and other resources as available, perform soil profiling surveys in the central area (between FIG/QUINCE and Cactus crater areas) where no profile data is currently available. Ten to 15 profiles should be sufficient. Location and spacing of the sampling sites must be coordinated between JTG and ERSP and must lie on the 50 meter grid lines or agreed subdivisions thereof. Sampling locations selected must directly contribute to data required for cleanup survey and for certification. This effort should be initially limited to those areas selected for stockpiling contaminated debris and contaminated soil. (See h and i below for sampling techniques and analyses.)

f. Using backhoes, FRST, and other resources as available, perform soil profiling surveys in the FIG/QUINCE and Cactus crater areas. Sample locations and spacing must be coordinated between JTG and ERSP and must lie on the 50 meter grid lines or agreed subdivisions thereof. Sampling locations, insofar as possible, must be directly contributory to data needed for cleanup survey and for certification. This effort is intended to determine the physical limits of the subsurface contamination pockets indicated by soil sample data at sample points AEC 104, 111, 112; USAF-EPA 16, 12-1; and USAF-RHL 8, 15, 32, 10, 31, 27 and 9. If possible, this profiling effort should await completion of the in-situ survey of d above, but this is not a necessity. Profiling can be done before or concurrent with the in-situ effort. It is envisioned that this profiling effort will use iterative "one-half distance" techniques to establish the size of the subsurface pockets showing contamination levels in excess of 400 pCi/g PU 239/240. (Use of the "one-half distance" technique should not imply that the contamination can be characterized by a mathamatically continuous function. Random discontinuities must be expected. See Encl 1.)

g. As resources permit, continue soil profiling in other areas in northern half of Runit. Sample locations and spacing should be directly contributory to data needed for cleanup survey and for certification as well as characterization. Additional samples should be taken in each of the three areas, FIG/QUINCE, Cactus crater, and the central area. The objective is to further the assurance of presence or absence of subterranian contamination. If pockets of contamination are found they should be defined as in f above.

h. Soil profiling operations will be subject to continuing coordination between JTG and ERSP to ensure maximum usability of data obtained. In general, a profile site depth of 120 cm will be sufficient. However, conditions may dictate greater depth, particularly near Ground Zero locations and berm or mound areas. Soil sample depth increment should be 20 cm with a discrete 5 cm deep sample taken from each 20 cm increment. Location of the 5 cm sample within the 20 cm increment to be coordinated between JTG and ERSP. Local conditions of interest may dictate additional samples or change of sample techniques. Such changes are the prerogative of CJTG in coordination with ERSP, subject to availability of resources.

i. Soil sample analysis should be done by first characterizing samples by a gross exposure rate gamma scan in the ERSP laboratory, if possible gating for 60 Kev gamma from AM 241. Samples which have very high or very low levels of contamination, as shown by gamma scan, may be set aside. The intermediate level samples would require further analysis by gross alpha count and by additional radio-chemical analysis of approximately five percent of these selected samples. Variation of these procedures is the prerogative of CJTG in coordination with ERSP. All samples taken must be properly identified for possible future analysis in support of certification.

j. Runit characterization soil sample inputs to the ERSP laboratory must be restricted in order to not interfere with other cleanup operations. Daily sample input of 50 soil samples can probably be supported without interfering with other operations. Final adjustment is the subject of coordination between JTG and ERSP. Resources allocated to Runit characterization should be adjusted as necessary to maintain work flow without laboratory overload.

k. As resources permit, transects should be cut through all berms and mounds on northern Runit. Soil profile samples from such transects should be taken to radiologically characterize the contents. Soil profile cuts below the original surface may be required in such transects. This effort must contribute to cleanup survey and certification as well as characterization. Such work in the Cactus crater ejecta lip should be done only as opportune to other necessary operations. Major effort to characterize this ejecta lip should not be made until extent of entombment area is better defined.

l. It is recognized that soil sampling locations indicated on the Runit data map are only approximate. Specific coordinates by the local grid system are not available. Locations shown on the Runit data map are the best presently available and on-site location must be done by scaling from the map. Coordinate data available has been provided separately.

m. CJTG must provide adequate priority for resources; logistics, transportation and personnel, to ensure smooth operational continuity. Priority should be second to Lojwa and Runit construction and equal to other radiological cleanup operations. Work schedules and immediate priorities must be set by CJTG in coordination with ERSP and other organizations concerned. The Runit characterization efforts outlined in a through f above should be considered as a part of the beginning cleanup operation and given appropriate priority. Target date for completion of data acquisition resulting from a through f above is 15 January 1978.

n. Stockpiling of contaminated debris and soil from other islands may have to be adjusted from planned locations to avoid interference with characterization of the FIG/QUINCE area. Contaminated soil must be separated into two stockpiles: one stockpile for soil excised from areas contaminated to levels greater than 400 pCi/g; the second stockpile of soil excised from areas of lesser contamination.

Charles J. Treat
CHARLES J. TREAT
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Chairman

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SUMMARIZED MINUTES

CONFERENCE ON RUNIT CLEANUP

4 - 5 OCTOBER 1977

LAS VEGAS, NEVADA

ENCL 1

The signatures of the participants recorded on the next page indicate only their agreement that the summarized minutes accurately reflect the discussions, agreements and consensus reached during the conference. Any exceptions to either the minutes or to the chairman's report by any participant are as noted below. Exceptions and explanations provided to the chairman by participants are appended to the minutes.

EXCEPTIONS/COMMENTS ATTACHED:

Mr McCraw .... Encl 7

Dr Smale .... Encl 8

Ms Barnes .... Encl 9

Mr Church .... Encl 10

Mr Doles .... Encl 10

Mr Hendricks .... Encl 11

Mr Bernhardt .... Encl 11

PARTICIPANTS

NAME	AGENCY	SIGNATURE
Richard F. Smale	LASL	
Donald W. Hendricks	USEPA	
Robert E. Yoder	Rockwell	
Thomas R. Crites	LLL	
Edward T. Bramlitt	FCDNA	
Tommy F. McCraw	USDOE	
A. E. Doles	Eberline	
Bruce W. Church	USDOE/NV	
David E. Bernhardt	EPA/ORP	
Edwin T. Still, LtCol, USAF	AFRRI/DNA	
Arden E. Bicker	REECO	
Alfred W. Western	REECO	
Charles Treat, Col, USA	FCDNA	
Madaline Barnes	DRI	

MINUTES OF CONFERENCE

1. A conference convened at Las Vegas, Nevada, 4-5 October 1977 to examine means of meeting requirements for a more definitive, quantitative characterization of the scope of work involved in the radiological cleanup of Runit Island, Enewetak Atoll. The message convening the conference is enclosure 1. A listing of participants and observers is enclosure 2.

2. The conference opened with introduction of participants and observers, and brief remarks by BG Grayson D. Tate, Jr., Commander, Field Command, Defense Nuclear Agency, and Mr. Roger Ray, Department of Energy, Nevada Operations Office, DOE Project Officer. General Tate stressed the overall importance of Runit in the cleanup, the necessity to obtain a better definition of the scope of work involved, and the desire to explore alternative methods of meeting cleanup requirements. Mr. Ray addressed the purpose of the conference and the possible alternative of performing cleanup of Runit first in order to determine resources remaining for use on other islands of the atoll.

3. The chairman briefly reviewed the background of the cleanup, the cleanup requirements, the plan of operations to achieve cleanup, and the specific problem relating the scope of work on Runit to total resources and the availability of resources for cleanup of other islands (enclosure 3). Mr. McCraw questioned the FCDNA position that cleanup of all soil contaminated to levels of greater than 400 pCi/g is mandatory and has priority over cleanup of contamination levels between 40 and 400 pCi/g. Mr. McCraw stated that the intent of the AEC Task Group had been to place both conditions at equal priority so long as resources were available. LTC(P) Sanches read an extract from the AEC Task Group report on this subject (enclosure 4). (More explanation of enclosure 4 can be found on pages 8 & 9 of Appendix III.) (See also enclosure 7) The chairman reiterated the FCDNA position and the fact that resources are constrained, limiting the total amount of work which can be done. This condition forces consideration of reducing the scope of work involved on Runit and the placing of priorities on tasks considered to firm requirements.

4. Dr. Bramlitt reviewed the available data, how the data was obtained and showed views of the island as it appeared during test operations and as it appears now. Printed data is enclosure 5. There were discussions of Plutonium/Americium ratios, plutonium 238 to plutonium 239/240 ratios and uranium contamination levels. Dr. Bramlitt reviewed the work done on the Erie test site and sampling methods used on areas of southern Runit.

5. The chairman asked participants to consider the question of what can be concluded from the available data and whether that data can lead to a better definition of the scope of work under conditions prevailing on Runit Island. There were discussions of the methods used to obtain available data; the relative degree of preciseness of aerial in-situ survey and van in-situ survey. The aerial survey technique integrates readings over approximately one hectare each second to approximately three centimeters depth. Aerial survey isopleth lines are probably limited to an accuracy of ± 100 feet. The in-situ survey integrates over a field of view of 68.8 feet diameter and approximately three centimeters depth. It was concluded that the data presently available would not support refinement of the scope of work involved. Further data is highly desirable.

6. The chairman then addressed the obtaining of such data. There was discussion of methods of measuring both surface level and subsurface contamination levels and the specified removal criteria. Mr. McCraw read extracts from the four removal criteria contained in the operations plan (OPLAN 600-77) (encl 6). Miss Barnes stated that it would be impossible to reach even the 50 percent confidence level of not having missed significant subsurface contamination without doing much more profile sampling. A lower density of measurements would result in lower confidence in the estimate and a greater error term. For example, to find a particular region of contamination two feet wide, under worst case with the seam parallel to the grid lines, would require sampling every four feet. To provide such characterization would require commitment of substantial resources.

a. If the characterization is done on a simple yes-no criteria i.e. contamination exceeds a specified level, the sampling need not be so precise. Using the highest contamination level recorded on the island, 3200 pCi/g, Dr. Crites demonstrated a calculation showing that a pocket of contamination which would average greater than 400 pCi/g over a 21 meter (68.8 ft) field of view would be approximately seven meters in diameter. Thus sampling on a grid of less than seven meters should locate such a minimum pocket size subsurface contamination of interest (see also encl 8).

b. There was discussion on the one half distance technique for determining the presence or absence (yes-no) of subsurface contamination. Available data indicates only a few sample locations showing subsurface contamination at greater than 400 pCi/g levels. Sample locations are spaced on approximately a 200 foot grid. Moving one half the distance between greater than and less than sample points iteratively should provide boundary definition of contamination areas of interest (see encl 8). This investigation would be limited to those areas where available data indicates high subsurface contamination levels, thus reducing the effort involved. The "7 meter" criteria would set the lower bound of the iterative half distance.

7. There were discussions of techniques for taking profile samples centered primarily on advantages of backhoe versus auger. During the Erie test area investigation 40 sample sites were completed in about 10 days using the backhoe. This was accomplished in spite of the delay imposed by operating in anti-contamination clothing as required by rad-safe procedures. It was concluded that the backhoe was probably faster and provided more precise sampling.

8. The chair requested participants to address the northern half of Runit as three distinct areas, the Cactus crater area, a central area, and the Fig/Quince area, and what sampling should apply to each. The consensus was that the Cactus area, showing high levels of subsurface contamination should be treated as is the Fig/Quince area, i.e., one half distance yes-no sampling in the vicinity of locations showing high subsurface contamination. The background history of the central area provides no reason to suspect high subsurface contamination in that area. Therefore, sampling in this area should be limited to a few confirmatory samples sites in areas not covered by the available data. (This probably amounts to something on the order of 20 sites or less.)

9. The ejecta (lip) of Cactus crater presents a special problem. Past history and available data tend to indicate that there may be high subsurface contamination below the pre-detonation surface level. This level is now buried under the ejecta. This condition lead to a brief explanation of the cratering operation and the possible extent of the area to be covered by the entombment. Consensus was that this area should be considered after a better knowledge of the extent of the area to be covered is gained. If the area is to be covered by cement/soil mixture no further sampling is needed. If it is not to be covered, then sampling should be done to confirm presence or absence of greater than 400 pCi/g contamination levels, both in the ejecta and below the pre-detonation surface.

10. The method of analysis of samples was discussed. It was agreed that a gross alpha count was probably the fastest and simplest method to obtain the yes-no answer sought. This would not define the isotopic contamination content but would provide a base to be supplemented by radio-chemistry analysis which would provide the isotopic content and should be correlatable to gross alpha count for any specific area.

11. Discussion turned to sampling increment to be utilized. Increments discussed included the averaged 10 centimeter depth used for most of the available data; averaged 20 centimeter depth, based on a nominal 6-inch cut capability for a dozer; and 20 centimeter increments with a specific 5 centimeter sample from each increment. The operations plan specifies 5 cm sample depth because of past experience at Nevada Test Site. Five centimeter depth samples will be the basis for certification of the condition of the islands upon completion of cleanup. Discussion included the advantages and disadvantages of horizontal averaging versus vertical averaging for sampling. Consensus favored vertical averaging. Discussion also included the capability of the laboratory to analyze the samples produced. Maximum capability would be about 150 samples per day for gamma scan and gross alpha count plus about five percent radiochemical analysis. This level would not permit support of other operations. Other operations could be supported at levels of 50 samples per day input. It was agreed that gamma scan of samples at the laboratory could be used to select samples for analysis. Only the "hot" samples would be analyzed. Other samples would be held for future use depending on the outcome of the "hot" samples analysis. This technique was favored over using gamma scan on sample site sidewalls and only sampling "hot" areas (see encl 9). This concluded the first day's discussion.

12. Discussion resumed on 5 October. The chair outlined the two incremental sampling techniques discussed and proposed adoption of 20 cm sampling increments with a discrete 5 cm sample to be taken from each 20 cm increment. This technique should suffice for characterization and may also meet some certification requirements. The proposal was accepted.

13. The chair requested the group consider depth to which sampling should extend. Consensus indicated that a depth of 120 cm generally will suffice but that the option to go deeper should be left to field personnel. It may be particularly desirable to go to greater sampling depths in areas of ground zeros, in burm or mound areas, and in ejecta areas near Cactus crater. The backhoe may not suffice for some of these depths (greater than 10 feet) and other equipment may be required.

14. Discussion reverted to the sampling grid to be used for characterization. Mr. Church proposed, for consideration, a 10 meter grid for the "hot" areas (Fig/Quince and Cactus crater areas), and a wider spaced grid for the "cool" area in between. Several members indicated their support for the half distance technique for initial exploration with grid size to be decided later based on data obtained from initial efforts. This lead to extensive discussion of desire for data versus reasonable expenditure of resources and purpose and extent of characterization. The chair maintained that characterization should be limited to determining the extent of known subterranean pockets and the extent of surface contamination areas. The effort should not extend to exploration to locate other

possible subterranean pockets. Mr. Church stated that the available data was not extensive enough to support a contention that other pockets did not exist. For purposes of certification there would have to be additional data taken. The same method of obtaining data for certification applies to all islands. This consists of in-situ and surface soil sample surveys, and investigation of suspected burial sites, supplemented by selected soil profiling data. Obviously, the greater the density of soil sampling profile data, the lower the chance of being surprised later in the cleanup.

a. After extensive discussion, the following was proposed and accepted. The northern half of the island will be gridded on a 50 meter grid. The "cool" area will be sampled first in order to characterize the areas to be used for stockpiling of soil and debris from other islands. Approximately 16 to 50 sample sites will be required, depending on initial findings. Areas are to be decided based on stockpile locations. Sampling transects should be cut through the mounds in this area to characterize the contents thereof. Characterization of the extent of subsurface pockets can use an adaptation of the one half distance technique, working along the 50 meter grid lines. Density of other sampling in the "hot" areas can be decided on basis of data obtained from the "pocket" investigation.

b. Use of the standard 50 meter grid will permit use of data obtained during characterization for consideration for certification. Although Runit will be no different in method for certification, the history of the island and available data do indicate a probable requirement for higher density survey than may be required for other islands. This led to a discussion of the advantages and disadvantages of placing contaminated stockpiles on relatively uncontaminated areas. It would generally be better to put contaminated stockpiles in areas known to be contaminated to similar or higher levels. The "cool" area requires relatively few sampling sites and to place the contaminated stockpile in the "hot" area may interfere with the characterization effort.

15. It was agreed that when resources permit it would be highly desirable to use one IMP to further refine the area of surface contamination to be removed. These areas are defined, in the Fig/Quince area, by aerial survey contours. The Cactus crater area is not defined. In-situ survey refinement would assist considerably in refining the estimates of area, and thus volume, to be excised. Mr. Church proposed to use the IMP only to move in toward "hot" areas and define the periphery of those areas over 400 pCi/g. This would not be a full survey but would refine the area boundries and would avoid risk of high contamination of the IMP. There was discussion of use of this "peripheral" technique as compared to a full survey. It was agreed that the peripheral technique would not totally

define the surface area but certainly should provide better estimating data than the aerial survey. Used on the grid lines the characterization effort would be directly applicable to the full survey for certification and, thus, is not wasted effort.

16. It was recommended by Mr. Doles that the FRST and field instruments be used to search the Fig/Quince area for very localized "hot spots" and "chunks". Removal of such spots, by shovel and bagging techniques, could contribute measurably to reducing the areas measured to be over 400 pCi/g by in-situ survey. This should be done prior to soil profiling and in-situ survey. It appears that the overlap period for FRST members would be an excellent opportunity to conduct this effort. It would contribute to training with a meaningful effort. This may also apply to soil profiling efforts.

17. The question was raised whether soil profiling in known hot pocket areas would disturb the validity of the in-situ survey. It was concluded that it probably would not. It would be desirable to perform the in-situ survey before soil profiling but this is not an absolute necessity. "Hot" piles from soil profiling can be shielded from the IMP view.

18. The cost in resources and time required was addressed. It was generally agreed that these costs can not be accurately assessed at this time. Density of profiling efforts and of the in-situ survey effort depends, to some extent, on the initial data obtained. However, the effort does not appear to be excessive. Additionally, as proposed for conduct it largely contributes directly to effort required anyway for certification. Thus only minimal resource expenditure is devoted exclusively to the characterization effort. The efforts which may not be directly contributory are the delineation of the subterranean pockets and the FRST pick up of "hot spots".

19. Mr. Doles asked what priority would be given to this characterization operation. He indicated that without some priority the operation would be only sporadic and require a long time. The chair replied that this operation should receive the same priority as the beginning of cleanups on Lujor and Boken. Hopefully assets available would permit simultaneous work on cleanup and characterization. Mr. Doles expressed concern that much time would be wasted unless the characterization effot had priority on logistic support, particularly boat transportation support. The chair stated that priority within reason would be afforded to ensure as smooth an operation as possible under circumstances existing on the atoll.

20. The group discussed time frames and future meetings. It was agreed that 90 days appeared to be a reasonable target for obtaining data for the characterization. Data only for certification could be obtained during cleanup of Runit. The group would plan to meet again, at the call of the Chairman, after the characterization data is available.

21. The chair addressed the question of "plowing" to further homogonize Runit soil, thus reducing the "hot spot" concentrations. Mr. Yoder stated that cleanup experience so far indicates that we have had to go back repeatedly to cleanup to new, lower levels. Plowing will simply make such future cleanup more difficult and he strongly recommends against plowing. Further discussion indicated that plowing generally tends to lower average concentrations, and if the primary problem is air resuspension, plowing may help. However, in the specific case of Runit plowing might result in increasing surface levels by bringing subsurface contamination to the surface. This condition would be worse than doing nothing. It was generally agreed that plowing should not be used to meet cleanup criteria. After cleanup plowing may be considered to further reduce concentration in "hot" areas. However, if plowing is used, for any reason, it must be fully justified and defensible. Plowing should in all cases be kept shallow, on the order of six inches.

22. The concept of limiting disposal soil quantities by spreading lower level contaminated soil from other islands on Runit was discussed. It was agreed that leaving such soil uncontained on Runit was preferable to leaving it on other islands of greater potential benefit. If this concept is used the soil should not be spread on Runit. The soil should, instead, be used to fill in holes, left by cleanup of Runit, and/or left in one stockpile. Whichever is done the area should be clearly identified and delineated for future reference. A re-assay of the soil would be necessary for certification purposes.

23. The group indicated a consensus that amounts of soil excised, amounts of soil entombed, and amounts of soil left uncontained should be recorded. An estimate of the curie content of activity entombed and left uncontained should be recorded for future use. This could be done by sampling truckloads and estimating content thereof.

24. The chair thanked the attendees and outlined his plan for report and minutes submission. The conference adjourned.

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TO: AFRRI WASHINGTON DC/RPC/LTC STILL

DNA WASH DC/LGEC/MR STEVENS

DR ROBERT E. YODER, DIRECTOR, HEALTH, SAFETY AND ENVIRONMENT, ROCKWELL INTERNATIONAL ATOMICS INTERNATIONAL DIVISION, ROCKY FLATS PLANT, PO BOX 464 GOLDEN CO 80401

MR. ARDEN E. BICKER, MANAGER, ENVIRONMENTAL SCIENCES DEPARTMENT (MAIL STOP 709) AND MR. ALFRED W. WESTERN, DIRECTOR, FIELD OPERATIONS (MAIL STOP 235) REYNOLDS ELECTRICAL & ENGINEERING, INC., PO BOX 14400, LAS VEGAS, NV 89114

DR. TOM CRITES, LAWRENCE LIVERMORE LABORATORY, PO BOX 808, LIVERMORE CA 94550

MISS MADELINE BARNES, DESERT RESEARCH INSTITUTE, LAS VEGAS, NV

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MR. AL DOLES, VICE PRESIDENT, EBERLINE INSTRUMENT CORP, PO BOX 2108, SANTA FE, NM 87501

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SIGNATURE: Grayson D. Tate, Jr.

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MESSAGE HANDLING INSTRUCTIONS

FROM:

TO: MR. BRUCE CHURCH, CHIEF, RADIOLOGICAL BRANCH, BIOENVIRONMENTAL SCIENCES DIV, USERDA, PO BOX 14100, LAS VEGAS, NV 89114

MR. DONALD W. HENDRICKS, DIRECTOR, OFFICE OF RADIATION PROGRAMS, AND MR. DAVID E. BERNHARDT, PROGRAM MANAGER FOR DOSE ASSESSMENT, US ENVIRONMENTAL PROTECTION AGENCY, LAS VEGAS FACILITY, PO BOX 15027, LAS VEGAS, NV 89114

MR. JEROME DUMMER, H1 GROUP LEADER (MS -401) AND MR. RICHARD F. SMALE, ASSISTANT H1 GROUP LEADER, PO BOX 1663, LOS ALAMOS SCIENTIFIC LABORATORY, LOS ALAMOS, NM 87545

INFO: DIRDNA WASH DC

FCDNA LIAISON OFC LAS VEGAS NV/FCTCL

USERDA LAS VEGAS NV/ROGER RAY

FCDNA HICKAM AFB HI/FCLP

CJTG ENEWETAK ATOLL MI/FCR

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MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

UNCLAS

SUBJ: CONFERENCE ON RUNIT CLEANUP

1. THIS MESSAGE ANNOUNCES A CONFERENCE TO BE CONVENED AT THE ENERGY RESEARCH AND DEVELOPMENT (ERDA) NEVADA OPERATIONS OFFICE, LAS VEGAS, NEVADA, 4-5 OCT 1977. CONFERENCE WILL BEGIN AT 0830, 4 OCT. ADDRESSEES ARE REQUESTED TO ATTEND.

2. PURPOSE OF THE CONFERENCE IS TO EXAMINE MEANS OF MEETING REQUIREMENTS FOR A MORE DEFINITE, QUANTITATIVE CHARACTERIZATION OF THE SCOPE OF WORK INVOLVED IN THE RADIOLOGICAL CLEANUP OF RUNIT ISLAND.

3. BACKGROUND:

A. DIRECTOR DNA HAS BEEN DESIGNATED AS THE DOD PROJECT MANAGER FOR THE CLEANUP OF THE ENEWETAK ATOLL. THE ERDA IS RESPONSIBLE FOR RADIOLOGICAL SUPPORT. THIS INCLUDES DEFINING AND RECOMMENDING TO DNA THE AREAS WHICH QUALIFY FOR RADIOLOGICAL CLEANUP; DEFINING AND RECOMMENDING THE VOLUME OF SOIL TO BE REMOVED (ALL WITHIN THE GUIDELINES SPECIFIED IN THE ENVIRONMENTAL IMPACT

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FROM:

TO:

STATEMENT (EIS) AND FCDNA OPLAN 600-76); AND CERTIFYING THAT CLEANUP HAS BEEN COMPLETED IN ACCORD WITH THOSE GUIDELINES.

B. IN APPROVING THIS OPERATION, THE CONGRESS LIMITED RESOURCES TO AN APPROPRIATION OF $20 MILLION PLUS ERDA AND DOD ASSISTANCE. ERDA IS PROVIDING RADIOLOGICAL SUPPORT. THE MILITARY SERVICE COMPONENTS ARE PROVIDING MEN AND EQUIPMENT FOR OPERATIONS; DNA IS PROVIDING FUNDING FOR CAMP OPERATIONS AND PERSONNEL FOR PROJECT DIRECTION. THIS OPERATION IS ONE OF SEVERELY CONSTRAINED RESOURCES WHICH MUST JUDICIALLY BE EXPENDED TO MAXIMIZE THE BENEFITS TO BE OBTAINED. FOR EXAMPLE, THE METHOD OF DISPOSAL OF CONTAMINATED MATERIAL REQUIRES PROCUREMENT OF CEMENT. IF THE VOLUME OF CONTAMINATED SOIL EXCEEDS THE ESTIMATED QUANTITIES, MONEY MUST BE REALLOCATED FROM SOME OTHER TASK TO PROCURE MORE CEMENT.

C. THE ENEWETAK CLEANUP GUIDANCE DOCUMENTS REQUIRE CERTAIN MANDATORY TASKS: DISPOSAL OF HAZARDOUS, NONRADIOACTIVE DEBRIS; DISPOSAL OF RADIOACTIVE DEBRIS; EXCISING BURIAL SITES ON AOMON

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE

SPECIAL INSTRUCTIONS

RELEASER TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

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05 OF 07								SEP	77

BOOK | MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

ISLAND (AND OTHER BURIAL SITES DISCOVERED DURING THE OPERATION); AND EXCISING OF SOIL CONTAMINATED WITH PU 239/240 TO LEVELS GREATER THAN 400 PCI/G FROM LUJOR, BOKEN AND RUNIT ISLANDS (AND OTHER AREAS DISCOVERED DURING THE OPERATION). AREAS CONTAMINATED TO LEVELS LESS THAN 40 PCI/G DO NOT REQUIRE CLEANUP. CLEANUP OF 239/240 PU CONTAMINATED SOIL IN THE RANGE OF 40 TO 400 PCI/G, ON THESE AND OTHER ISLANDS, IS TO BE BASED ON A CASE-BY-CASE ANALYSIS GUIDED BY COST BENEFIT CONSIDERATIONS.

D. THE RADIOLOGICAL SITUATION ON RUNIT ISLAND, AS PORTRAYED BY AVAILABLE DATA, IS A HETEROGENEOUS ADMIXTURE OF LAYERS AND POCKETS OF HIGH LEVELS OF CONTAMINATION ABOVE, BELOW, AND BETWEEN AREAS OF RELATIVELY LOWER CONTAMINATION. THERE MAY BE MILLIGRAM SIZED PARTICLES OF PU CONTAMINATION SCATTERED IN SOME AREAS. THIS HIGHLY HETEROGENEOUS SITUATION HAS LED TO AN UNCERTAINTY IN THE VALIDITY OF THE ESTIMATED VOLUME OF SOIL TO BE EXCISED FROM RUNIT. BY SOME ESTIMATES, RUNIT ACCOUNTS FOR 80 PERCENT OF ALL CONTAMINATED SOIL TO BE EXCISED ON THE ATOLL. THE

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06 OF 07									SEP	77

BOOK | MESSAGE HANDLING INSTRUCTIONS

FROM:

TO:

UNCERTAINTY IN THE VALIDITY OF ESTIMATED SOIL VOLUME LEADS TO UNCERTAINTY IN THE SCOPE OF WORK INVOLVED IN THE CLEANUP OF RUNIT. THIS COMBINED WITH CONSTRAINED RESOURCES, INDUCES UNCERTAINTY IN PLANNING FOR RESOURCES WHICH MAY BE AVAILABLE FOR CLEANUP OF OTHER ISLANDS OF GREATER BENEFIT TO THE ENEWETAK PEOPLE.

4. THIS CONFERENCE WILL BE ASKED TO REVIEW THE PRESENTLY AVAILABLE RUNIT RADIOLOGICAL DATA, ADVISE AS TO WHETHER ADDITIONAL DATA WILL ASSIST IN REFINING THE SCOPE OF WORK, AND RECOMMEND METHODS AND RESOURCES INVOLVED IN OBTAINING SUCH ADDITIONAL DATA. PERTINENT INFORMATION IS BEING FORWARDED TO CONFEREES FOR REVIEW PRIOR TO THE CONFERENCE.

5. SINCE BOTH RADIOLOGICAL AND OVERALL CLEANUP RESOURCES WILL BE EFFECTED BY THE DISCUSSION, FCDNA, AS A REPRESENTATIVE OF THE OVERALL PROJECT MANAGER, WILL CHAIR THIS CONFERENCE. COL CHARLES J. TREAT HAS BEEN DESIGNATED AS CHAIRMAN. CONFEREES NEEDING ASSISTANCE AT ERDA, LAS VEGAS, SHOULD CONTACT MR. ROGER

DISTR:

DRAFTER TYPED NAME, TITLE, OFFICE SYMBOL, PHONE & DATE

SPECIAL INSTRUCTIONS

RELEASER

TYPED NAME, TITLE, OFFICE SYMBOL AND PHONE

SIGNATURE

SECURITY CLASSIFICATION

UNCLASSIFIED

PARTICIPANTS

NAME	AGENCY	TELEPHONE NO.
Richard F. Smale	LASL	(505) 667-7137
Donald W. Hendricks	USEPA	(702) 736-2969
Robert E. Yoder	Rockwell	(303) 497-2206
Thomas R. Crites	LLL	(415) 447-1100 x 3854
Edward T. Bramlitt	FCDNA	(505) 264-6487
Tommy F. McCraw	USDOE	(301) 353-3721
A. E. Doles	Eberline	(505) 471-3232
Bruce W. Church	USDOE/NV	FTS 598-3181
David E. Bernhardt	EPA/ORP	FTS 595-2969 Local 796-2[illegible]
Edwin T. Still, Lt Col, USAF	AFRRI/DNA	av comm 202-295-0227
Arden E. Bicker	REECO	FTS 546-9810
→ Alfred W. Western	REECO	FTS 546-2571
Madaline Barnes	DRI	(702) 734-3277
Charles Treat, COL, USA	FCDNA	(505) 264-7236

OBSERVERS

NAME	AGENCY	TELEPHONE NO.
Grayson D. Tate, JR. BG, USA	FCDNA	(505) 264-4515
Roger Ray	DOE/NV	FTS 598-3553
M. E. Stevens	HQ DNA	(202) 325-7132
H. N. Friesen	DRI	(702) 734-3277
Edwin N. Dodd, Jr, LTC, USA	JTG, FCDNA	
Ernest D. Campbell	DOE/NV	FTS 598-3181
John V. Hemler, Jr, COL, USA	FCDNA	(505) 264-0681
John Moroney	DOE/NV	FTS 598-3181
Phlip Lyberg	EMSL-LV/EPA	comm 736 FTS 595-2969 x-374
Don R. Martin	DOE/NV	FTS 598-3237
John Tipton	EGG	FTS 598-0584
John Stewart	DOE/NV	FTS 598-3306
Paul J. Mundra	DOE/NV	FTS 598-3306
Ron Spencer	FCDNA	(505) 264-4515 AV 964-4515
Manuel L. Sanches, LTC (P), USA	FCDNA	(505) 264-6326

Encl 2 to Encl 1

RUNIT CLEANUP CONFERENCE

AGENDA

0830 4 OCT 77

1. INTRODUCTION -

2. BACKGROUND -

3. PROBLEM -

4. DATA REVIEW -

5. DISCUSSION -

Encl 3 to Encl 1

RUNIT MEETING
AGENDA

1. INTRODUCTION - COL Treat

2. BACKGROUND/REQUIREMENT/PLAN - COL Treat

   a. BACKGROUND (View Graph)
      - Enewetak Evacuated - 1947
      - Tests 1947 thru 1958
      - Runit worst - 18 tests
      - Return to TTPI - 1972
      - Auth for Cleanup - 1976
      - Limitations - 20 or +

   b. REQUIREMENT (View Graph)
      1. Hazardous nonradioactive debris
      2. Radioactive debris
      3. Burial site(s)
      4. >400 pCi/g - mandatory (NBLB)
      5. 40-400 pCi/g - case by case
      6. <40 pCi/g - no action

   c. PLAN (View Graph)
      1. Classify debris
      2. Clear brush
      3. Rad measurement (survey)
      4. Excise soil
      5. Re-survey
      6. Excise soil
      7. Etc: to level
      8. Concurrent - burial sites
      9. Move to Runit - radioactive
      10. Dump nonradioactive
      11. Stockpile & dispose (crater)

3. PROBLEM (View Graph)

   a. Runit vs Resources
   b. Heterogeneous = uncertainty
   c. Volume - 80% or 63,000 cu yd vs 16,000 cu yd. Validity
   d. Uncertainty → uncertainty
   e. Can we get better definition of scope of work - within reasonable expenditure of resources.
   f. Recommend - method
      size of effort

4. DATA REVIEW (Runit Map)
   a. Pace data
   b. EPA data
   c. NVO - 140 data
   d. Crater area
   e. "Clean area"
   f. Fig/Quince area

5. OPEN DISCUSSION
   a. Can we get definition
   b. How (method(s))
   c. Cost (Resources)

options. The numerical guidance therein should be reduced by the factors of 50 percent for individual exposure and 20 percent for gonadal exposure considering that exposures cannot be precisely predicted. The detailed rationale for these reductions is provided in Appendix III. The resulting guides for planning cleanup actions will then be:

Whole body and bone marrow -	0.25 Rem/yr
Thyroid -	0.75 Rem/yr
Bone -	0.75 Rem/yr
Gonads -	4 Rem in 30 yr

- Since there is no adequate scientific information which would support general guidance for cleanup of plutonium contaminated soil, guidance can only be developed on a case-by-case basis using conservative assumptions and safety factors. With this in mind, the Task Group recommends the following for use in making decisions concerning ^{239}Pu cleanup operations at Enewetak:

  a. < 40 pCi/gm of soil - corrective action not required.

  b. 40 to 400 pCi/gm of soil - corrective action determined on a case-by-case basis* considering all radiological conditions.

  c. > 400 pCi/gm of soil - corrective action required.

ASSESSMENT OF DOSES AND THE RESULTS OF ALTERNATIVE CORRECTIVE ACTIONS

The Task Group approach for development of judgments and recommendations for the radiological cleanup and rehabitation of Enewetak was to consider a number of alternatives for exposure reduction that may be feasible. Basically, the procedure involved four steps:

---

*See Appendix III for additional guidance.

Encl 4 to Encl 1

ISLAND	RATIO OF MEANS $\overline{P}/\overline{A}$	P/E	P(1)/P
ALICE	2.83±0.12	3.97±0.17	0.088±.007
BELLE	3.78±0.19	4.70±0.13	0.11±.006
CLARA	4.18±0.64	5.36±0.32	0.12±.014
DAISY	4.12±0.42	5.08±0.16	0.12± 008
EDNA	3.34±0.15	5.96±0.37	
IRENE	7.69±0.45	3.65±0.13	0.43±.03
JANET	3.06±0.074	5.10±0.11	0.062
KATE	2.84±0.084	4.70±0.26	
MARY	2.77±0.092	5.76±0.29	
NANCY	2.30±0.067	4.70±0.17	
OLIVE	3.04±0.13	5.76±0.34	0.23±.031
PEARL	6.79±0.47	4.92±0.30	0.46±0.036
PERCY	2.78±0.14	5.05±0.47	
RUBY	8.74±1.80	1.49±0.073	0.11
SALLY	5.93±0.94	5.04±1.52	0.021±.0035
TILDA	2.77±0.30	6.58±1.50	
URSULA	2.73±0.14	4.27±0.28	
VERA	2.76±0.23	5.53±0.41	
WILMA	2.81±0.21	6.17±0.43	
S YVONNE	8.43±0.67	4.18±0.49	0.39±.013
N YVONNE	12.2±0.84	21.2±13.6	0.072±.022

ENCL 5 to ENCL 1

USAF - EPA

DEPTH (cm)	11	11-2	12-1	12-2	12-3
0 - 1	NV	3.6 [.58]	NV	NV	NV
0 - 2.5	1.7 [.09]	NV	NV	68 [.57]	28 [.57]
0 - 5		NV	600 [.55]		
1 - 2		4.6 [.52]			
2 - 3		8.7 [.50]			
3 - 8		5.2 [.46]			
8 - 14		6.4 [.34]			
14 - 20		7.8 [.38]			

USAF - EPA

DEPTH (cm)	16
0 - 2.5	800 [<.01]
30 - 31	700 [.03]
31 - 32	800 [.02]
32 - 33	170 [<.04]
91 - 92	2500 [.02]
122 - 123	3200 [.02]

CACTUS : .5
BLACKFOOT : .26
FIG/QUINCE : .03

[ ] = Pu-238/Pu-239+240

ERIE : .4

AEC

DEPTH (cm)	107	106	105	104	103	102	101
0 - 10	.3 (.055)	6.4 [.20]	4.2 [.12]	495	1.9 [.11]	5.1 [.11]	2.9 [.14]
10 - 20	1.8 [.10]	11 (.062)	4.1 [.10]	366	.1 [.23]	1.9 [.31]	1.4 [.11]
20 - 30	.5 [.17]	2.4 [.27]	3.4 [.24]	316	<.03	1.3 [.39]	.04
30 - 40	.3 [.25]	.2 [.17]	6.7 [.25]	294	<.01	.4 [.34]	.04
40 - 50	.03	.1	1.1	399	.03	.5 [.33]	.007
50 - 60	<.01	.04	.7	272	<.01	.7 [.37]	<.03
60 - 70	<.02	.01	<.01	268	<.01	.4 [.37]	<.02
70 - 80	<.01	.03 [.24]	<.03	442	<.01	<.07	<.03
80 - 90	<.01	<.005	<.03	441	<.01	<.08	<.02
90 - 100	<.007	<.005	<.05	794	NV	.06	<.04
100 - 110	.02	<.06	<.03	58	<.01	.07 [.15]	<.03
110 - 120	NV	<.01	.05	36	NV	<.007	<.01

( ) = Pu-240/Pu-239

AEC

DEPTH (cm)	146	145	144	143	142	141	140
0 - 10	38	9.0	11	117	3.8	72	6.2
10 - 20	[.07] 54	[.51] 3.3	20	181	.02	37	[.53] 5.0
20 - 30	[.04] 150	.5	45	3.4	.02	29	[.51] 2.2
30 - 40	[.04] 83	.01	14	1.3	.01	20	3.2
40 - 50	[.04] 36	.01	23	.5	15	5.4	2.8
50 - 60	[.09] 10	.01	55	.5	.03	2.5	4.1
60 - 70	7.7	.01	22	.5	.05	2.9	5.6
70 - 80	5.6	1.8	13	10	.09	2.9	4.8
80 - 90	3.4	.001	12	34	.6	2.1	3.7
90 - 100	3.3	.01	10	51	.1	1.7	1.2
100 - 110	2.7	.01	4.7	77	.2	1.4	1.5
110 - 120	2.9	.02	10	10	2.2	3.0	.01

AEC

DEPTH (cm)	139	138	137	136	135
0 - 10	21	8.5	1.8	14	4.4
	[.51]	[.50]		(.062)	(.070)
10 - 20	26	1.4	.8	<.04	2.4
	[.50]	[.18]			[.25]
20 - 30	1.4	.2	.5	1.9	1.6
		[.18]		[.26]	[.25]
30 - 40	1.8	.03	.2	.6	2.8
				[.24]	[.24]
40 - 50	1.5	.02	.03	.3	2.8
					[.23]
50 - 60	1.2	<.01	.03	.4	3.0
					[.23]
60 - 70	.9	<.03	.01	.1	4.9
				[.43]	[.26]
70 - 80	.9	.04	.07	<.03	.3
					[.16]
80 - 90	1.4	.01	.02	.04	1.3
				[.40]	[.08]
90 - 100	23	<.01	.03	<.02	.4
					[.19]
100 - 110	3.6	<.01	.02	<.01	.3
					[.30]
110 - 120	43	<.01	.01	<.02	<.03

AEC

DEPTH (cm)	134	133	132	131	130	129	128	126	125
0 - 10	156 [.26]	150 [.260]	33 (.061)	92 [.26]	26 (.061)	39 (.060)	53 (.059)	63 (.059)	300 [.05]
10 - 20	18 [.22]	8.9 (.058)	15 (.059)	98 [.26]	3.4 (.060)	18 (.060)	33 (.060)	2.8 (.066)	181 [.08]
20 - 30	5.0	1.1 (.066)	4.1 (.059)	14 [.26]	.6 (.059)	2.8 (.060)	96 (.061)	.4 (.080)	53 [.24]
30 - 40	.4	.1 (.064)	.1 (.050)	2.5	.06 (.067)	.3 [.22]	26 (.061)	.09 (.114)	30 [.25]
40 - 50	.5	.07 (.178)	.07 (.046)	1.4	.03 (.055)	.09 [.48]	.09 (.170)	.2 (.057)	12
50 - 60	.3	.02 (.152)	.01 (.036)	.6	.01 (.067)	.04 (.134)	.06 (.059)	.02 (.070)	17
60 - 70	.8	<.02	.01 (.053)	.3	.04 (.056)	.04 (.278)	.03	<.02	.5
70 - 80	.4	.01 (.060)	.02 (.046)	.4	.002 (.079)	.01	.002 (.058)	.001	1.0
80 - 90	1.4 [.12]	.04 (.069)	.01 (.104)	.03	.005 (.058)	.03 (.077)	.02 (.065)	<.008	.3
90 - 100	2.8 [.10]	.03 (.056)	.01 (.028)	.1	.003 (.073)	.03 (.068)	.007 (.126)	<.02	.0
100 - 110	.2	.03 (.068)	.005 (.036)	.08	.001 (.027)	.008 (.058)	.02	<.01	NV
110 - 120	.2	.02	.03 (.051)	.1	.001 (.071)	.003 (.058)	.01	.01	.1

AEC

DEPTH (cm)	124	123	122	121	120	119	118	117	116
0 - 10	52 [.10]	21 (.054)	64 [.07]	62 (.055)	369	60 (.057)	342 [.02]	314 [.02]	734 [.02]
10 - 20	.8 [.18]	.3 [.20]	51 [.04]	1.8 [.02]	202	.9 [.03]	139	121 [.03]	.4
20 - 30	.5 [.19]	.1 [.25]	37 [.22]	.1	29	.2	15 [.02]	250 [.02]	16 [.02]
30 - 40	1.9 [.19]	.09 [.15]	109 [.24]	.2	3.2	.3	7.4 [.02]	36 [.07]	.1
40 - 50	.1 [.14]	<.01	3.3	.09	14	<.02	.9	11 [.08]	NV
50 - 60	.02	<.01	1.3	.1	4.1	<.02	.3	.9	.1
60 - 70	<.01	.06	.6	.03	1.4	<.02	.8	1.6	.0[illegible]
70 - 80	.007 (.059)	<.01	.3	<.01	.4	<.02	.8	.6	NV
80 - 90	<.02	<.02	.07	<.01	.6	.08	2.1 [.02]	.6	.0[illegible]
90 - 100	.02 (.074)	<.02	.03	.02	.8	<.01	.1	.1	.0[illegible]
100 - 110	.07	.05	.04	.04	.4	<.01	.3	NV	.0[illegible]
110 - 120	.02 (.051)	.04	.05	<.01	3.8	<.01	NV	.008	.0[illegible]
120 - 130								.9	
130 - 140								.01	

AEC

DEPTH (cm)	115	114	113	112	111	110	109	108
0 - 10	214	217	176	125	136	26	1.8	451
10 - 20	[.04] 1.9	[.02] 1.4	[.03] 49	128	(.055) 532	5.5	[.03] 7.3	193
20 - 30	[.17] 2.7	[.03] NV	[.02] 136	168	(.055) 20	10	[.03] .2	143
30 - 40	[.12] .6	.6	[.03] 211	341	(.057) 182	6.2	.1	20
40 - 50	.4	.7	[.02] 104	843	12	15	.02	5.9
50 - 60	.9	.4	[.02] 45	582	(.059) 2.3	8.9	.06	6.1
60 - 70	28	15	[.02] .6	840	[.02] .6	34	.07	5.0
70 - 80	[.25] 74	[.03] NV	.05	185	[.19] .3	27	.1	4.6
80 - 90	[.26] 26	9.6	[.26] 3.8	50	[.19] .3	3.6	.03	4.3
90 - 100	1.0	[.03] 1.5	.9	622	[.25] 2.9	5.3	.05	5.6
100 - 110	.05	.5	.7	65	[.06] NV	1.8	.2	5.3
110 - 120	.008	2.9	.2	136	NV	1.3	< .01	4.5
120 - 130				20				
130 - 140				30				
140 - 150				41				

23.6000		3.9200		6.0204		6.8500		3.4453		-0.0000		-0.0000	61	105/115	YVONNE
38.9000		5.9800		6.5050		11.5000		3.3826		-0.0000		-0.0000	61	115/125	YVONNE
24.3000		3.5100		6.9231		7.1100		3.4177		-0.0000		-0.0000	61	125/135	YVONNE
8.9400		1.2100		7.3884		2.8100		3.1815		-0.0000		-0.0000	61	135/145	YVONNE
4.6600		.5060		9.2095		1.4430		3.2294		-0.0000		-0.0000	61	145/15	YVONNE
2.2300		.4600		4.7650		.5980		3.7291		-0.0000		-0.0000	61	155/16	YVONNE
1.8500		.3400		5.3448		.5370		3.4637		-0.0000		-0.0000	61	165/17	YVONNE
2.3000		.2660		8.6466		.6700		3.4328		-0.0000		-0.0000	61	175/18	YVONNE
2.8800		.3660		7.8689		.2160		13.2110		.4090		.1420	101	0/10	YVONNE
1.4200	<	.1070	>	13.2710		.0626		22.6837		.1580		.1113	101	10/20	YVONNE
.0448	<	.0043	>	.5314	<	.0415	>	1.0795	<	.0170	<	.3795	101	20/30	YVONNE
.0415	<	.0935	>	.4439	<	.0453	>	.9161	<	.0106	<	.2554	101	30/40	YVONNE
5.1400		.2430		21.1523		.3870		13.2817		.5450		.1060	102	0/10	YVONNE
1.8800	<	.1140	>	16.4912		.3490		5.3868		.5900		.3138	102	10/20	YVONNE
1.3400	<	.1000	>	13.4000		.2970		4.5118		.5270		.3933	102	20/30	YVONNE
.4150	<	.1050	>	3.9524	<	.0799	>	5.1940		.1430		.3446	102	30/40	YVONNE
.5410	<	.1030	>	5.2524		.1220		4.4344		.1770		.3272	102	40/50	YVONNE
.6760	<	.1350	>	5.0074	<	.0925	>	7.3081		.2500		.3698	102	50/60	YVONNE
.3780	<	.1290	>	2.9302	<	.0879	>	4.3003		.1420		.3757	102	60/70	YVONNE
.0748	<	.0435	>	1.7195	<	.0290	>	2.5793		.0112		.1497	102	100/110	YVONNE
1.8600		.1740		10.6897		.1730		10.7514		.2080		.1118	103	0/10	YVONNE
.1150	<	.0476	>	2.4160	<	.0337	>	3.4125		.0259		.2252	103	10/20	YVONNE
495.0000		41.1000		12.0438		1.7900		276.5363		-0.0000		-0.0000	104	0/10	YVONNE
366.0000		18.4000		19.8913		1.9400		188.6598		-0.0000		-0.0000	104	10/20	YVONNE
316.0000		21.6000		14.6296		2.3200		136.2069		-0.0000		-0.0000	104	20/30	YVONNE
294.0000		19.1000		15.3927		1.8000		163.3333		-0.0000		-0.0000	104	30/40	YVONNE
399.0000		19.0000		21.0000		1.7600		226.7045		-0.0000		-0.0000	104	40/50	YVONNE
272.0000		15.5000		17.5484		1.3800		197.1014		-0.0000		-0.0000	104	50/60	YVONNE
268.0000		13.5000		19.8519		1.1000		243.6364		-0.0000		-0.0000	104	60/70	YVONNE
442.0000		19.7000		22.4365		1.0600		416.9811		-0.0000		-0.0000	104	70/80	YVONNE
441.0000		23.4000		18.8462		.9350		471.6578		-0.0000		-0.0000	104	80/90	YVONNE
794.0000		44.9000		17.6837		1.3200		601.5152		-0.0000		-0.0000	104	90/10	YVONNE
57.7000		6.0900		9.4745		1.4500		39.7931		-0.0000		-0.0000	104	100/11	YVONNE
35.7000		3.6800		9.7011		1.2700		28.1102		-0.0000		-0.0000	104	110/12	YVONNE
4.2300		.2350		18.0000		.2910		14.5361		.5090		.1203	105	0/10	YVONNE
4.1300		.5520		7.4819		.3470		11.9020		.4320		.1046	105	10/20	YVONNE
3.3800	<	.1330	>	25.4135		.4550		7.4286		.8240		.2438	105	20/30	YVONNE
6.7100		.5270		12.7324		.7370		9.1045		1.6700		.2489	105	30/40	YVONNE
1.0700		.1480		7.2297		.1440		7.4306		.2340		.2187	105	40/50	YVONNE
6.4400		.3930		16.3868		.5430		11.8600		1.3200		.2050	106	0/10	YVONNE
11.4000		1.0100		11.2871		1.2600		9.0476		-0.0000		-0.0000	106	10/20	YVONNE
2.3700	<	.1190	>	19.9160		.3150		7.5238		.6130		.2586	106	20/30	YVONNE
.1500	<	.0954	>	1.5723	<	.0515	>	2.9126		.0259		.1727	106	30/40	YVONNE
.1060	<	.0781	>	1.3572	<	.0439	>	2.4146	<	.0155	<	.1462	106	40/50	YVONNE
.0355	<	.0322	>	.4319	<	.0461	>	.7701	<	.0048	<	.1344	106	50/60	YVONNE
.0127	<	.0338	>	.1516	<	.0415	>	.3060	<	.0043	<	.3409	106	60/70	YVONNE
.0330	<	.0898	>	.3764	<	.0494	>	.5842		.0081		.2411	106	70/80	YVONNE
.2580		[illegible]		[illegible]		[illegible]		[illegible]							

.0330	<	.0898	>	.3764	<	.0494	>	.6842		.0081		.2411	106	70/80	YVONNE
.2590		3.1600		.0820		.5050		.5129		-0.0070		-0.0000	107	0/10	YVONNE
1.7600	<	.1410	>	12.4823		.3380		5.2071		.1820		.1034	107	10/20	YVONNE
.4590	<	.0889	>	5.1631		.0486		9.4444		.0788		.1717	107	20/30	YVONNE
.3100	<	.0782	>	3.9642		.0545		5.6801		.0766		.2471	107	30/40	YVONNE
.0277	<	.0655	>	.4229	<	.0360	>	.7694	<	.0126	<	.4549	107	40/50	YVONNE
451.0000		23.0000		19.6087		1.3100		344.2748		-0.0000		-0.0000	108	0/10	YVONNE
193.0000		25.1000		7.6892		.9190		210.0109		-0.0000		-0.0000	108	10/20	YVONNE
143.0000		17.0000		8.4118		.9540		149.8952		-0.0000		-0.0000	108	20/30	YVONNE
20.4000		3.0900		6.6019		.6950		29.3525		-0.0000		-0.0000	108	30/40	YVONNE
5.9100		.4350		13.5862		7.4700		.7912		-0.0000		-0.0000	108	40/50	YVONNE
6.0800		.4910		12.3829		.9420		6.4544		-0.0000		-0.0000	108	50/60	YVONNE
4.9900		.4730		10.5497		.7630		6.5400		-0.0000		-0.0000	108	60/70	YVONNE
4.6400		.3150		14.7302		.8130		5.7073		-0.0000		-0.0000	108	70/80	YVONNE
4.2600		.2820		15.1064		.6690		6.3677		-0.0000		-0.0000	108	80/90	YVONNE
5.5900		.4170		13.4053		.9380		5.9595		-0.0000		-0.0000	108	90/100	YVONNE
5.2500		.4710		11.1465		.9760		5.3791		-0.0000		-0.0000	108	100/110	YVONNE
4.4700		.2850		15.6842		.7910		5.6511		-0.0000		-0.0000	108	110/120	YVONNE
1.8300		.6000		3.0500	<	.1300	>	14.0769		.0500		.0273	109	0/10	YVONNE
7.2500	<	.0811	>	89.3958	<	.0609	>	119.0476		.2130		.0294	109	10/20	YVONNE
.1610	<	.0671	>	2.3994	<	.0544	>	2.9596	<	.0626	<	.3888	109	20/30	YVONNE
.1130		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	30/40	YVONNE
.0259		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	40/50	YVONNE
.0613		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	50/60	YVONNE
.0694		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	60/70	YVONNE
.1210		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	70/80	YVONNE
.0298		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	80/90	YVONNE
.0527		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	90/10	YVONNE
.2160		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	109	100/11	YVONNE
25.5000		2.8500		8.9474		.7070		36.0679		-0.0000		-0.0000	110	0/10	YVONNE
5.4700		.5780		9.4637		.4980		10.9839		-0.0000		-0.0000	110	10/20	YVONNE
9.8700		1.0900		9.0550		1.2100		8.1570		-0.0000		-0.0000	110	20/30	YVONNE
6.1900		.7260		8.5262		.7160		8.6453		-0.0000		-0.0000	110	30/40	YVONNE
15.0000		1.3900		10.7914		1.4600		10.2740		-0.0000		-0.0000	110	40/50	YVONNE
8.9400		1.1800		7.5763		1.2500		7.1520		-0.0000		-0.0000	110	50/60	YVONNE
34.2000		2.5700		13.3074		3.7100		9.2183		-0.0000		-0.0000	110	60/70	YVONNE
27.4000		2.3700		11.5612		3.5500		7.7183		-0.0000		-0.0000	110	70/80	YVONNE
3.6200	<	.1200	>	30.1667		.2640		13.7121		-0.0000		-0.0000	110	80/90	YVONNE
5.2700	<	.1020	>	51.6667		.1140		46.2281		-0.0000		-0.0000	110	90/100	YVONNE
1.7500		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	110	100/11	YVONNE
1.2600		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000		-0.0000	110	110/12	YVONNE
136.0000		9.0400		15.0442		1.0200		133.3333		-0.0000		-0.0000	111	0/10	YVONNE
532.0000		9.6500		55.1295		.7400		718.9189		-0.0000		-0.0000	111	10/20	YVONNE
20.4000		1.5600		13.0769		.9970		20.4614		-0.0000		-0.0000	111	20/30	YVONNE
182.0000		18.6000		9.7849		2.4800		73.3871		5.7200		.0314	111	30/40	YVONNE
12.2000		.6530		18.6830		1.3900		8.7770		-0.0000		-0.0000	111	40/50	YVONNE

P=PU239+24
AM=AM241
P1=PU238
EU=EU155

P		AM		P/AM		EU		P/EU	P1	P1/P	LOC	DEPTH	ISLAN
136.0000		9.0400		15.0442		1.0200		133.3333	-0.0000	-0.0000	111	0/10	YVONNE
532.0000		9.6500		55.1295		.7400		718.9189	-0.0000	-0.0000	111	10/20	YVONNE
20.4000		1.5600		13.0769		.9970		20.4614	-0.0000	-0.0000	111	20/30	YVONNE
182.0000		-0.0000		-0.0000		2.4800		73.3871	-0.0000	-0.0000	111	30/40	YVONNE
12.2000		.5350		22.8037		1.3900		8.7770	-0.0000	-0.0000	111	40/50	YVONNE
2.2800		.2730		8.3516		.2430		9.3827	.0401	.0176	111	50/60	YVONNE
.5770	<	.0923	>	6.2514	<	.0507	>	11.3807	.1090	.1889	111	60/70	YVONNE
.2850	<	.0790	>	3.6076	<	.0428	>	6.6589	.0536	.1881	111	70/80	YVONNE
.3170	<	.0788	>	4.0228	<	.0473	>	6.7019	.0779	.2457	111	80/90	YVONNE
2.8500		.1940		14.6907		.0999		28.5285	.1760	.0618	111	90/100	YVONNE
125.0000		14.1000		8.8652		1.3000		96.1538	-0.0000	-0.0000	112	0/10	YVONNE
128.0000		16.8000		7.6190		.9140		140.0438	-0.0000	-0.0000	112	10/20	YVONNE
168.0000		18.0000		9.3333		.7410		226.7206	-0.0000	-0.0000	112	20/30	YVONNE
341.0000		38.6000		8.8342		9.2400		36.9048	-0.0000	-0.0000	112	30/40	YVONNE
843.0000		97.3000		8.6639		.7320		1151.6393	-0.0000	-0.0000	112	40/50	YVONNE
582.0000		71.8000		8.1058		.5380		1081.7844	-0.0000	-0.0000	112	50/60	YVONNE
840.0000		93.2000		9.0129		.5410		1552.6802	-0.0000	-0.0000	112	60/70	YVONNE
185.0000		-0.0000		-0.0000		.5070		364.8915	-0.0000	-0.0000	112	70/80	YVONNE
49.8000		4.7300		10.5285		.5000		99.6000	-0.0000	-0.0000	112	80/90	YVONNE
622.0000		53.9000		11.5399		.7320		849.7268	-0.0000	-0.0000	112	90/100	YVONNE
65.4000		4.9500		13.2121		.1710		382.4561	-0.0000	-0.0000	112	00/110	YVONNE
136.0000		10.8000		12.5926		.4700		289.3617	-0.0000	-0.0000	112	10/120	YVONNE
20.1000		1.6300		12.3313		.4030		49.8759	-0.0000	-0.0000	112	20/130	YVONNE
30.0000		2.6600		11.2782		1.3800		21.7391	-0.0000	-0.0000	112	30/140	YVONNE
41.4000		3.2700		12.6606		4.3100		9.6056	-0.0000	-0.0000	112	40/150	YVONNE
176.0000		13.3000		13.2331		1.6300		107.9755	5.2800	.0300	113	0/10	YVONNE
49.1000		16.0000		3.0687		1.0900		45.0459	.9800	.0200	113	10/20	YVONNE
136.0000		11.9000		11.4286		1.0900		124.7706	4.0800	.0300	113	20/30	YVONNE
211.0000		32.6000		6.4724		.7020		300.5698	4.2200	.0200	113	30/40	YVONNE
104.0000		6.9800		14.8997		.1350		770.3704	2.0800	.0200	113	40/50	YVONNE
45.0000		3.4400		13.0814	<	.0689	>	653.1205	.9000	.0200	113	50/60	YVONNE
.5950	<	.0583	>	10.2058	<	.0339	>	17.5516	-0.0000	-0.0000	113	60/70	YVONNE
.0523	<	.0697	>	.7504	<	.0349	>	1.4986	-0.0000	-0.0000	113	70/80	YVONNE
217.0000		4.0400		53.7129		.1800		1205.5556	4.3400	.0200	114	0/10	YVONNE
1.3900	<	.0571	>	24.3433	<	.0259	>	53.6680	.0400	.0288	114	10/20	YVONNE
-0.0000	<	.0523		-0.0000	<	.0258		-0.0000	-0.0000	-0.0000	114	20/30	YVONNE
.6170	<	.0509	>	12.1218	<	.0260	>	23.7308	-0.0000	-0.0000	114	30/40	YVONNE
15.3000	<	.0488	>	313.5246	<	.0267	>	573.0337	.4500	.0294		60/7	YVONNE

.6170	< .0509	> 12.1218	< .0260	> 23.7308	-0.0000	-0.0000	114	30/40	YVONNE
15.3000	< .0488	> 313.5246	< .0267	> 573.0337	.4500	.0294		60/7	YVONNE
9.6400	< .0829	> 116.2847	< .0417	> 231.1751	.2900	.0301		80/9	YVONNE
21.4000	1.4700	14.5578	.2130	100.4695	.8600	.0402	115	0/10	YVONNE
1.9100	< .0947	> 20.1690	.1430	13.3566	.3200	.1675	115	10/20	YVONNE
2.6800	< .0990	> 27.0707	.1240	21.6129	.3200	.1194	115	20/30	YVONNE
27.6000	2.1300	12.9577	3.4600	7.9769	6.9000	.2500	115	60/70	YVONNE
74.3000	6.9400	10.7061	10.4000	7.1442	19.3000	.2598	115	70/80	YVONNE
2.5700	.2930	8.7713	.3990	6.4411	-0.0000	-0.0000	115	80/90	YVONNE
734.0000	57.0000	12.8772	.7000	1048.5714	14.7000	.0200	116	0/10	YVONNE
.4190	1.9200	.2182	.1020	4.1078	-0.0000	-0.0000	116	10/20	YVONNE
16.2000	< .0829	> 195.4162	< .0609	> 266.0099	.3200	.0198	116	20/30	YVONNE
314.0000	29.9000	10.5017	.6700	468.6567	6.2800	.0200	117	0/10	YVONNE
121.0000	17.6000	6.8750	.7200	168.0556	3.6300	.0300	117	10/20	YVONNE
250.0000	8.9100	28.0584	.9530	262.3295	5.0000	.0200	117	20/30	YVONNE
35.5000	3.9200	9.0561	1.2300	28.8618	2.4900	.0701	117	30/40	YVONNE
11.4000	.8670	13.1488	.3690	30.8943	.9100	.0798	117	40/50	YVONNE
.9460	< .1920	> 4.9271	< .1840	> 5.1413	-0.0000	-0.0000	117	50/60	YVONNE
342.0000	36.5000	9.3699	< .1790	>1910.6145	6.8400	.0200	118	0/10	YVONNE
1.3900	1.8700	.7433	< .1580	> 8.7975	-0.0000	-0.0000	118	10/20	YVONNE
15.2000	1.5800	9.6203	< .1350	> 112.5926	.3000	.0197	118	20/30	YVONNE
7.4300	.6660	11.1562	< .0214	> 347.1963	.1500	.0202	118	30/40	YVONNE
.8550	< .0478	> 17.9079	< .0292	> 29.3151	-0.0000	-0.0000	118	40/50	YVONNE
.7790	.1260	6.1825	< .0176	> 44.2614	-0.0000	-0.0000	118	60/70	YVONNE
2.1300	< .0279	> 76.3441	< .0187	> 113.9037	.0420	.0197		80/9	YVONNE
59.5000	-0.0000	-0.0000	.1090	545.8716	-0.0000	-0.0000	119	0/10	YVONNE
.9140	< .1120	> 8.1607	< .0849	> 10.7656	.0301	.0329	119	10/20	YVONNE
.2050	< .0434	> 4.7235	< .0263	> 7.7947	< .0316	< .1541	119	20/30	YVONNE
369.0000	39.9000	9.2481	4.8400	76.2397	-0.0000	-0.0000	120	0/10	YVONNE
202.0000	28.0000	7.2143	2.8900	69.8962	-0.0000	-0.0000	120	10/20	YVONNE
28.6000	3.1000	9.2258	.6900	41.4493	-0.0000	-0.0000	120	20/30	YVONNE
3.2300	.2820	11.4539	< .0704	> 45.8807	-0.0000	-0.0000	120	30/40	YVONNE
13.5000	.2620	51.5267	< .0744	> 181.4516	-0.0000	-0.0000	120	40/50	YVONNE
4.0900	< .0972	> 42.0782	< .0675	> 60.5926	-0.0000	-0.0000	120	50/60	YVONNE
1.4200	.1860	7.6344	< .0652	> 21.7791	-0.0000	-0.0000	120	60/70	YVONNE
62.2000	4.8000	12.9583	.2020	307.9208	-0.0000	-0.0000	121	0/10	YVONNE
1.7700	< .0988	> 17.9150	< .0456	> 38.8158	.0360	.0203	121	10/20	YVONNE
63.5000	5.6900	11.1599	2.1500	29.5349	4.4500	.0701	122	0/10	YVONNE
50.5000	5.1400	9.8249	1.4300	35.3147	2.0200	.0400	122	10/20	YVONNE
36.5000	3.0500	11.9672	3.9700	9.1940	8.0300	.2200	122	20/30	YVONNE
109.0000	9.8100	11.1111	14.0000	7.7857	26.1600	.2400	122	30/40	YVONNE
3.2900	< .2020	> 16.2871	< .1640	> 20.0610	-0.0000	-0.0000	122	40/50	YVONNE
20.9000	1.6800	12.4405	1.5200	13.7500	-0.0000	-0.0000	123	0/10	YVONNE
.3370	< .1850	> 1.8216	< .1800	> 1.8722	.0725	.2151	123	10/20	YVONNE
.1350	< .0295	> 4.5763	< .0377	> 3.5809	.0332	.2459	123	20/30	YVONNE
.0919	< .0904	> 1.0166	< .0864	> 1.0637	.0139	.1513	123	30/40	YVONNE
52.3000	4.3600	11.9954	1.7900	29.2179	5.0000	.0956	124	0/10	YVONNE

.7840	<	.1860	>	4.2151	<	.1600	>	4.9000		.1450		.1849	124	10/20	YVONNE
.4680	<	.1800	>	2.6000	<	.1460	>	3.2055		.0869		.1857	124	20/30	YVONNE
1.9200		.1580		12.1519		.1410		13.6170		.2530		.1318	124	30/40	YVONNE
.1360	<	.0921	>	1.4767	<	.0632	>	2.1519		.0195		.1434	124	40/50	YVONNE
.0165	<	.0900	>	.1833	<	.0436	>	.3784	<	.0098	<	.5939	124	50/60	YVONNE
300.0000	<	.1600	>	1075.0000	<	.1270	>	2362.2047		15.0000		.0500	125	0/10	YVONNE
181.0000		10.8000		16.7593		4.2900		42.1911		14.4800		.0800	125	10/20	YVONNE
52.7000		4.1700		12.6379		5.5200		9.5471		12.6500		.2400	125	20/30	YVONNE
30.4000		2.7100		11.2177		3.0300		10.0330		7.6000		.2500	125	30/40	YVONNE
11.6000		.9710		11.9464		1.0500		11.0476		-0.0000		-0.0000	125	40/50	YVONNE
17.4000		1.2000		14.5000		1.7100		10.1754		-0.0000		-0.0000	125	50/60	YVONNE
.4820	<	.0265	>	18.1867		.0405		11.9012		-0.0000		-0.0000	125	60/70	YVONNE
63.1000		4.5200		13.9602		4.5900		13.7473		-0.0000		-0.0000	126	0/10	YVONNE
2.7900		.2870		9.7213		.3500		7.7933		-0.0000		-0.0000	126	10/20	YVONNE
.4400	<	.0918	>	4.7930	<	.0753	>	5.8433		-0.0000		-0.0000	126	20/30	YVONNE
52.7000		3.9700		13.2746		1.6100		32.7329		-0.0000		-0.0000	128	0/10	YVONNE
32.7000		2.3400		13.9744		2.6900		12.1561		-0.0000		-0.0000	128	10/20	YVONNE
95.5000		8.1400		11.7322		9.4300		10.1273		-0.0000		-0.0000	128	20/30	YVONNE
25.9000		2.1500		12.0465		2.7600		9.3841		-0.0000		-0.0000	128	30/40	YVONNE
.9410	<	.0516	>	18.2364	<	.0456	>	20.6360		-0.0000		-0.0000	128	40/50	YVONNE
38.6000		3.3600		11.4881		3.6000		10.7222		-0.0000		-0.0000	129	0/10	YVONNE
18.1000		1.4100		12.8369		1.5700		11.5287		-0.0000		-0.0000	129	10/20	YVONNE
2.8400	<	.1440	>	19.7222		.3650		7.7808		-0.0000		-0.0000	129	20/30	YVONNE
.3360	<	.0539	>	6.2338	<	.0359	>	9.3593		.0752		.2238	129	30/40	YVONNE
.0865	<	.0380	>	2.2763	<	.0250	>	3.4600		.0419		.4844	129	40/50	YVONNE
26.2000		2.0200		12.9703		2.4200		10.8264		-0.0000		-0.0000	130	0/10	YVONNE
3.3600	<	.1510	>	22.2517		.2990		11.2375		-0.0000		-0.0000	130	10/20	YVONNE
.5990	<	.0909	>	6.5897	<	.0806	>	7.4318		-0.0000		-0.0000	130	20/30	YVONNE
91.9000		6.4000		14.3594		10.3000		8.9223		23.8900		.2600	131	0/10	YVONNE
98.2000		6.3900		15.3678		9.8600		9.9594		25.5300		.2600	131	10/20	YVONNE
13.9000		.9610		14.4641		1.4200		9.7887		3.6100		.2597	131	20/30	YVONNE
2.5100		.2140		11.7290		.2310		10.8658		-0.0000		-0.0000	131	30/40	YVONNE
1.4400	<	.1090	>	13.2110	<	.0809	>	17.7998		-0.0000		-0.0000	131	40/50	YVONNE
33.1000		1.9900		16.6332		3.1500		10.5079		-0.0000		-0.0000	132	0/10	YVONNE
14.9000		1.5900		9.3711		2.1800		6.8349		-0.0000		-0.0000	132	10/20	YVONNE
4.0900		.3310		12.3565		.3260		12.5460		-0.0000		-0.0000	132	20/30	YVONNE
.0977	<	.1010	>	.9673	<	.0776	>	1.2598		-0.0000		-0.0000	132	30/40	YVONNE
150.0000		10.4000		14.4231		13.6000		11.0294		39.1000		.2607	133	0/10	YVONNE
8.8700		1.0100		8.7822		1.0200		8.6961		-0.0000		-0.0000	133	10/20	YVONNE
1.0900		.1570		6.9427		.1710		6.3743		-0.0000		-0.0000	133	20/30	YVONNE
.1340	<	.0530	>	2.5283	<	.0314	>	4.2675		-0.0000		-0.0000	133	30/40	YVONNE
156.0000		9.7400		16.0164		14.7000		10.6122		40.5600		.2600	134	0/10	YVONNE
17.8000		1.2000		14.8333		1.8500		9.5216		3.9200		.2202	134	10/20	YVONNE
5.0500		.3320		15.2108		.5500		9.1818		-0.0000		-0.0000	134	20/30	YVONNE
.4030	<	.1050	>	3.8381	<	.0612	>	6.5850		-0.0000		-0.0000	134	30/40	YVONNE
1.3500		.1950		6.9231		.2900		4.6552		.1730		.1259		80/9	YVONNE
2.8400	<	.2160	>	13.1481		.7180		3.9554		.2330		.0985		90/1	YVONNE

	[illegible]		[illegible]													
	4.3900		.2740		16.0219		.5780		7.5952		-0.0000		-0.0000	135	0/10	YVONNE
	2.4400		.1510		16.1589		.3340		7.3054		.6220		.2549	135	10/20	YVONNE
	1.5600		.1290		12.0930		.2550		6.1176		.3970		.2545	135	20/30	YVONNE
	2.8100		.2740		10.2555		.4440		6.3288		.6710		.2308	135	30/40	YVONNE
	2.8100		.3040		9.2434		.5010		5.6080		.6580		.2342	135	40/50	YVONNE
	3.0500		.2100		14.5238		.4390		6.9476		.7120		.2334	135	50/60	YVONNE
	4.9100		.3270		15.0153		.5500		8.7993		1.2700		.2587	135	60/70	YVONNE
	.2570	<	.0879	>	2.9238	<	.0546	>	4.7070		.0405		.1576	135	70/80	YVONNE
	1.2800		.1130		11.3274		.4050		3.1605		.1080		.0844	135	80/90	YVONNE
	.3610	<	.1040	>	3.4712		.1370		2.6350		.0667		.1848	135	90/100	YVONNE
	.2730	<	.0905	>	3.0166	<	.0554	>	4.9278		.0815		.2985	135	00/110	YVONNE
	14.1000		1.0300		13.6893		1.4900		9.4631		-0.0000		-0.0000	136	0/10	YVONNE
<	.0384		.4950	<	.0776		.7680	<	.0500	<	.0279		-0.0000	136	10/20	YVONNE
	1.9000		.3420		5.5556		.3530		5.3824		.5000		.2632	136	20/30	YVONNE
	.6350	<	.0826	>	7.6877	<	.0712	>	8.9185		.1558		.2441	136	30/40	YVONNE
	.2980	<	.0906	>	3.2092	<	.0574	>	5.1916	<	.0285	<	.0956	136	40/50	YVONNE
	.1060	<	.0847	>	1.2515	<	.0498	>	2.1285		.0455		.4292	136	60/70	YVONNE
	.0362	<	.0840	>	.4310	<	.0482	>	.7510		.0143		.3950	136	80/90	YVONNE
	1.7900	<	.0968	>	18.4917		.3490		5.1289		-0.0000		-0.0000	137	0/10	YVONNE
	.8470	<	.0886	>	9.5598		.1810		4.6796		-0.0000		-0.0000	137	10/20	YVONNE
	8.5100		.3860		22.0466		2.2900		3.7162		4.2400		.4982	138	0/10	YVONNE
	1.3700	<	.0274	>	50.0000		.4480		3.0580		.2490		.1818	138	10/20	YVONNE
	.2310	<	.0936	>	2.4679	<	.0783	>	2.9502		.0426		.1644	138	20/30	YVONNE
	21.4000		2.7400		7.8102		12.2000		1.7541		10.9100		.5098	139	0/10	YVONNE
	26.3000		1.9300		13.6269		8.5700		3.0688		13.1500		.5000	139	10/20	YVONNE
	1.4100	<	.1930	>	7.3057		.5420		2.6015		-0.0000		-0.0000	139	20/30	YVONNE
	1.8100	<	.2000	>	9.0500		.7350		2.4626		-0.0000		-0.0000	139	30/40	YVONNE
	1.5000	<	.1840	>	8.1522		.6580		2.2796		-0.0000		-0.0000	139	40/50	YVONNE
	1.1800	<	.1460	>	8.0822		.2670		4.4195		-0.0000		-0.0000	139	50/60	YVONNE
	.9140	<	.1620	>	5.6420		.4050		2.2568		-0.0000		-0.0000	139	60/70	YVONNE
	.9230	<	.1680	>	5.4940		.3920		2.3546		-0.0000		-0.0000	139	70/80	YVONNE
	1.3500	<	.1730	>	7.8035		.4170		3.2374		-0.0000		-0.0000	139	80/90	YVONNE
	2.3200	<	.1850	>	12.5405		.6640		3.4940		-0.0000		-0.0000	139	90/100	YVONNE
	3.5800	<	.3180	>	11.2579		1.5900		2.2516		-0.0000		-0.0000	139	00/110	YVONNE
	4.2600	<	.2240	>	19.0179		1.1400		3.7368		-0.0000		-0.0000	139	10/120	YVONNE
	6.2200		.3680		16.9022		2.1500		2.8930		3.3000		.5305	140	0/10	YVONNE
	4.9500		.3870		12.7907		1.5000		3.3000		2.5200		.5091	140	10/20	YVONNE
	2.1900		.1760		12.4432		.7250		3.0207		-0.0000		-0.0000	140	20/30	YVONNE
	3.1700	<	.2990	>	10.6020		1.0600		2.9906		-0.0000		-0.0000	140	30/40	YVONNE
	2.7800	<	.2500	>	11.1200		.6340		4.3849		-0.0000		-0.0000	140	40/50	YVONNE
	4.1400	<	.2920	>	14.1781		1.4400		2.8750		-0.0000		-0.0000	140	50/60	YVONNE
	5.5900		.8870		6.3021		5.3800		1.0390		-0.0000		-0.0000	140	60/70	YVONNE
	4.7700	<	.3800	>	12.5526		1.6500		2.8909		-0.0000		-0.0000	140	70/80	YVONNE
	3.6700	<	.2700	>	13.5926		.8830		4.1563		-0.0000		-0.0000	140	80/90	YVONNE
	1.2100	<	.2280	>	5.3070		.3000		4.0333		-0.0000		-0.0000	140	90/100	YVONNE
	1.4600	<	.2090	>	6.9856		.4430		3.2957		-0.0000		-0.0000	140	00/110	YVONNE
	[illegible]	<	[illegible]	>	.0447		.5520		.0118		-0.0000		-0.0000	140	10/120	YVONNE

20.1000		3.2600		6.1656		9.1300		2.2015	-0.0000	-0.0000	141	30/40	YVONNE
5.4200	<	.4230	>	12.8132		2.0000		2.7100	-0.0000	-0.0000	141	40/50	YVONNE
2.4700	<	.3500	>	7.0571		.8750		2.8229	-0.0000	-0.0000	141	50/60	YVONNE
2.9100	<	.3550	>	8.1972		1.3800		2.1087	-0.0000	-0.0000	141	60/70	YVONNE
2.8500	<	.4180	>	6.8182		.7410		3.8462	-0.0000	-0.0000	141	70/80	YVONNE
2.0800	<	.4160	>	5.0000		.7970		2.6098	-0.0000	-0.0000	141	80/90	YVONNE
1.6700	<	.4010	>	4.1646		.8460		1.9740	-0.0000	-0.0000	141	90/100	YVONNE
1.4000	<	.3890	>	3.5990	<	.3290	>	4.2553	-0.0000	-0.0000	141	00/110	YVONNE
3.0500	<	.4160	>	7.3317		1.9600		1.5561	-0.0000	-0.0000	141	10/120	YVONNE
3.8400		.4140		9.2754		2.0700		1.8551	-0.0000	-0.0000	142	0/10	YVONNE
.1680	<	.1010	>	1.6634	<	.0556	>	3.0216	-0.0000	-0.0000	142	10/20	YVONNE
117.0000		14.4000		8.1250		58.1000		2.0138	-0.0000	-0.0000	143	0/10	YVONNE
181.0000		23.6000		7.6695		76.6000		2.3629	-0.0000	-0.0000	143	10/20	YVONNE
3.4300	<	.3930	>	8.7277		1.0500		3.2667	-0.0000	-0.0000	143	20/30	YVONNE
1.3300	<	.3310	>	4.0181	<	.2480	>	5.3629	-0.0000	-0.0000	143	30/40	YVONNE
10.4000		1.2000		8.6667		4.6800		2.2222	-0.0000	-0.0000	143	70/80	YVONNE
34.1000		2.5900		13.1660		14.3000		2.3846	-0.0000	-0.0000	143	80/90	YVONNE
50.6000		5.6900		8.8928		21.8000		2.3211	-0.0000	-0.0000	143	90/100	YVONNE
77.1000		5.8200		13.2474		22.9000		3.3668	-0.0000	-0.0000	143	00/110	YVONNE
10.1000		1.3000		7.7692		3.1400		3.2166	-0.0000	-0.0000	143	10/120	YVONNE
10.8000		.9320		11.5880		4.6600		2.3176	-0.0000	-0.0000	144	0/10	YVONNE
19.9000		2.8300		7.0318		7.9000		2.5190	-0.0000	-0.0000	144	10/20	YVONNE
44.9000		4.7100		9.5329		21.9000		2.0502	-0.0000	-0.0000	144	20/30	YVONNE
14.4000		1.8100		7.9558		6.4700		2.2257	-0.0000	-0.0000	144	30/40	YVONNE
23.3000		2.4200		9.6281		8.8100		2.6447	-0.0000	-0.0000	144	40/50	YVONNE
55.2000		5.7200		9.6503		23.0000		2.4000	-0.0000	-0.0000	144	50/60	YVONNE
21.8000		2.4200		9.0083		10.0000		2.1800	-0.0000	-0.0000	144	60/70	YVONNE
12.9000	<	.8460	>	15.2482		5.8300		2.2127	-0.0000	-0.0000	144	70/80	YVONNE
11.9000		1.1600		10.2586		4.7200		2.5212	-0.0000	-0.0000	144	80/90	YVONNE
10.3000	<	.3450	>	29.8551		3.3500		3.0746	-0.0000	-0.0000	144	90/100	YVONNE
4.6900	<	.3250	>	14.4308		.8540		5.4918	-0.0000	-0.0000	144	00/110	YVONNE
9.9900	<	.4370	>	22.8604		3.0100		3.3189	-0.0000	-0.0000	144	10/120	YVONNE
8.9500		1.1900		7.5294		5.5200		1.6232	4.5700	.5100	145	0/10	YVONNE
3.3200		.5330		6.2289		1.6600		2.0000	-0.0000	-0.0000	145	10/20	YVONNE
.5050	<	.1230	>	4.1057		.0878		5.7517	-0.0000	-0.0000	145	20/30	YVONNE
.0106	<	.1030	>	.1029	<	.0746	>	.1421	-0.0000	-0.0000	145	30/40	YVONNE
37.6000		5.8900		6.3837		1.6900		22.2485	2.6300	.0599	146	0/10	YVONNE
54.1000		3.9400		13.7310		1.5900		34.0252	2.1600	.0399	146	10/20	YVONNE
150.0000		12.4000		12.0968		2.1000		71.4286	6.0000	.0400	146	20/30	YVONNE
83.3000		6.6300		12.5641		1.1900		70.0000	3.3300	.0400	146	30/40	YVONNE
36.4000		1.6900		21.5385		1.7900		20.3352	3.2800	.0901	146	40/50	YVONNE
10.3000		.8410		12.2473		1.8100		5.6906	-0.0000	-0.0000	146	50/60	YVONNE
7.6600		.4690		16.3326		1.2500		6.1280	-0.0000	-0.0000	146	60/70	YVONNE
5.5900		.3430		16.2974		.8270		6.7594	-0.0000	-0.0000	146	70/80	YVONNE
3.4100	<	.1210	>	28.1818		.5780		5.8997	-0.0000	-0.0000	146	80/90	YVONNE
3.2500		.2750		11.8182		.5250		6.1905	-0.0000	-0.0000	146	90/100	YVONNE
2.7100	<	.1340	>	20.2239		.7780		3.4833	-0.0000	-0.0000	146	00/110	YVONNE

DATE 10/03/77 TIME OF DAY 09.08.06

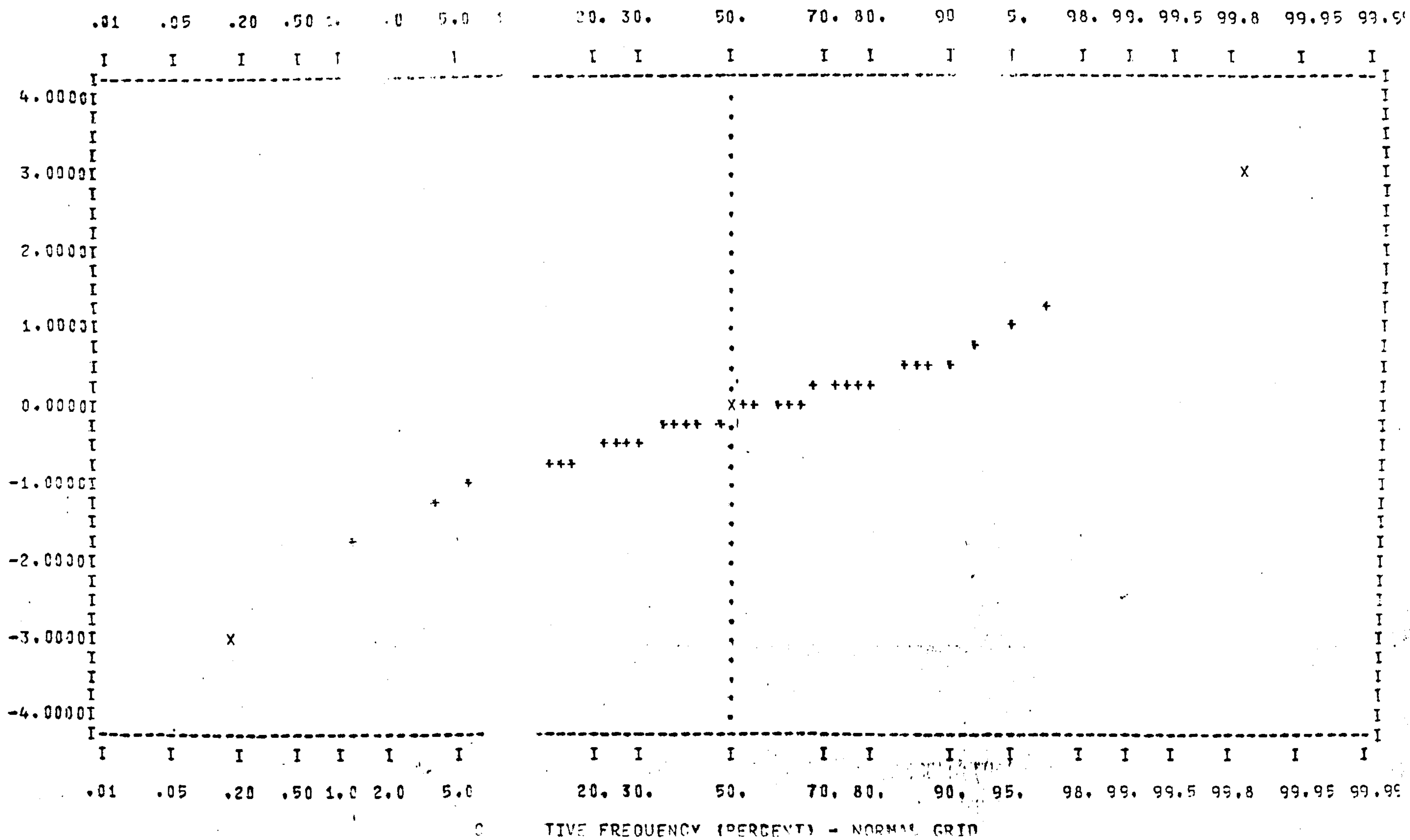
NUMBER OF SAMPLES	.420000E+02	239/240/... = 13.1995 TOP 10 CM. SAMPLES 100+
MEAN	.131995E+02	
STD. DEV.	.777710E+01	
VARIANCE	.604046E+02	
MAX. X	.537129E+02	
MIN. X	.820000E-01	
RANGE	.536309E+02	
SUM. X	.554378E+03	
SUM. X SQUARE	.979737E+04	
CORRECTION TERM	.731750E+04	
SUM. SMALL X SQUARE	.247987E+04	
STD. DEV. (MEAN)	.120005E+01	
VARIANCE (MEAN)	.144011E+01	

NORMALITY TEST

MEAN DEV.	.435391E+01
THIRD MOMENT	.151142E+04
FOURTH MOMENT	.655910E+05
A	.566617E+00
SQRT B SUB1	.333131E+01
B SUB2	.188142E+02

MIDPOINT	FREQ.	
.250000E+01	2	XX
.750000E+01	11	XXXXXXXXXXX
.125000E+02	18	XXXXXXXXXXXXXXXXXX
.175000E+02	8	XXXXXXXX
.225000E+02	2	XX
.275000E+02	0	
.325000E+02	0	
.375000E+02	0	
.425000E+02	0	
.475000E+02	0	
.525000E+02	1	X
	42	

CUMULATIVE DISTRIBUTION CHART



g. The concept of phased operations presents the opportunity to make an initial gross survey of the islands to identify those with the highest probability for soil removal. These data will greatly assist in developing working estimates of soil to be removed.

h. An ERDA aerial survey system will be fielded as early as possible (i.e., shipped in mid-June and operational shortly thereafter). This aerial system would proceed to survey the islands where soil removal possibilities exist (see Tabs A and B to Appendix 2 of Annex C).

i. The first van will be shipped approximately 1 July and become operational in mid-July, a second van, will be operational in August and both will commence with the fine surveys. By the August/September time frame, sufficient fine surveys can be completed to allow soil removal to begin in the planned mid-November time frame. As noted in 3.b above, the initial soil samples for van calibrations will be sent to McClellan AFB for analysis. The Radiochemistry Laboratory is expected to become operational on Enewetak in August.

j. A third van is expected to be on Enewetak at the end of September. This van is intended as an operating spare replacement for the operating vans.

4. PU SURVEY CRITERIA:

a. The AEC Task Group recommendations and guidance were by design, general in nature. Subsequently, criteria have been developed by ERDA to guide the in situ soil assay.

b. A case-by-case evaluation by the CJTG (with the advice of the RCC) of the requirements for soil removal, taking into consideration the location

Encl 6 to Incl 1

(island), planned use, economics and the AEC/ERDA Task Group recommendations, will be required for each of the islands where contamination is found to exist. The resulting evaluation should lead to one of the four following conditions which have been recommended by ERDA.

(1) Condition A. When an assay area[1] is determined by either direct measurement or extrapolation, to exceed 400 pCi/g (at the 67 percent confidence level[2]), the following actions will be taken:

(a) The area will be fine surveyed and isopleths drawn which define the region which exceeds local background[3].

(b) Vertical soil profiles will be taken to evaluate the effectiveness of excavation as a means of reducing the resuspension potential[4].

(c) An iterative excavation plan will be executed to:

1. Reduce the assay area average concentration below 400 pCi/g[5].

2. Reduce the average concentration of the "defined region" to some lower number which shall be determined by cost-benefit considerations but will usually not be below local background.

(d) The region will be resurveyed and the results documented.

(2) Condition B. When a half hectare is determined by either direct measurement or extrapolation to exceed 100 pCi/g (at the 67 percent confidence level), the following actions will be taken:

(a) The area will be fine surveyed and isopleths drawn which define the region which exceeds local background.

(b) Vertical soil profiles will be taken to evaluate the effectiveness of excavation as a means of reducing the Resuspension Potential.

(c) An iterative excavation plan will be executed to:

1. Reduce the half hectare area average concentration below 100 pCi/g.

2. Reduce the average concentration of the "defined region" to some lower number which shall be determined by cost-benefit considerations but will usually not be below local background.

(d) The region will be resurveyed and the results documented.

(5) Condition C: When a quarter hectare is determined by either direct measurement or extrapolation to exceed 40 pCi/g (at the 67 percent confidence level number), the following actions will be taken:

(a) The area will be fine surveyed and isopleths drawn which define the region which exceeds local background.

(b) Vertical soil profiles will be taken to evaluate the effectiveness of excavation as a means of reducing the Resuspension Potential.

(c) An iterative excavation plan will be executed to:

1. Reduce the quarter hectare area average concentration

below 40 pCi/g.

2. Reduce the average concentration of the "defined region" to some lower number which shall be determined by cost-benefit considerations, but will usually not be below local background.

(4) Condition D: An assay area whose average Pu concentration is any 5 cm thickness of soil below the surface layer when measured[/6] (at the 67 percent confidence level) to exceed 400 pCi/g will be excavated and measured iteratively until its average Pu concentration in the new 5 cm layer is found by measurement (at the 50 percent confidence level) to be reduced in the defined region to some lower number which shall be determined by cost - benefit considerations, but will usually not be below local background.

Footnotes:

/1 Assay Area. The field of view of the in situ detector in its normal operating position; typically a 28 meter diameter circle of 3 - 5 cm in depth. Scattered measurement can be used to estimate average concentrations between such measurements by means of a linear estimator program known as "Krigging."

/2 Statistically, two-thirds of the time the actual concentration will be below the guide number. One-third of the time the actual concentration may exceed the number by some percentage which must be empirically determined (up to 20-30 percent, as an estimate). This is similar to using a 50 percent confidence level with a numerical guide 20-30 percent (estimated) lower. If a 90 percent confidence level were used with the numerical guide, the equivalent guide at a 50 percent confidence level would

Department of Energy
Washington, D.C. 20545

NOV 9 1977

Col. Charles J. Treat
Chairman, Conference on Runit Cleanup
Field Command, Defense Nuclear Agency
Kirtland Air Force Base, New Mexico 87115

Dear Col. Treat:

I appreciate the opportunity to review your draft report and the draft minutes of the October 4-5 conference. The draft report to Commander, FCDNA, is quite acceptable. I have no suggestions. I do have a measure of concern for what appears an honest difference of opinion that surfaced in the meeting on the general subject of how the Task Group's recommendations for cleanup of transuranium elements in soil are to be interpreted.

In the discussion in Las Vegas, I attempted to describe the assumptions and realizations of the Task Group as we tried to prescribe the letter and intent of the recommendations. The more important of these are:

1. Cleanup criteria must be flexible enough to allow judgements to be made in the field.

2. A prejudgement was needed that soil cleanup should be conducted above a certain contamination level.

3. A prejudgement was needed that soil cleanup was not required below a certain level.

4. For the range in between judgements made in the field case-by-case by experts were likely to be superior to any judgements that could be made in advance.

5. Guidance for these field judgements was presented in Appendix III, pages III-8 and III-9, of the Task Group report.

6. The following quotes from this Appendix define the intent of the recommendations:

   a) "Any areas or locations where soil concentrations of ^{239}Pu are greater than 400 pCi/g <u>should</u> receive corrective action...." (underlining added).

Encl 7 to Encl 1

b) "Situations with soil levels in the 40 to 400 pCi/g range may receive corrective action ...." (underlining added).

c) "Islands with soil levels in the above range may be divided into two categories, those of sufficient size for construction of permanent houses, and those that are not .... Removal of ^{239}Pu contaminated soil is better justified within the range above for the larger islands such as JANET or SALLY where permanent housing may some day be located and for near surface locations on the larger islands .... The smaller islands may be considered of less concern ...."

Note: This is the only place in the guidance where an indication of relative priorities for cleanup of contaminated soil is given. The highest priority is given to larger islands and near surface locations on larger islands.

I made two statements in the meeting that were derived from the material just quoted:

1. Cleanup of areas above 400 pCi/g should not be considered to be any more mandatory than cleanup in the 40 to 400 pCi/g range once a judgement (case-by-case) has been made that such cleanup is justified.

2. Cleanup of levels above 40 pCi/g on Enjebi should be as high a priority as cleanup above 400 pCi/g on some small island like Boken.

I strongly urge that in the implementation and interpretation of the Task Group recommendations, the impression not be given that cleanup actions that are to be taken on the basis of case-by-case determinations in the field are of less importance and lower priority than what may be described as prejudgement actions. We must be equally prepared, if not more so, to defend case-by-case decisions to perform or not perform cleanup along with prejudgement decision and actions. Viewed in this context, statements that cleanup of islands with soil concentration above 400 pCi/g is the only mandatory action are in error. If the requirements for cleanup are to be stated in absolute terms, it must be stated instead that performing case-by-case determinations for 40 to 400 pCi/g areas is also a firm requirement and, therefore, mandatory and any associated field determination that an action is justified in this range makes that action mandatory as well.

The "should" and the "may" previously underlined were intended to separate situations where a decision has already been made from situations where a decision is yet to be made in the field. These terms and attendant language do not establish two categories of action such as mandatory cleanup to be given priority and case-by-case cleanup to be left until last. This is a very fundamental concept we must agree upon if cleanup is to achieve the greatest good. I do not consider that anything in the EIS or Op Plan changes or supersedes the interpretation of the AEC soil cleanup criteria just outlined, and believe we must engage in a continuing dialogue to insure that interpretation of these criteria do not change with time.

My specific comment on the draft minutes, item 3, pages 1 and 2, is that the section does not adequately reflect what I said. For instance, I did not say that the priorities for cleanup above 400 and between 40 and 400 pCi/g were the same so long as resources were available. I stated that they were the same, period. Further, the statement read and used as Enclosure 4 is a very brief summary of the recommended soil cleanup criteria without the interpretative text that was provided and as such is not as good a reference as quoted above, i.e., pages 8 and 9 of Appendix III. Further, as to the FCDNA position on mandatory/priority cleanup above 400 pCi/g, I stated that in my opinion this was not a proper interpretation of the Task Group's recommendations.

The final point to be made concerns an important exchange of views not covered in the draft minutes. This was the question of whether or not the soil cleanup criteria for Enewetak apply to ^{239}Pu alone. The position several members took was that even though the Task Group report used the terms "plutonium" and "^{239}Pu," the criteria apply to all the transuranium elements in Enewetak soil. Also, the 400 pCi/g value comes from Jack Healy's report wherein a mix of transuranium elements in soil was assumed.

If part 3 of the draft can be revised to accommodate the comments above, my signoff can stand. Also, this letter may be included as addenda.

Sincerely,

Tommy F. McCraw

Tommy F. McCraw, Acting Chief
Surveillance Projects Branch
Division of Operational and
Environmental Safety

UNIVERSITY OF CALIFORNIA
LOS ALAMOS SCIENTIFIC LABORATORY
(CONTRACT W-7405-ENG-36)
P.O. Box 0
MERCURY, NEVADA 89023

IN REPLY
REFER TO: H1-NTS-3337
MAIL
STOP: 900

19 October 1977

Commander, Field Command
Defense Nuclear Agency
ATTN: Colonel Charles J. Treat
Kirtland Air Force Base, NM 87115

Dear Colonel Treat:

Thank you for sending me the draft Chairman's Report and the draft Synopsized Minutes of the conference held in Las Vegas, Nevada on 4-5 October 1977.

I concur with both the draft report and the draft minutes with the following exceptions:

> On page 4, item f, of the Chairman's Report the statement is made: "It is envisioned that this profiling effort will use the iterative 'one-half distance' techniques to establish the size of the subsurface pockets showing contamination levels in excess of 400 pCi/g PU 239/240."
>
> And on page 3, item 6, of the synopsized minutes the statement is made: "Moving one half the distance between greater than and less than sample points iteratively should provide boundary definition of contamination areas of interest."

Both these statements could be construed to imply that the contamination can be characterized by a mathematically continuous function that can be treated by classical statistical techniques. I take exception to this concept and believe that the increased sampling points characterizes the contamination in a "shotgun effect:" i.e., that it decreases the probability that a significant amount of random contamination will be missed.

Incl 8 - to Incl 1

A brief statement of my exception is as follows:

"The use of the 'one-half distance' technique should not imply that the contamination can be characterized by a mathematically continuous function. Random discontinuities must be expected."

Sincerely yours,

Richard F. Smale

Richard F. Smale
Group H-1, LASL

RFS:nr

CY: Bruce W. Church
U. S. Department of Energy
Nevada Operations Office
Radiological Branch
Post Office Box 14100
Las Vegas, NV 89114

Harry S. Jordan, H-DO, LASL, MS-690
Jerome E. Dummer, H-1, LASL, MS-401
ISD-5, LASL, MS-150 (2)
J-3 M&R, NTS, MS-900

WATER RESOURCES CENTER
Desert Research Institute — University of Nevada System

4582 Maryland Parkway
Las Vegas, Nevada 89109
(702) 736-2293

November 2, 1977

Commander, FCDNA (FCZ)
Kirtland AFB, NM 87115

Dear Sir:

I have examined carefully the draft Chairman's Report and the draft Minutes of the Runit Cleanup Conference held in Las Vegas 4-5 October, 1977. I have one exception to the Synopsized Minutes, regarding Item 11 from the first day. The minutes indicate that subsurface sampling would consist of sidewall soil samples, one 5 cm increment in each 20 cm depth, instead of gamma scanning the sidewalls.

However, my notes indicate that the gamma scanning of the sidewalls would at least be attempted, to see if the results were reliable enough to be useful. If so, then only the "hot spots" would need to be sampled, and if not, the technique would be dropped. The "5 cm-in-each-20 cm" increment would be used to check the reliability of gamma scanning, and would become the primary sampling technique if the gamma scanning proved to be unusable.

I find the remainder of the Minutes, and the Report, to be clear and accurate.

Sincerely,

Madaline Barnes

MB:cm

Madaline Barnes
Research Statistician
Desert Research Institute

Encl 9 to Encl 1

Department of Energy
Nevada Operations Office
P.O. Box 14100
Las Vegas, NV 89114

NOV 10 1977

Commander, Field Command
Defense Nuclear Agency
ATTN: Colonel Charles J. Treat
Kirtland AFB, New Mexico 87115

Dear Colonel Treat:

COMMENTS ON THE MINUTES OF THE RUNIT CLEANUP CONFERENCE

Realizing the goal of the subject conference was to advise on the need and method for data collection (to gain a better definition of the RUNIT scope of work), I wish to preface my comments with two observations gained from participating directly in five Nevada-directed cleanups and from many conferences listening to other organizations who share similar experiences.

1. One can never gather enough prior information to prevent surprises during actual operations. To gather sufficient data becomes self-limiting in that it is more efficient to do the actual cleanup in conjunction with the data gathering process. Actual cleanup operational problems contribute greatly to this (i.e., type of equipment available, logistics, etc.).

2. Generally, even with what is believed to be the best available information as to scope of work, for every experience I am aware of, without exception, the planned cost and time have been different by factors when compared with the actual experience. The best advice then must be - Be prepared to deal with changes in terms of factors, perhaps 2-4, or more.

The following specific comments address your numbered sections:

1-4. No comment.

Encl 10 to Encl 1

5. For clarity, any detector measuring ^{241}Am in-situ (which includes the aerial survey), will not detect material below 3cm.

6. The discussion by Madaline Barnes should be amplified to include the point that low density measurements or less frequent measurements result in a lower confidence in the estimate and a greater error term.

In Tom Crites' discussion the point was left out that the calculated grid size was a direct variable in relation to the chosen contamination level. This hypothetical case only applies to homogeneous distributions which we don't have on RUNIT. I also wish to reemphasize that the half-distance technique also implies a somewhat homogeneous distribution. This means the greater the distance between sample points, the less confidence and the more you have to be prepared for surprises.

I very strongly support the master grid concept, and that every sample must lie on the grid, or sub-component.

7-9. No comment.

10. I believe this method has some utility for the quick and dirty answer, but caution that it also contains high variability in individual results.

11-13. No comment.

14. In my opinion the choice of grid size or intensity of investigation is where you really trade cost and effort of scoping against the desire to gain high confidence of estimates. One must carefully watch the data here, because the situation exists where a little effort may increase the confidence a great deal, or it may take a great deal of effort to increase the confidence a little.

15-17. No comment.

18,19. I believe we will all be surprised at the amount of resources it will take for the job outlined, and that there will be no such thing as minimal resource expenditure. I agree with the concern that without giving priority to the RUNIT task that it will take a very long time.

20. Looking at the time spent on RUNIT during the 1972 survey, the

time spent to gather the ERIE GZ information, I can not agree that 90 days is a reasonable target for obtaining characterization data.

21,22. No comment.

23. Agree with this section, with the exception that the curie content can probably be just as accurately established in measured areas to be excavated, as trying to gain a meaningful sample from a truckload, and will help keep the laboratory sample load down.

Enclosed are the comments from Mr. A. E. Doles, Eberline Instrument Corp., as submitted to NV.

Sincerely,

Bruce W. Church

Bruce W. Church, Chief
Radiological Branch
Bioenvironmental Sciences Division

BSDR:BWC-216

Enclosure:
As stated

October 21, 1977

EI-916262

B. W. Church, Chief
Radiological Branch
Department of Energy
Nevada Operations Office
P. O. Box 14100
Las Vegas, Nevada 89114

Reference: Letter from Charles J. Treat, Colonel, USA, dated 14 October 197[illegible]
re: Conference on Runit Cleanup

Dear Mr. Church:

The following comments are submitted for your review and/or incorporation in DOE-NV's comments to the referenced letter.

Minutes of Conference:

The minutes of the conference do not reflect a considerable amount of meaning-ful dialogue that I would have incorporated in the minutes.

Many exceptions were expressed to subjects that the minutes portray as agree-ments and consensus. Therefore, I can not agree that the "minutes accuratel[illegible] reflect the discussions, agreements and consensus reached during the conference." I can agree that the "minutes of the conference" are adequate [illegible] serve as a reminder to the participants of the conference as to subject matters covered and the many expressed opinions of different parties.

Chairman's Report:

Conclusions:

a. Concur

b. Concur

c. I believe a considerable expenditure of resources will be required to define the scope of work on Runit.

d. I would not recommend that this program be justified on the bases that i[illegible] will furnish direct information to certify the radiological condition of Runit after cleanup. It's recognized that all information is beneficial but Runit may be severely restructured during cleanup so as to render th[illegible] precleanup data invalid.

(continued on page -2-)

EBERLINE INSTRUMENT CORPORATION, P.O. BOX 2108, SANTA FE, NEW MEXICO 875C1 TELEPHONE (505) 471-3232, TWX 910-

e. I concur with the first portion of the sentence. See d above concerning the last portion of the sentence.

f. Concur

<u>Recommendations - a thru n</u>

I would recommend the following steps be taken to establish a coordinated program to define the scope of work involved on Runit.

Step I - DOE-NV assume technical responsibility for this program and design a program which would include such detailed definition as to use of the IMP system, sampling locations, sampling density, sampling technique, sample analysis, data reduction and other technical parameters. In the design of this program, due consideration should be given to the recommendation of the chairman (conference on Runit cleanup) and other opinions expressed during the conference. Included in this program design should be a proposed schedule and a commitment of DOE-NV assets to support the program.

Step II - The program design should be submitted to Commander Joint Task Group (CJTG) to prepare a detailed operational plan to accomplish the program. Included in this operation plan should be a firm schedule and a commitment of existing or additional resources to accomplish the program.

This operational plan should include a clear assignment of responsibilities of the various units participating in the program.

Step III - Execution should commence upon approval of the operational plan by DOE-NV and Field Command Defense Nuclear Agency (FCDNA).

Very truly yours,

EBERLINE INSTRUMENT CORPORATION

A E Doles

A. E. Doles
Vice President

AED:igs

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION PROGRAMS-LAS VEGAS FACILITY
P.O. BOX 15027, LAS VEGAS, NEVADA 89114
(702) 736-2969 • FTS 595-2969

NOV 8 1977

Colonel Charles J. Treat
Defense Nuclear Agency
Kirtland Air Force Base
Albuquerque, NM 87115

Dear Colonel Treat:

Mr. Bruce Church has provided me with a copy of your draft Chairman's Report and a copy of your draft Synopsized Minutes of the subject October 4-5, 1977, conference. Mr. Bernhardt and I have reviewed these drafts. Our comments are as follows:

General

Since there was considerable commentary on the scope and objectives of the conference, these should be clearly delineated in both documents. Presumably the objective was to determine if the existing data base is adequate to estimate the resources necessary to cleanup Runit and to delineate the initial operations plan. A secondary objective was to define what additional data should be gathered if the data base was considered inadequate. It should also be noted that the decision as to the necessity for Runit cleanup or the extent of Runit cleanup was stated to be outside the conference scope.

Summary

Page 2, Item 2.f. Delete the last sentence. Plowing or mixing should not be used. We believe that this was also the group consensus.

Page 3, Item e. For the central northern area we believe that the recommendation was to conduct two cross-island traverses. Assuming an average island width of 700 feet and sample spacing of 10 meters, this would result in about 40 samples. This should have a fairly high priority in determining the relative mass for cleanup. Suggest replacing Item e with Item k.

Page 5, Item h. Given the uncertainties associated with sampling only one 5-centimeter section out of each 20-centimeter vertical increment, samples should be removed and stored from each 5-centimeter section for potential future analysis. Believe this was suggested and at one point adopted at the meeting.

Encl 11 to Incl 1

Page 5, Item i. Is it clear that samples which have a very low gamma level of contamination also have a low plutonium level, particularly in the FIG/QUINCE area? This should be verified.

Minutes

Page 3, 1st full para. It would be helpful to define "simple yes-no criteria" in a more specific manner.

Page 4, Item 8. See above comments on the summary, Item e. Our past experience with cleanup of sites also shows that simply because we are unable to find a record or reason for possible contamination in a specific area doesn't mean that that area is uncontaminated. If there were cable runs or line-of-sight pipes in the central area, then the possibility of contamination should be thoroughly investigated.

Page 5, Item 9, last sentence. It scarcely seems prudent to spread contamination once it has been gathered together. Believe that the group consensus was that this should not be done.

Page 5, Item 11, 3rd sentence. Don't really believe that averaging samples of greater depth leads to anomalous data output. It might lead to misunderstanding of the results because of a lower picocurie per gram value. Suggest this sentence be checked with Bruce Church.

Page 7, Item 14, last sentence. While it may have been the Chairman's contention that the effort should not include exploration to locate other possible subterranean pockets, don't believe that this was the group consensus.

Page 12, Item 21. See above comments on Summary, Page 2, Item 2.f.

Page 13, Item 22. Not sure that there was agreement that soil brought to Runit could be used to fill in holes left by cleanup. This could result in recontaminating an area that had just been cleaned.

The iterative "one-half distance" technique for delineating the size of pockets of various levels of contamination is mentioned several times (e.g., Summary, Page 4, Item f and Minutes, Page 3). This technique is useful for relatively continuous areas or pockets of contamination, but may have limited utility for the heterogeneous contamination situation at Runit (contaminated material may vary from particle size to many cubic meters).

We do not agree with limiting these comments to the status of "minority reports." Rather, it would be more proper to revise the

"Summary" and "Minutes" accordingly. This is especially true for the general comment (scope and objective) and the first two specific items. Unless the reports are modified, they stand as the summary and conclusion of the Chairman, not the delegates.

Sincerely yours,

Donald W. Hendricks
Director, Office of Radiation
Programs-Las Vegas Facility

David E. Bernhardt
Program Manager for Dose
Assessment, Field Studies Branch

CRATER CONTAINMENT OF CONTAMINATED MATERIAL AT ENEWETAK

DESIGN ANALYSIS

PREPARED BY
U.S. ARMY ENGINEER DIVISION
PACIFIC OCEAN
CORPS OF ENGINEERS
HONOLULU, HAWAII

29 NOVEMBER 1976
* REVISED 16 DECEMBER 1976

43383

A. References.

1. Environmental Impact Statement Vol. 1 - IV, Defense Nuclear Agency, 15 April 1975.

2. Engineering Study for a Cleanup Plan, Enewetak Atoll, Marshall Islands, Vol. I - III, Holmes and Narver, Inc., April 1973 and Vol. III revised September 1974.

3. Instructions furnished by DNA meeting at DNA, Hickam AFB, dated 5 October 1976, titled, "POD Guidance for Crater Design".

4. Cleanup of Enewetok Atoll Marshall Islands, using a Joint Task Group, FCDNA, Kirtland AFB, New Mexico 87115, FCDNA CONPLAN 1-76 revised 15 September 1976.

5. Feasibility Study for Crater Containment of Contaminated Material at Enewetak, POD, 21 March 1975.

6. FCLS-N Memorandum, subject: PU Contamination in Vicinity of Cactus Crater, Runit Island, dated 30 September 1976.

7. Summary of the Geological, Geophysical and Material Properties Environment around Cactus and LaCrosse Crater, Runit Island.

8. Radiological Cleanup Plan for Enewetak Atoll, 23 July 1976, FCDNA.

9. Groundwater Resources Evaluation: Enewetak Atoll, the Defense Nuclear Agency, October 1976.

* 10. Message, 171745Z Aug 76 from HQ DNA WASH DC//OALG//, subject: "Cleanup of Enewetak". *

B. Responsibilities of Corps of Engineers, Pacific Ocean Division for the Enewetak Cleanup Program. Engineering input requirements are limited to the crater encypment of the contaminated material to include the following:

1. Provide plans, details and instructions as required for the crater containment of the contaminated material.

2. Determine slurry mix for the contaminated material.

3. Determine concrete mix for key wall and concrete cap.

* 4. Provide descriptive data and requirements for batch plant, quarry, rock crushing, screening, and construction equipment. *

5. Provide design for a salt water system for dust abatement, wash down areas, mixing plant, storage yard sprinkler system, and area around the southern lip of the crater.

6. provide plans and details for a brackish water system for the laundry,

7. provide design for the electrical distribution system and flood lighting,

8. provide equipment list for concrete slurry placement,

9. provide design of ramp at north end of Runit for off loading dump trucks.

C. Description of Work.

1. Encrypment of Contaminated Material. The volume of contaminated material will vary from 70,000 cy to 200,000 cy. Drawings have been prepared to show the configuration to contain this variable volume. The concrete slurry mix which is placed under water may require from 2 - 8 bags of cement per cubic yard. The amount of cement required will be determined by Waterways Experiment Station (WES). The concrete mix of the contaminated material placed above water will be approximately 2 bags of cement per cubic yard. This mix will be compacted by a vibrator roller to obtain a stable compact mass. Placement of the mix above water may be by concrete pump, transit mix,

and/or windrow mixing. The method used will be determined in the field. Encrypment of the contaminated material will be at the Cactus Crater site with the mound adjusted to accommodate the volume of contaminated material generated by the cleanup operations. Consideration has been given to the use of LaCrosse Crater in addition to Cactus Crater but is not recommended since more time, materials and costs will be incurred under this scheme. See Appendix A.

a. Recommended sequence of contaminated material placement is as follows:

(1) Dump large pieces of radioactive material into bottom of crater. Material should be well dispersed to preclude subsequent material from "hang-up". Scrap metal should be cut up into pieces to prevent voids. The dispersion should be monitored to assure optimum placement of concrete slurry.

(2) Place concrete slurry with concrete pump and barge as shown on the drawings. Concrete slurry shall be placed up to the top of the tidal level (approximate elevation +5.0).

(3) During the slurry placement the keywall on the north end of the crater on the exposed reef can be constructed. It is estimated that 1/2 of the keywall on the north (seaward) side of the crater will be anchored 1'-0 into firm coral reef and the remaining 1/2 of the key wall will be embedded to a maximum of 8'-0 into factured coral reef and where no reef exists. The applicable keywall to use will be determined in the field.

* (4) The amount of contaminated material may be known by this time and the configuration of the mound determined. The location of the keywall should be staked out and all surrounding material within the containment area removed to the elevation of the existing coral reef located on the north end of Cactus Crater. *

(5) Complete construction of the enclosing keywall.

(6) Placement of the contaminated concrete mix above the water line shall be compacted by vibrator roller and shaped to receive the concrete cap.

b. Keywall. The concrete keywall will be constructed completely around the encrypted material. The pace data (reference 7) indicates there is a coral reef on the north side of Cactus Crater. In this area the keywall will be tied one foot into the existing coral reef. In areas where no coral reef existed or where the reef has been fractured the keywall will be constructed to a depth 8'-0 below the top of the adjacent coral reef. This wall can be constructed by driving sheet piling, excavating the space between the piling, dumping concrete below the water line and terminating with conventional concrete placement above the water line. The wall can also be constructed by excavating, placing forms, pouring concrete as described above and then backfilling. A precast concrete option has been indicated on the drawing. The depth of this 8'-0 embedment will preclude scouring and undermining of the keywall from tidal waves and severe storm wave action. See Appendix C.

c. Concrete Cap. The contaminated material will be encapsuled with a 18" thick concrete cap. The cap will be poured in maximum 20' x 20' panels (22 cy) to reduce shrinkage cracks. Concrete with a strength of 3000 psi at 28 days will be used. Keys will be formed at slab joints to prevent differential movement between slabs.

(Rev. 16Dec76)

d. Quarry, rock crushing, screening and central mix batch plant operations and equipment lists. See Appendix B.

e. Landing ramp. A ramp will be required on the lagoon side of Runit close to the storage area to unload dump trucks laden with contaminated material from outlying islands. The ramp site will be graded to a maximum slope of 10%. A leveling course of gravel will be placed prior to placement of precast concrete slabs. The ramp will be 40'-0" wide to accommodate LCU landing craft. Coral heads will be removed by explosives. The Navy shall verify suitability of the elevation of the toe of the ramp for the operation of the craft used.

f. Water Supply.

(1) A brackish water supply will be provided for the laundry. The skimming well will be located near the test pits contained in reference 9. The location is close to the end of the runway which will provide a good recharge surface area to replenish the fresh

* water supply. Waste water will be disposed of by utilizing a *

seepage pit. See Appendix D.

(Rev. 16Dec76)

(2) A salt water system will be provided for the sprinkler system at the storage yard area, fill station and wash down area. Water will be drawn from a pit located near the shoreline on the lagoon side adjacent to the landing ramp. The fill station will provide water for the water trucks for dust abatement of the roads.

Another salt water system will provide salt water for the batch, mixing plants, and crater area. The source of water will be LaCrosse Crater. Cast iron pipe will be placed and anchored with precast concrete blocks.

* Each water system will utilize engine-driven pumps with a spare * provided for backup.

g. Mole Construction. The requirements for the mole construction are shown on the drawings. See Appendix F.

h. Electrical Requirements. Floodlight for night operation will be furnished utilizing light sets and generator sets available * through Army TOE. See drawings for additional electrical requirements. *

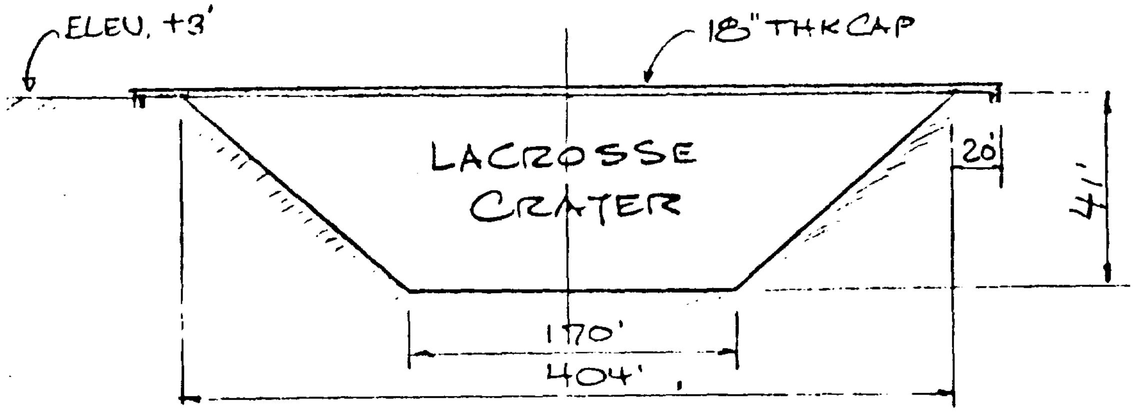
i. Quantity Estimates and Cost Data. See Appendix E.

APPENDIX A

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE ______ SH NO. ____ OF ____ SHS
LOCATION ______ SECTION ______
DRAWING (S) NO. ______
COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

DESIGN ANALYSIS



1974 VOLUME (LACROSSE)

$$VOL = \frac{\pi h}{3}\left[(R)^2+(R)(r)+(r)^2\right]$$
$$= \frac{\pi 41}{3}\left[(202)^2+(202)(85)+(85)^2\right]$$
$$= 42.9\left[40804+17170+7225\right]$$
$$= 2,797,037\ FT^3 = 103,593\ YD^3$$

CEMENT REQ'D FOR CAP USING 6 BAGS/YD^3

$\pi r^2 \times thk. = \pi\,(222)^2 \times 1.5 \times \frac{6}{27} = 51,610$ BAGS

KEY WALL $\pi\,(444)\,(1)\,\frac{6}{27} =$ $= 310$

51,920 BAGS

POD Form 115
1 Jul 70

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE ______ SH NO. ______ OF ______ SHS
LOCATION ______ SECTION ______
DRAWING(S) NO. ______
COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

DESIGN ANALYSIS

CEMENT USED FOR SLURRY (LACROSSE)

2 BAG MIX × 103,593 YD³ = 207,186 BAGS
4 BAG MIX × 103,593 YD³ = 414,372 "
6 BAG MIX × 103,593 YD³ = 621,558 "
8 BAG MIX × 103,593 YD³ = 828,744 "

TOTAL CEMENT REQ'D FOR 103593 YD³ ENCRYPTMENT.

	CAP	+ SLURRY	
(2 BAG) =	51,920	+ 207,186 =	259,106 BAGS
(4 BAG) =	"	+ 414,372 =	466,292 "
(6 BAG) =	"	+ 621,558 =	673,478 "
(8 BAG) =	"	+ 828,744 =	880,664 "

POD Form 115
1 Jul 70

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE ______ SH NO. ______ OF ______ SHS
LOCATION ______ SECTION ______
DRAWING (S) NO. ______
COMPUTED BY ______ DATE ______ CHECKED BY ______ DATE ______

DESIGN ANALYSIS

1964 CACTUS VOL. = 51917 YD^3

CEMENT FOR CAP (6 BAGS/YD^3)

$\pi (18.5)^2 (1.5) \left(\frac{6}{27}\right) = 35{,}840$ BAGS

KEY WALL 2,906

38,746 BAGS

CEMENT FOR SLURRY (CACTUS)

2 BAG MIX	x	51917 YD^3	=	103834	BAGS
4 " "	x	"	=	207668	"
6 " "	x	"	=	311502	"
8 " "	x	"	=	415336	"

TOTAL CEMENT REQ'D. FOR 51917 YD^3 ENCRYPT.

		CAP +			
2 BAG	=	38,746	+ 103834	= 142580	BAGS
4 BAG	=	"	+ 207668	= 246414	"
6 BAG	=	"	+ 311502	= 350248	"
8 BAG	=	"	+ 415336	= 454082	"

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE ______ SH NO. ____ OF ____ SHS
LOCATION ______ SECTION ______
DRAWING(S) NO. ______
COMPUTED BY ______ DATE ____ CHECKED BY ______ DATE ____

DESIGN ANALYSIS

TOTAL CEMENT REQ'D USING BOTH CRATERS
LACROSSE + CACTUS

2 BAG MIX =	259106 + 142580 = 401,686	BAGS
4 "	466292 + 246414 = 712,706	"
6 "	673478 + 350248 = 1023,726	"
8 "	880664 + 454082 = 1,334,746	"

CONCLUSION: —

IT IS NOT ECONOMICALLY FEASIBLE TO UTILIZE THE "LACROSSE" CRATER AS PART OF THE TOTAL VOLUME FOR ENCRYPTMENT OF CONTAMINATED WASTE. THE ACCOMPANYING GRAPH SHOWS THAT THE QUANTITY OF CEMENT REQ'D IS ALLWAYS MORE WHEN "LACROSSE IS USED. IN ADDITION OTHER EXPENSES WOULD BE INVOLVED SUCH AS THE CONSTRUCTION OF THE MOLE & CAUSEWAY ETC,

POD Form 115
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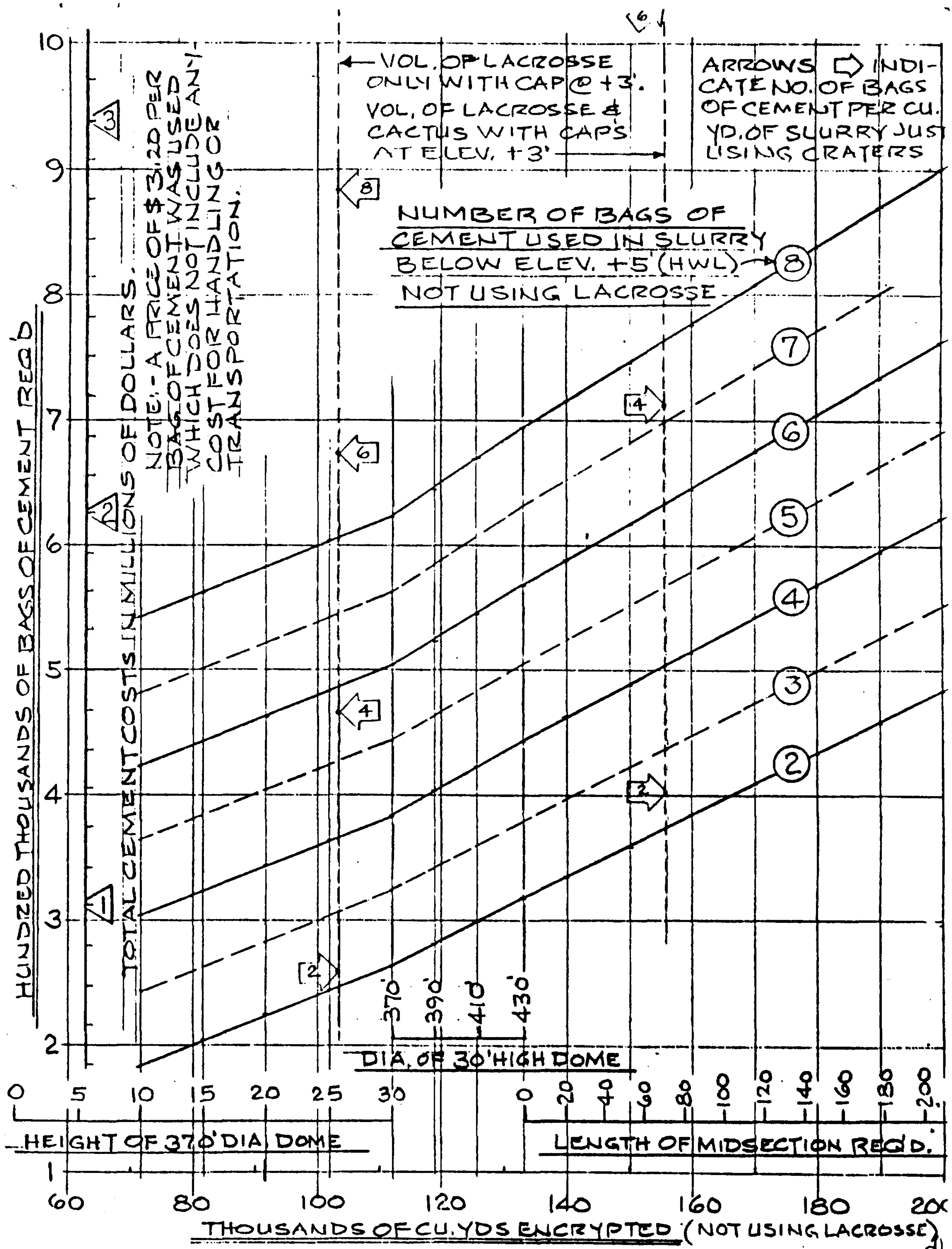
Design Analysis Nov '74



HUNDRED THOUSANDS OF BAGS OF CEMENT REQ'D
TOTAL CEMENT COSTS IN MILLIONS OF DOLLARS.
NOTE:- A PRICE OF $3.20 PER BAG OF CEMENT WAS USED WHICH DOES NOT INCLUDE ANY COST FOR HANDLING OR TRANSPORTATION.
← VOL. OF LACROSSE ONLY WITH CAP @ +3'.
VOL. OF LACROSSE & CACTUS WITH CAPS AT ELEV. +3' →
ARROWS ⇨ INDICATE NO. OF BAGS OF CEMENT PER CU. YD. OF SLURRY JUST USING CRATERS
NUMBER OF BAGS OF CEMENT USED IN SLURRY BELOW ELEV. +5' (HWL) NOT USING LACROSSE
DIA. OF 30' HIGH DOME
370'
390'
410'
430'
HEIGHT OF 370' DIA. DOME
LENGTH OF MIDSECTION REQ'D.
THOUSANDS OF CU. YDS ENCRYPTED (NOT USING LACROSSE)

FIG. No. ______

APPENDIX B

PODED-G 18 November 1976

GENERAL GUIDELINE FOR DRILLING AND BLASTING CORAL REEF FOR ARMOR STONE AT ENEWETOK ATOLL, M.I.

A. PURPOSE

1. Based on the Corps drilling and blasting experience in the Marshall Islands provide guidance in the planning and execution of a coral reef quarry operation. Under the best controlled drilling and blasting methods the approximate yield of armor stone size pieces remains low, or about 15 percent. Consequently, to be sucessful in mining armor stone the quarry operation must be rigidly controlled.

B. ASSUMPTIONS

1. Fully qualified individuals with proven experience shall provide the supervision or technical direction.

2. Control drilling and blasting techniques will be used.

3. Safety and accident prevention planning and protection will be closely followed.

C. ITEMS TO CONSIDER

1. Drilling and loading can be successfully done only at times of low tide levels. Only four to five days out of every other week will low tides occur during the daylight hours.

2. A potential armor stone quarry is generally located in thick reef crusts on the ocean side of the atoll. Visually the quarry site should be selected where the reef is widest and surface elevations are highest. The reef rock will be thickest near the ocean and thinning toward dry land. The higher the reef crust is above low tide the greater is the depth of calcification and hardening.

3. The reef structure decreases in hardness with depth and grades into unconsolidated clastic sediments (silt, sand, gravel & cobble size particles) suitable only for concrete aggregates and fill materials.

4. Freshly mined armor stone pieces are soft and tend to break and crumble on handling. Exposure of rock pieces to air for several days causes further calcification and strengthening (like case hardening). To minimize breakage, armor stone should be quarried and the individual pieces temporarily stored on the adjacent reef surface.

5. To recover armor stone sized rock it is necessary that controlled blasting merely fracture the reef crust to just the extent necessary that proper excavation equipment can break off the required size of stone. Consequently a carefully planned excavation technique must be developed together with the blasting procedure.

6. Powder to rock ratios will range from less than one pound to more than two pounds per cubic yard. Where the hard reef crust layers are less than four to five feet thick excess energy (more than one pound per cubic yard) is either absorbed in the more porus underlayers or is vented (wasted) at the reef surface. Excess energy occuring where hard reef crust layers exceed five feet will cause crumbling or shattering and must be avoided in blasting for armor stone.

7. For coral reef blasting, contractors have used a five minute delay train with two detonating cord trunk lines and a non-electric fuse lighter.

8. Shot holes should be sounded with a calibrated blasting stick to insure no caving has occurred prior to loading. Shot holes should be loaded immediately after drilling. Rising tides can carry sand into open holes unless the top of holes are closed (stoppers).

9. Drilling and loading will be done under increasing depths of water within the drill hole. All loaded shot holes will be detonated the same day of loading.

10. Team work and close coordination is necessary to efficiently use the short daylight work period.

D. <u>INVESTIGATIONS</u>

1. Investigations are to outline and define the thickest and hardest reef crust layers for mining 1500 to 3000 pound armor stones.

2. Select widest reef area on ocean side for a quarry site.

3. Within the widest reef area select the highest elevated reef crust for inital investigations.

4. Sand and rock rubble may cover portions of the selected reef area. Clearing exploration paths through the rubble is required to expose the reef surface and for keeping test shot holes open.

5. Horizontal survey controls are necessary for locating exploratory paths and positioning exploratory and shot holes to be drilled to measure and map the coral reef crust thickness and hardness. Exploratory paths (lines) can be laid out on about 100 feet centers normal to dry land or reef front. Locate preliminary investigative shot holes on approximately 50 centers. Decrease the distance between shot holes if correlation between holes is not apparent.

E. INVESTIGATIVE OBSERVATIONS AND MEASUREMENTS.

1. Thickness of reef crust can be determined by exploratory and shot holes by measuring the depth where the hole caves when the bit is removed. Caving normally is where underlying loose sand prevents deepening by a percussion drill due to the increase energy needed to blow the hole clean.

2. Hardness of the reef crust will vary with the sound and response of the drill.

3. Timing the rate of drilling and comparing with investigative rock excavation will provide experience in siting a quarry area. Strips painted on drill steel aids in making estimates of drilling rates. Comparing the rates of drilling for bit sizes 2½", 3" and 4" can be used to plan drilling and blasting arrays.

4. Uniformity in drilling operations is necessary when comparing results. To minimize variations in percussion drilling the compressor must maintain a constant CFM volume at controlled pressure and the sequence of drilling and blowing should be nearly uniform.

5. The success of observations and measurements depends on the experience and ability of the drill operator.

F. BLASTING DESIGN

1. Criteria for blasting design can be found in TM 5-332 - Pits and Quarries, EM 1110-2-3800 - Systematic Drilling and Blasting for Surface Excavation.

2. Shot hole arrays will depend on the thickness of the reef crust layer. Vary hole spacing and powder-rcok ratio as necessary to obtain desired results. (The anticipated yield is about 15%).

3. The following general criteria will aid in planning initial test blasting:

General Guideline for Drilling and Blasting Coral Reef for Armor Stone at Enewetok Atoll, M.I.

a. Drill 2½-inch diameter holes in reef crust layers less than six feet thick beginning with a 5'x5' array in a rectangular pattern. Drill 3 and 4 inch diameter holes where the reef crust is more than six feet thick. The hole array will exceed 5'x5'.

b. Use 40 or 50 percent weight strength, water resistant, straight gelatin dynamite with instant caps and prima cord. The powder-rock ratio should be between 1.0 and 1.6 pounds per cubic yard depending on hardness of rock. A smaller charge is used in harder (slower drilling) rock.

c. Experience and trial and error under controlled conditions will furnish additional guides as work progresses.

4. The amount of blasting energy used per hole should be no more then necessary to crack the reef crust. If heaving and distortion occurs the powder-rock ratio should be reduced or the shot hole spacing increased or combination of both.

5. The best recovery (percentage yield) of armor stones will be obtained by excavating the pieces from the cracked reef crust.

6. A quarry should be developed to provide two or more faces which helps to relieve blasting stresses and makes excavation of large pieces easier. A sigzag (angled) quarry layout would provide the greater number of working faces.

7. Joints, cracks and surge channels in the reef crust should be considered free faces when planning shot holes.

8. Solution sinks, pot holes and cavaties will absorb blasting energy and should be avoided in planning shot holes.

9. Blasting formulas referenced in paragraph 1, hereinbefore, lists the many additional items and variables effecting blasting techniques. The culmination of experience in the field will ultimately dictate the most successful blasting procedure.

PODED-G 17 November 1976

QUARRY, ROCK CRUSHING, SCREENING AND CENTRAL MIX BATCH PLANT OPERATIONS FOR CLEANUP OF ENEWETOK ATOLL, M.I.

A. INTRODUCTION

1. PURPOSE:

a. Identify only significant types of equipment considered essential for practical completion of the designed containment of contaminated debris and soil.

b. Show types of equipment and number of each for the assumed operational-production rate. (If any operation is not scheduled simultaneously with another then common equipment need not be duplicated.)

c. The size of equipment is limited by the recommended capacity or equivalent shown. (Operational production dictates the size of equipment.)

d. Denote availability of equipment through either the Army "Table of Organization and Equipment (TOE)", Navy, or commercial.

e. Indicate equipment requiring a long procurement lead time.

f. Show the approximate continuous horsepower demand for electrically powered equipment.

g. Provide estimated area requirements for quarry and/or borrow sites, aggregate stockpiles, and crushing, screening and batch plant operations.

2. BASIC ASSUMPTIONS:

a. All required support maintenance tools and repair parts essential for satisfactory performance of equipment shall be the responsibility of the
* service organization. *

* b. The tasked organization shall contain teams of trained equipment * operators, maintenance personnel and helpers to insure an efficient equipment operation.

3. ASSUMED MINIMUM PRODUCTION REQUIREMENTS:

a. Crushing plant shall process a minimum of 60 tons per hour.

b. Screening and washing unit shall process a minimum of 60 ton per hour.

c. Central mix batch plant shall process a minimum of 60 cubic yards per hour.

(Rev. 16Dec76)

4. SPECIFIC ASSUMPTIONS: Assumptions for various studies are shown hereinafter in the respective analyses.

B. EQUIPMENT MATERIALS LIST

1. QUARRY OPERATIONS:

a.	Dozer, crawler-mounted with blade and single tooth ripper. Cat D-8 or larger. Supplier - Army	One Each
b.	Dragline, crawler-mounted, minimum capacity 40 tons and minimum bucket size 2 cu.yd. Supplier - Army	One each
c.	Crawler loader, minimum bucket size with digging teeth 2½ cu.yd. Supplier - Army	Two each
d.	Dump trucks, ten wheeled, 20 ton Supplier - Army	Five each
e.	Trac-drill with extendable boom, Joy Model Ram-hammer VCR 260 or equal Supplier - commercial	One each
f.	Portable compressor, 800 CFM @100 PSI, Quite Model Joy RPQ800 or equal Supplier - commercial (Army has portable compressor, 600 CFM @100 PSI which will operate a wagon drill, but not a trac-drill.)	One each
g.	Flatbed truck, bed size to be modified to accommodate mounting trac-drill and 800 CFM compressor. Approx bed size 8'± W x 20'± L, load weight 8± tons. Supplier - Army (To mount a wagon drill on a flatbed truck and maintain versatility in operating positions is not possible.)	One each
h.	Miscellaneous (Supplier - Army)	
(1)	Drill Bits - 2½", 3" & 4" diameter with replaceable teeth, extra teeth	Two bits of each size

(2)	Drill steel - 12'±, 16'±, & 20'± lengths	Two lengths of each size
(3)	Jack-hammer with pavement breaker point, chisels and cutter bits	One each
(4)	Portable compressor, 200 CFM @90 PSI	One each
(5)	Blasting machine to handle a minimum of 20 caps	One each
(6)	Galvanometer for testing blast circuits	One each
(7)	Blasting caps, standard instant delays	One each
(8)	Wire and reel for firing. Average depth of holes 5' - 10', approx 2000± holes	
(9)	Explosives, water resistant, 50% or stronger weight strength, gelatin dynamite. Estimated quantity	60,000 lbs

2. CRUSHER, SCREENING AND WASHING OPERATIONS:

a.	Primary crusher, 75 ton per hour capacity Supplier - Army	One each
b.	Secondary crusher, 75 ton per hour capacity Supplier - Army	One each
c.	Screening and washing unit, 75 ton per hour capacity. Washing unit should include as a minimum spray bars and screw type dehydrator Supplier - Army	One each
d.	Wheel loaders, minimum bucket size 2½ cu.yd. with digging teeth. Supplier - Army	Two each
e.	Water Pump (for washing unit) minimum pump capacity 500 GPM @25 PSI. Supplier - Army	One each
f.	Portable aggregate belt conveyors, 24" minimum X 50' Supplier - Army	Six each

3. CONCRETE AND SLURRY BATCHING:

a. Mobile central mix batch plant with self erecting mixer. Minimum plant capcity of 60 cu.yd. per hour. Minimum mixer capacity of 6 cu.yd. Automatic batching with option of dial or beam type scales.
Supplier - Navy — One each

b. Closed bucket or skrew conveyor with hopper for filling cement bin of batch plant.
Supplier - Navy? Commercial — One each

c. Wheel loaders, minimum bucket size 2½ cu.yd. with digging teeth.
Supplier - Army — Two each

d. Pnuematic tired fork lift, minimum capacity 5000 lbs.
Supplier - Army — One each

e. Transit-mix trucks, minimum capacity 6 cu.yd.
Supplier - Navy — Four each

f. Flatbed truck with tarps (transporting cement sacks on pallet boards)
Supplier - Army — One each

4. CONCRETE AND SLURRY PLACEMENT:

a. Pnuematic tired crane, minimum capacity 20 tons
Supplier - Army — Two each

b. Garbro type concrete bucket, minimum capacity 2 cu.yd.
Supplier - Army or Navy — Two each

c. Concrete pump, minimum capacity 60 cu.yd. per hour. Pipeline to transport slurry, a maximum of 800 feet. Pumping head equal to or less than the point of discharge from the pump.
* Supplier - Navy — Two each *

d. Dozer, crawler-mounted with blade. Cat D-7 or equal.
Supplier - Army — One each

(Rev. 16Dec76)

e. Motorized heavy road grader.
Supplier - Army — One each

f. Self-propelled vibratory steel drum roller, static weight approx 10 tons
Supplier - Navy — One each

g. Electric concrete vibrators
Supplier - Navy — Four each

5. EXCAVATOR FOR FOOTINGS:

a. Crawler-mounted or wheel type backhoe, bucket size 1/2 cu.yd. or larger
Supplier - Army — One each

6. REMOVAL OF OVERSIZE AND DEBRIS FROM CONTAMINATED MATERIALS:

* a. Portable grizzly capable of processing a minimum of 60 cu.yd. per hour *
Supplier - commercial — One each

C. PRIORITY EQUIPMENT PROCUREMENT.

1. Crusher, screening and washing units.

2. Mobile central mix batch plant.

3. Transit-mix trucks.

4. Concrete pump.

5. Self-propelled vibratory steel drum roller.

6. Trac-drill.

7. Portable compressor, 800 CFM

D. ESTIMATED AREA OF QUARRY SITE FOR ARMOR STONE.

1. Determine approximate area for armor stone quarry site. Stone sizes 1500 to 3000 pounds.

2. Assumptions:

a. Estimated quantity of armor stone — 2000 cu.yds$^{\pm}$ (neat line)

b. Estimated bulking factors for in-place stone 35%±

c. Percentage of yield from controlled quarry blasting and excavating 15%±

d. Average thickness of hard reef rock 2 feet ±

e. To insure a minimum buffer width of 100 feet between the reef front and seaward edge of the quarry site and a similar landward buffer zone of 100 feet from the shoreline high water mark, use 250 feet for the average width of quarry.

3. Estimated quarry surface area.

a. Equivalent excavated rock volume

2000 c.y./1 + bulking factor = 2000/1.35 = 1,482 cu.yd.

b. Total volume of excavation to yield 1,482 cu.yd.

1482 cy/yield factor = 1482/0.15 = 9880 cu. yds.

c. Length of borrow site using an average depth of 2 feet and width of 250 feet

$$\text{Length} = \frac{(9880\ \text{c.y.})(27\ \text{c.f./c.y.})}{(2\ \text{ft})\ (250\ \text{ft})} = 534\ \text{feet}$$

d. An experience factor has indicated a multiple of 1.5 should be used for estimating the required surface area of a potential coral ledge quarry site.

e. The approximate surface area dimensions for the armor shore quarry are 250 feet x 534 feet (1.5)

USE <u>250 feet width x 800 feet length</u>

E. ESTIMATED AREA OF BORROW SITE FOR CONCRETE AGGREGATE

1. The borrow for concrete aggregates shall be obtained from the disturbed undersized coral rock remaining after armor stone quarry operations. Crushing, screening and washing of borrow materials will be required.

2. Assumptions:

a. Estimated quantity of concrete aggregates

12,000 cu.yd. $\pm$ (In concrete)

b. Estimated proportions by volume to yield a workable mix design. (Final mix design shall be established in the field.)

3/4" to No. 4	45% $\pm$
Sand	55% $\pm$

c. Coarse aggregate placed in stockpiles will bulk and handling of aggregates will result in losses. The estimated percentages of bulking and losses are:

Bulking	+ 35% $\pm$
Losses	- 5% $\pm$
Total Correction factor	+ 40% $\pm$

d. The approximate proportions by volume of the yield from crushing, screening and washing operations are:

3/4" to No. 4	23% $\pm$
Sand	72% $\pm$
Losses from washing	5% $\pm$

3. Estimated surface area required for concrete aggregate borrow.

a. Determine total volumes of coarse and fine aggregates required for the estimated concrete mix.

3/4" to No. 4	(12000 cy)(45%)	=	5400 c.y. (mix)
Sand	(1200 c.y.)(55%)	=	6,600 c.y. (mix)

b. Determine total volumes of coarse aggregate to be stockpiled.

3/4" to No. 4 (5,400 c.y.)(1 + total correction factor)

(5,400 c.y.)(1 + 40%) = 7,560 c.y. (stockpiled)

c. The low yield for producing 3/4" to No. 4 size coarse aggregate shall dictate the quantity of material required for processing. Estimated quantity of material from borrow is:

7560 cy/23% = 32,870 cy

USE 32,900 c.y.

4. The approximate surface area dimensions for the aggregate borrow area using an average depth of 8 feet and width of 250 feet is:

$$\text{Length} = \frac{(32{,}900\ \text{c.y.})(27\ \text{c.f/c.y.})}{(250\ \text{ft})\ (8\ \text{ft})} = 444\ \text{ft.}$$

USE 250 feet width x 450 feet length

(within limits of proposed quarry site)

F. REQUIRED AREA FOR CRUSHING, SCREENING AND WASHING OPERATIONS; AGGREGATE STOCKPILING, WASTE STOCKPILING

1. Assuming the primary and secondary crushers are separate units and the screening and washing units are a common plant and all units are located in tandem and connected by conveyors, the area required for siting and conveyor off loading shall be approximately

110 feet wide x 250 feet long

2. Stockpiling Coarse Aggregate:

a. Quantity of 3/4" to No. 4 coarse aggregate stockpile equals approximately 7,560 c.y.

b. Recommend providing a nearly rectangular shaped stockpile 100 feet wide x 150 feet long. Height is approximately 10 feet clear and level 12 feet beyong the periphery.

3. Stockpiling Fine (sand) Aggregate:

a. Quantity of sand aggregate stockpile is approximately 6,600 c.y.

b. Recommend providing a nearly rectangular shaped stockpile 100 feet wide x 150 feet long. Height is approximately 8 feet. Clear and level 12 feet beyond the periphery.

4. Stockpiling waste aggregate (predominately sand) resulting from aggregate processing operation.

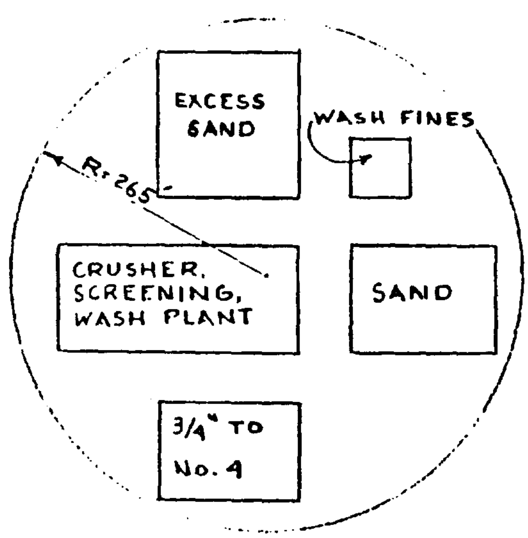
Sand	Produced	= (32,000 c.y.)(72%)	=	23,700± c.y.
	Stockpiled			6,600 c.y.
	Waste			17,100± c.y.

Washing Loss (32,400 c.y.)(5%) = 1,650± c.y.

Stockpile approximately 17,100 c.y. of excess sand in a nearly square area 150 feet on each side. Height is approximately 13 feet.

Stockpile approximately 1,650 c.y. of washed fines in a nearly square area 60 feet on each side. Height is approximately 10 feet.

5. Generalized layout of aggregate processing area to establish <u>overall</u> area requirements. (Conservative estimate)



Scale: 1" = 200'

Recommend a site encompassed by a 530 feet diameter circle be designated as an aggregate processing area.

G. REQUIRED AREA FOR CENTRAL MIX BATCH PLANT

1. Assumptions:

a. Batch plant will be located in proximity to the proposed site for encapsulation. Batch plant will be portable.

b. Dry storage area adjacent the plant should have sufficient capacity to store three days cement supply.

c. Cement to be procured in sacks in lieu of large rubber bladders. (cement filled rubber bladders would weigh approximately 4000 lbs each and require special equipment for handling.)

d. A closed bucket or screw elevator with hopper will transfer the cement to the batch plant bin.

e. Loaders will feed the aggregate or contaminated materials into the batch plant bins.

f. Nominal concrete aggregate storage area will be required adjacent the batch plant.

2. Central mix batch plant: (Minimum capacity 60 c.y. per hour)

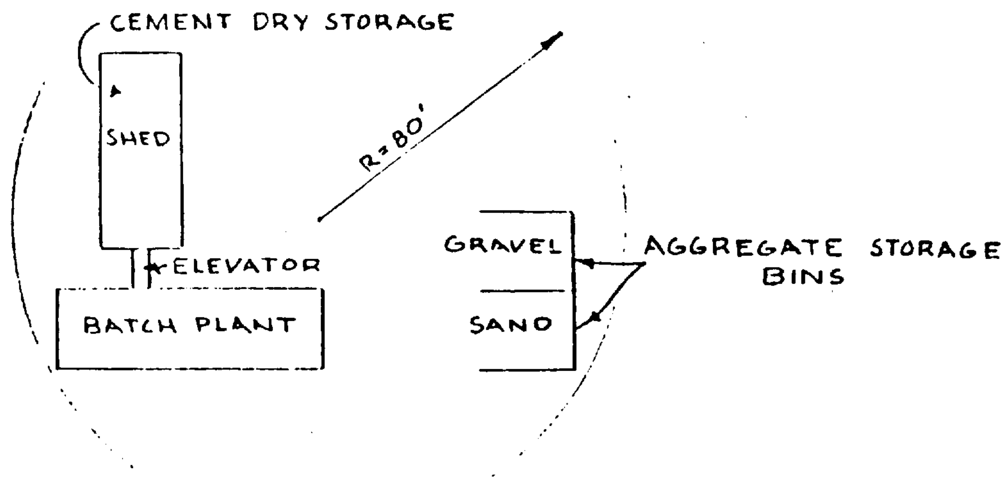
a. A portable batch plant with self erecting mixer can, generally, be contained in a 20 feet wide x 70 feet long area.

3. Cement dry storage area:

a. A wooden dry storage shed approximately 20 feet x 50 feet can store about 3600 cement sacks or roughly three days supply of cement.

b. A closed bucket or screw elevator will lead from the shed to the batch plant cement bin. A hopper type feed would be placed in the shed.

4. Generalized batch plant layout:



A site encompassed by a 160 feet diameter circle would provide a conservative area for locating the batch plant, cement storage shed and interim aggregate storage area.

H. ESTIMATED CONTINUOUS ELECTRICAL HORSEPOWER DEMAND FOR CRUSHERS, SCREENING, WASHING AND CENTRAL MIX BATCH PLANTS:

1. Aggregate processing plant: (Capacity min. 60 c.y. per hour)

   a. Jaw crusher 160 HP±

   b. Roller crusher 160 HP±

   c. Screening and washing units 125 HP±

   d. Conveyors (Five 10 HP motor) 50 HP±

   e. Where crushers are a combined unit approximately 200 HP± would be required.

   f. If crushers operate by diesel engines the horsepower demand would be less.

   g. Bigger the plant the larger the horsepower demand.

2. Central mix batch plant: (Capacity min. 60 cu.yd per hour)

   a. Batch Plant plus exterior cement conveyor 140 HP±

I. REFERENCES

1. Engineer Troop Organizations and Operations FM 5-1, Jul 1971

2. Engineer Construction and Construction - Support Units FM 5-162, Mar 1973

3. Pits and Quarries TM 5-332, Jul 1960

4. Roads and Airfield TM 5-250, Aug 1957

5. Use of Road and Airdrome Construction Equipment TM 5-252, Jan 1945

6. Army (TOE) 1975

7. Navy

Additional Recommended Equipment (Army TOE)

MAINTENANCE EQUIPMENT

1. Truck Wrecker, 10T
2. Grader road mtzd ded 12' blade
3. Welding shop trlr mtd, 300 amp
4. Tool kit welders
   Torch outfilt cutting/welding
5. Welding equip elect cc-cp type
6. Welding set are inert gas shield DC 115V
7. Lubricat serv unit power oper trlr mtd
8. Shop equip contact maint trk mtd
9. Shop equip gen purpose repair strlr mtd
10. Tool outfit pioneer portable elect tools
11. Semi trlr van repair parts storage, 6T
12. Saw power hack ptbl
13. Saw circular table type, 20' blade
14. Truck cargo, 5T
15. Saw chain gas driven, 18"
16. Truck tank fuel servicing

LIGHT EQUIPMENT

1. Survey set gen purpose
2. Drafting equip set bn
3. Test set concrete
4. Auger earth skid mtd 9' bore depth
5. Flood light set elec ptbl 6 light 5KW 120V/208V
6. Diving equipment set, SCUBA
7. Water pump 125GPM
8. Water pump centrifugal whl mtd, 1500 GPM, 60' head
9. Outboard motor, 25 HP
10. Boat landing inflat assclt 15 mcn
11. Winch drum pnue driven, 1T
12. Winch drum diesel driven, 5-3/4T

HEAVY EQUIPMENT

1. Hammer, pile driven self powrd dsl driven, 7000 lb (min capacity)
2. Distributor water trk mtd, 1000 gals (min)
3. Semi trailer low bed, 25T
4. Harrow, disc, hydraulic lift control
5. Scraper towed, 18 cu. yd. (need tractor)
6. Mixer conc trlr mtd, 16 cu. ft. — small jobs for ramp keyward, etc. with them
7. Barge assembly: 3x7, 5x12, or 6x18
8. Propelling unit outboard, 165 BHP

APPENDIX C

U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE Enewetak Cleanup SH NO. 1 OF 2 SHS
LOCATION ______ SECTION ______
DRAWING (S) NO. ______
COMPUTED BY KVK DATE 15Nov76 CHECKED BY ______ DATE ______

DESIGN ANALYSIS

1. ASSUMPTIONS.

a. No catastrophic movement in the coral reef structure ($\pm$ 5 feet horiz or vert) which will result in disastrous effects (major faulting) is predicted for the next 2,000 years.

b. The mean sea level will vary from 1 foot lower to 5 feet higher than existing MSL over the next 2,000 years.

c. Reef material is not removed or excavated (by nature or man) in the vicinity of the crater or seaward of the crater for a distance of 1,200 feet.

2. DESIGN SWL.

a. Max wave will occur when sea level is 5' higher than present elev.

Rise in H_2O level	+	Existing high water level	
5'		4.4	= 9'

Under this sea level condition, waves will wash completely over the island and there will be a very small wave and wind setup. The combined effect is estimated to be 1 foot. The rise in water surface due to atmosphere pressure drop is estimated to be about 2 feet for a major storm.

b. Based on the above the design SWL will be 9+1+2=12'.

3. DESIGN WAVE.

Based on controlling depth criteria for waves having periods between 15 and 20 seconds, the design wave height will be:

$$12 \div 1.27 = 9.5'$$

4. SCOUR.

a. From the report recently provided by the Navy Command, the ground surface around the crater has been severely fractured and the beach rock in this area is a very thin surface covering over coral, debris and sand.

U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

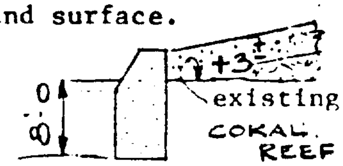
PROJECT TITLE Enewetak Cleanup SH NO: 2 OF 2 SHS
LOCATION ____ SECTION ____
DRAWING (S) NO. ____
COMPUTED BY KVK DATE 15Nov76 CHECKED BY ____ DATE ____

DESIGN ANALYSIS

b. This is contrary to our previous assumption. Based on present information on foundation material, the design wave condition would be expected to produce scour at the toe of the cut-off wall. It is estimated that the depth of scour could be as much as 5 feet. It is not anticipated that scour will be progressive rather material would be expected to be returned to the scour areas by natural processes over a period of time following the occurrence of major storms.

5. DESIGN RECOMMENDATIONS.

a. Extend cut-off wall 8 feet below existing ground surface.



b. Backfill to existing ground elevation around cut-off wall. Use coral pieces 6" to 18" in diameter for backfill.

6. OTHER CONSIDERATIONS.

If biological and chemical processes which promote cementation of coral are sufficiently well understood, measures to promote the cementation process in the backfill material around the outside of the cut-off wall might be considered.

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APPENDIX D

U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE Crater Containment - Enewetak SH NO. 1 OF 2 SHS
LOCATION Runit Isl - Skimming Well SECTION
DRAWING (S) NO.
COMPUTED BY WM DATE 12/1/76 CHECKED BY DATE

DESIGN ANALYSIS

1. References.

a. USGS report, "Ground-water Conditions on Enewetok Atoll, with Comments on the Effects of Use of Conventional Explosives," by F. C. Koopman, May 1973 (Incl 1).

b. Hawaii Institute of Geophysics Report, "Groundwater Resources Evaluation: Enewetak Atoll," by R. W. Buddemeier and R. C. Jansen, October 1976 (Incl 2).

2. Ref a states (pg 16) "The island of Runit does not have a shape favorable to the formation of a fresh-water or slightly saline-water lens. It is a long narrow island and the distance from its axis to the ocean is generally less than 300 feet, which does not make it a prospect for fresh-water accumulation under prevailing precipitation and other hydrologic conditions."

3. Ref b states (pg 50-51) ". . .the available water will normally be at least 25% seawater and may rise above 50% during dry seasons." Again under "C. Conclusions and Recommendations 1. . . . Actual salinities may range from a low of 20% seawater to a high value well in excess of 50% seawater."

4. It should be pointed out that 25 percent seawater means a chloride content of about 9,000 mg/l. This is far in excess of anyone's definition of freshwater. Note table I Quality Standards of same report shows permissible chloride content of 250 mg/l. Hence, 25 percent seawater is 36 times saltier than the "permissible" "standard."

5. Note that there is not significant inconsistency between the actual test data in two reports. However, statements and estimates on page 50 of ref b may be easily misinterpreted if taken out of context of the whole report, since in three places it refers to "total freshwater inventory" or "total freshwater equivalents." This inventory and these equivalents are actually highly saline brackish water.

6. The potential user must be cautioned that clothes laundered in 50 percent seawater will be salty when dried, and will be uncomfortable if worn for extended periods.

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U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
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PROJECT TITLE Runit - Skimming Well SH NO. 1 OF 3 SHS
LOCATION ____ SECTION ____
DRAWING(S) NO. Note: Water will be brackish, 20% to 50% seawater
COMPUTED BY W. L. M. DATE 10 Oct 76 CHECKED BY ____ DATE ____

DESIGN ANALYSIS

SKIMMING WELL AT RUNIT

The estimate of recharge given on page 50, ref b, beginning on line 8 of third paragraph is significantly overoptimistic. It fails to follow even the guidelines given on page 10 of the same report. "Light rains falling on dry soil may be completely lost to evaporation, plant uptake and soil moisture uptake." In addition rain falling within 100 feet of the shoreline generally contributes little or no fresh water to the lens. It is noted that the 100m radius centered at Y-3 intersects the lagoon shore. A more conservative estimate of recharge estimate is as follows:

Consider the maximum circle whose perimeter does not extend closer than 100 feet to the shoreline; ie, a 500 ft diameter circle whose center is about 350 feet from either shore, and about 220 north of centerline of air strip:

500" diam circle = 196,350 ft^2 area

annual recharge = 25% x 57.88 inches ÷ 12 x 196,350 =
= 236,764 cu ft x 7.48
= 1.77×10^6 gal/yr
÷ 365 = 4,850 gal/day
Required Capacity = 3,000 gal/day

The ground water level at center may be expected to be only about 0.2 feet above lagoon level at mean tide. The tidal efficiency may be expected to be about 0.10, that is the tidal range of the ground water may be expected to be about 0.4 feet.

The well will consist of a 12" diam corrugated metal pipe about 12 feet long, securely sealed at the bottom with a 1/4" plate welded watertight. The collector pipes will be 5-60 feet long, 2 inch diam corrugated polyethylene drainage tubing. This tubing is Commercial Standard CS 228-61 is available from several sources including Hancor Inc., PO Box 1047, Findlay, Ohio 45840, and Advanced Drainage System, Inc., PO Box 489, Pomona, CA 91769. The 2-inch collector tubes will radiate equally spaced at about 72°. The collector tubes must be precisely placed at the level of 1.0 ft below the mean ground water elevation. The latter criterion is extremely important because of the very thin brackish waterlines.

The pump will be 1/2 hp 230 volt single-phase submersible pump rated at 10 gpm. This pump is available from Sears and other sources. It is very important to avoid using an oversized pump, in order to prevent excessive drawdown. A windmill can be substituted: 27' tower, 8' diam fan, 2-3/4" x 12" x 24" pump cylinder rated at 6,000 gpd @ 15' lift: Aeromotor or equal.

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SH 2 OF 3

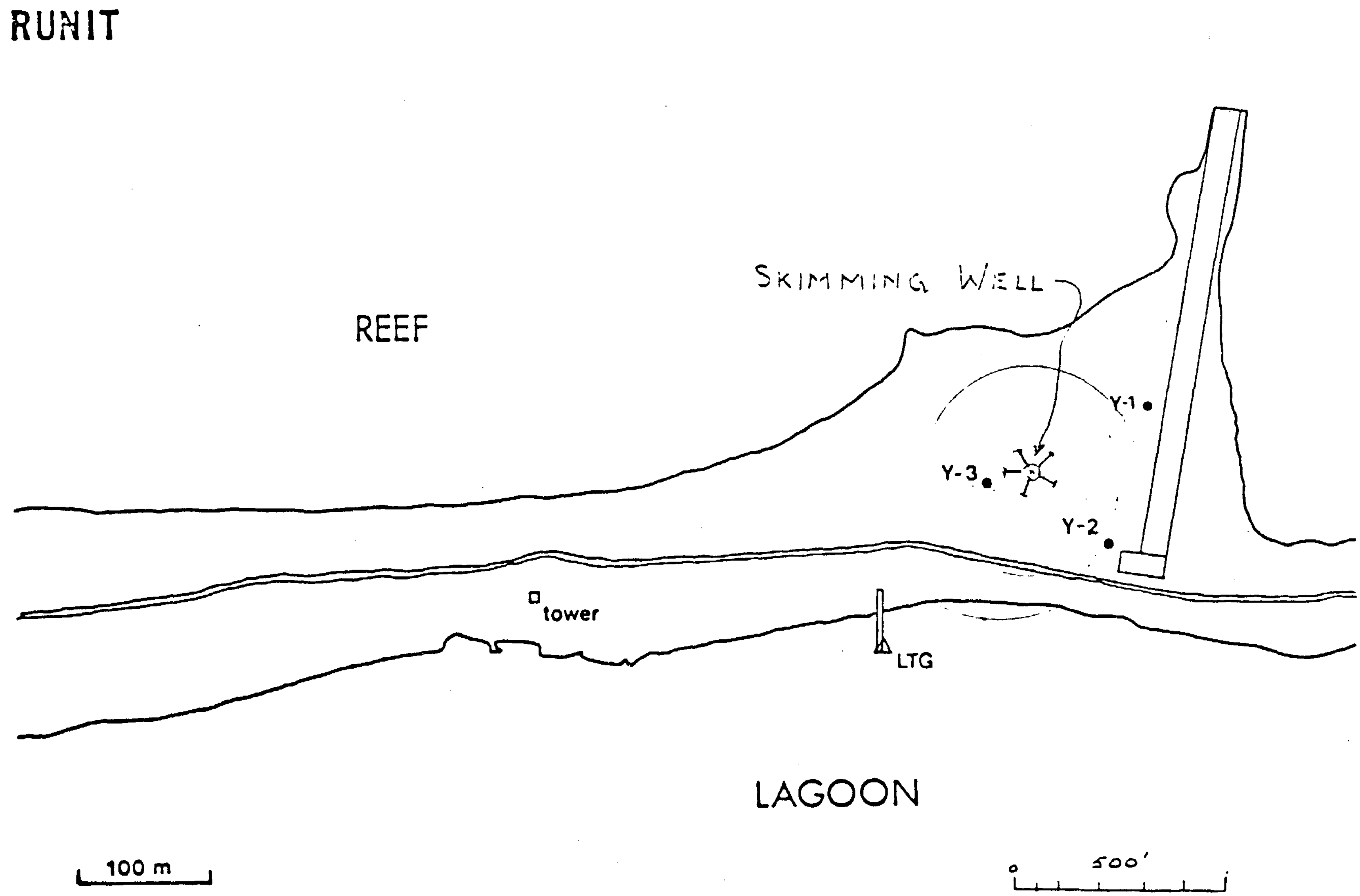


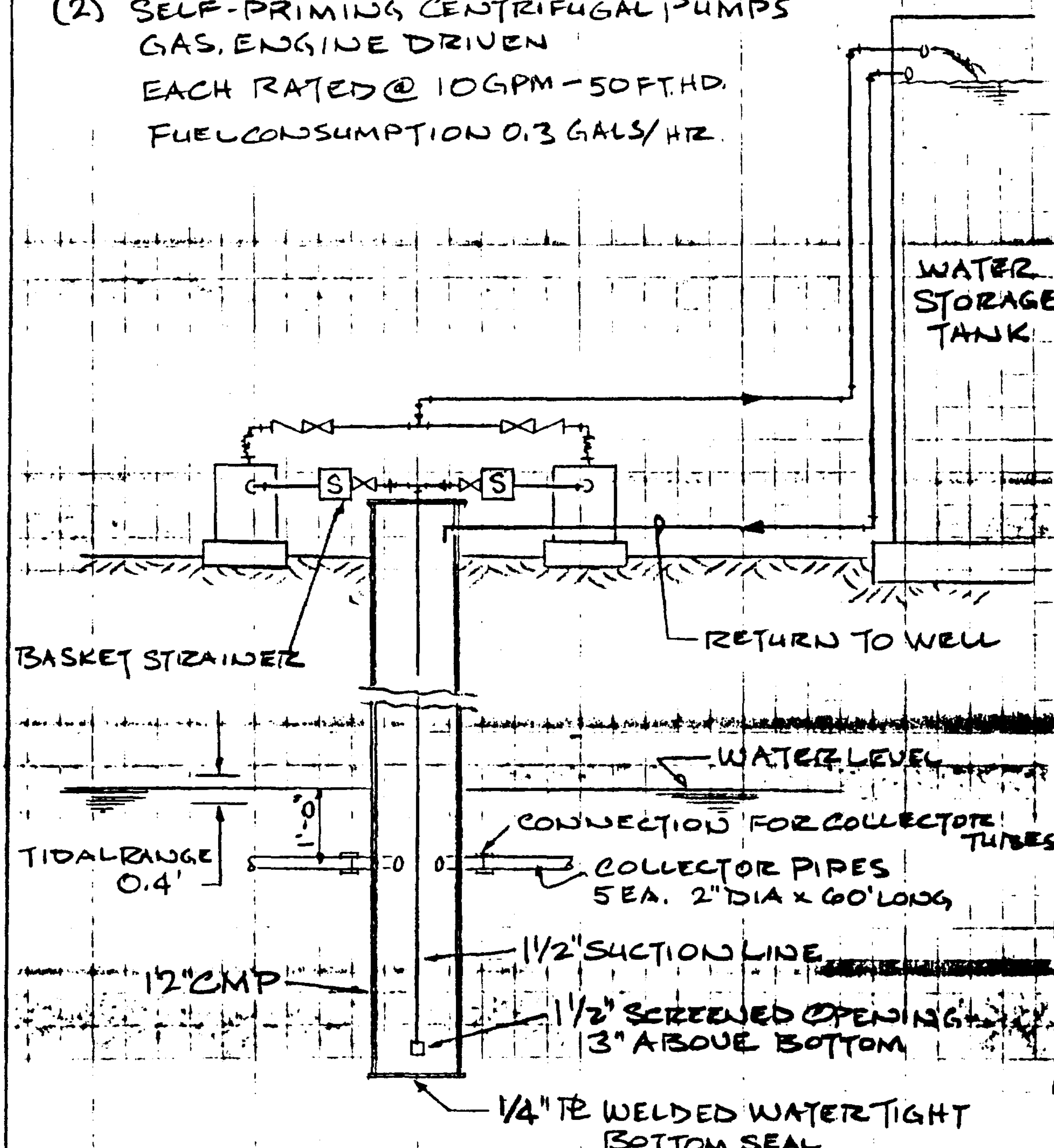
Figure 5

U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE SKIMMING WELL PUMPS SH NO. ____ OF ____ SHS
LOCATION RUNIT, ENEWETAK SECTION MECH.
DRAWING(S) NO. ____
COMPUTED BY ____ DATE ____ CHECKED BY ____ DATE ____

DESIGN ANALYSIS

(2) SELF-PRIMING CENTRIFUGAL PUMPS
GAS. ENGINE DRIVEN
EACH RATED @ 10GPM - 50FT.HD.
FUELCONSUMPTION 0.3 GALS/HR



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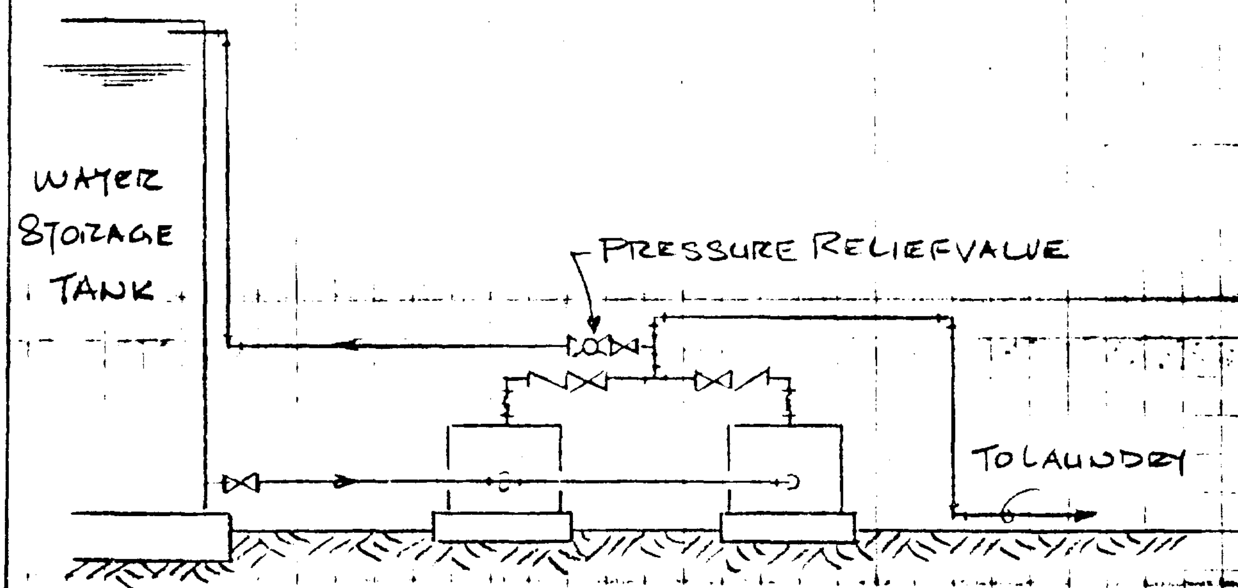
U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE LAUNDRY SUPPLY PUMPS SH NO. ____ OF ____ SHS
LOCATION RUNIT, ENEWETAK SECTION MECH
DRAWING(S) NO. ____
COMPUTED BY ____ DATE ____ CHECKED BY ____ DATE ____

DESIGN ANALYSIS



(2) SELF-PRIMING CENTRIFUGAL PUMPS
GAS-ENGINE DRIVEN
(SAME AS PUMPS AT SKIMMING WELL FOR INTERCHANGEABILITY)
EACH RATED @ 50 GPM - 80 FT. HD.

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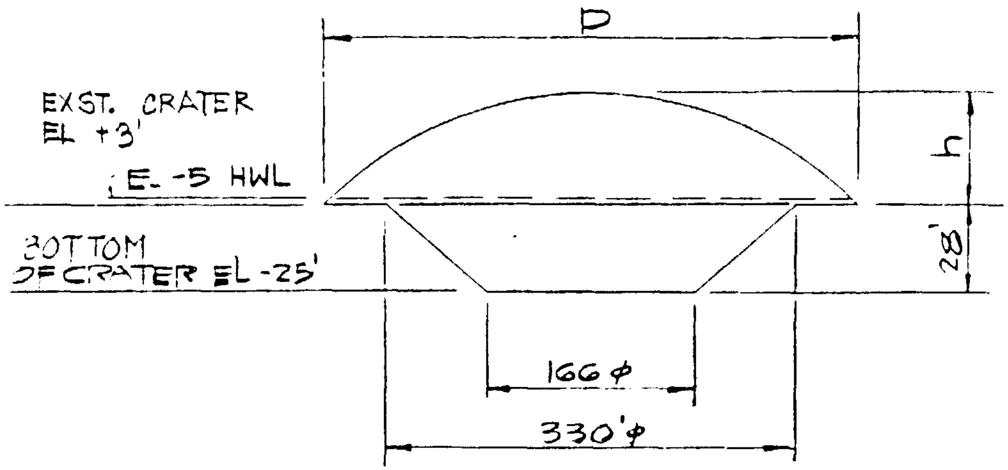
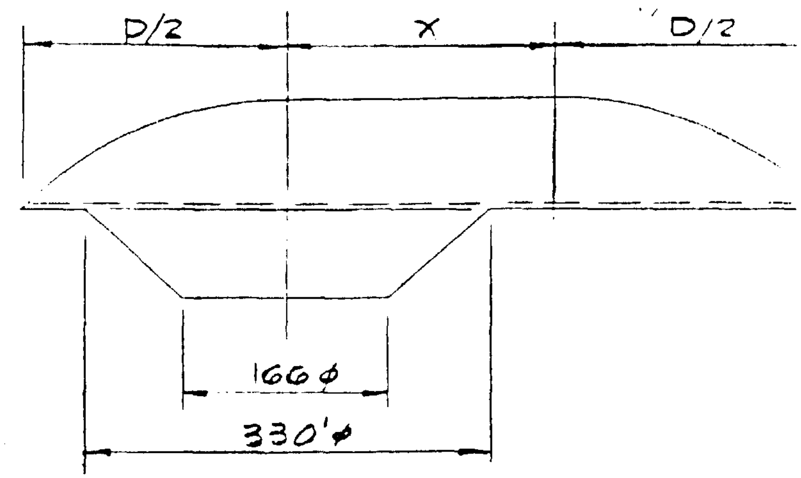
APPENDIX E

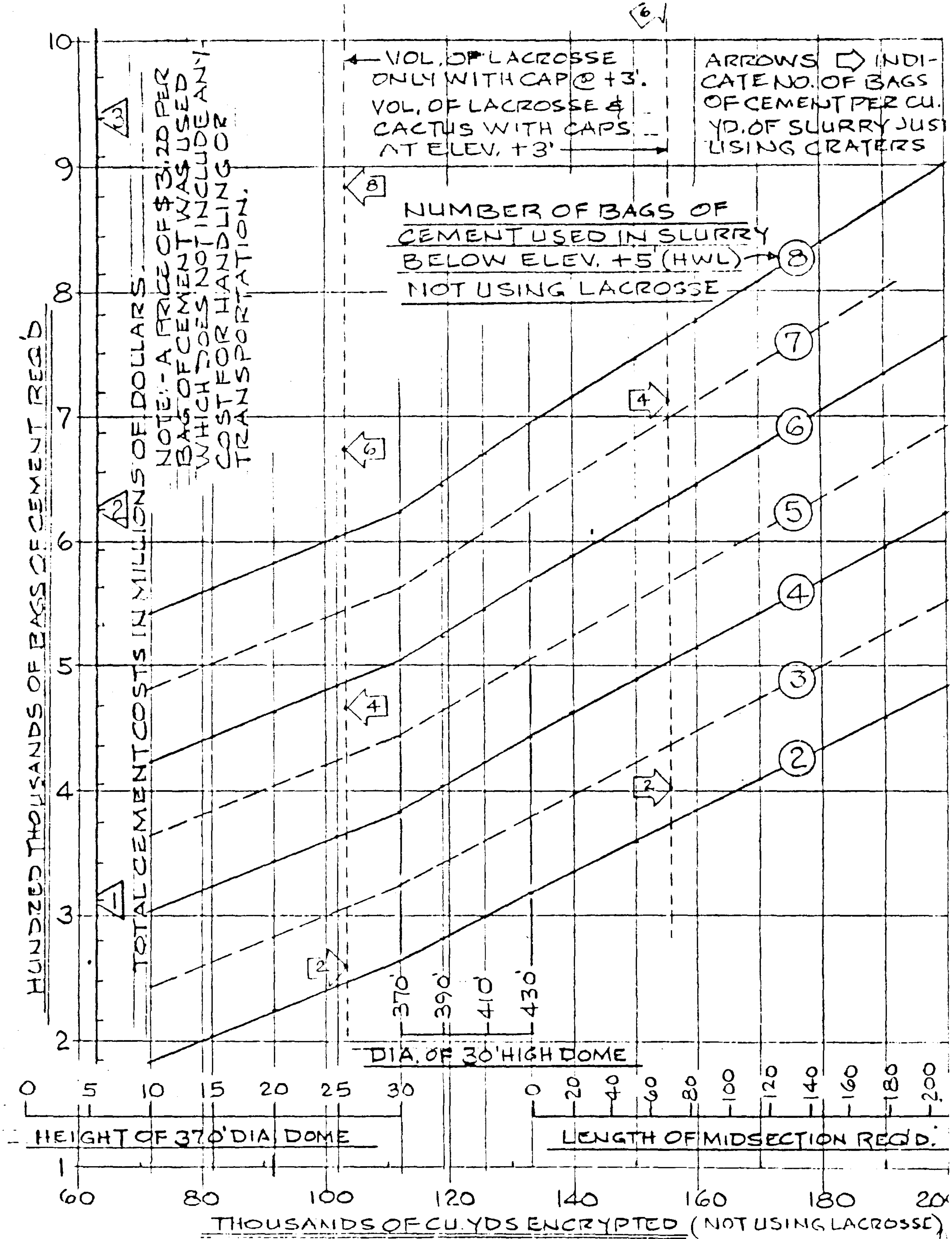
STORAGE VOL REQ'D CU.YDS	CONC CAP DIA FT	CONC CAP HGT FT	CONC CAP X FT	BAGS OF CEMENT REQ'D: KEYWALL 64 BAGS PER YD	CAP 6 BAGS PER YD	ABOVE EL+5 2 BAGS PER YD	SLURRY BELOW EL -5 (HNL): 2 BAGS PER YD	4 BAGS PER YD	6 BAGS PER YD	8 BAGS PER YD	TOTAL BAGS OF CEMENT REQ'D: USING 2 BAG SLURRY	USING 4 BAG SLURRY	USING 6 BAG SLURRY	USING 8 BAG SLURRY
71,847	370	0		2906	35946	23730	119734	[illegible]	359292	479056	92346	302310	422074	541838
81,854	"	10			36078	43014	"	"	"	"	202392	322416	442180	561944
91,887	"	20			36238	64000	"	"	"	"	222938	342702	462466	582230
101,778	"	25			36472	84232	"		"	"	243394	363158	482922	602686
112,144	"	30			36780	104524	"		"	"	263774	383738	503502	623266
118,773	390	"		3063	40764	116014	121552	243104	364596	486128	282373	402705	524437	646167
123,751	400	"		3220	44752	128008	124394	248788	373182	497576	299374	423068	546462	669856
133,077	430	"		3377	49350	140806	125345	250690	376044	501372	318881	444227	569577	694925
140,000	"	"	21.78	3486	52553	153264	126736	253472	380208	506944	335999	462735	589471	716207
150,000	"	"	53.25	3644	57084	171260	128740	257480	386220	514960	360728	489465	618208	746945
160,000	"	"	84.72	3801	61650	189256	130744	261488	392232	522976	385451	516195	646939	777683
170,000	"	"	116.18	3958	66222	207250	132750	265500	398250	531000	410180	542930	675680	808430
180,000	"	"	147.65	4116	70788	225246	134754	269508	404262	539016	434904	569658	704412	839166
190,000	"	"	179.12	4273	75366	243242	136758	273516	410274	547032	459633	596391	733149	869907
200,000	"	"	210.58	4430	79926	261238	138762	277524	416286	555048	484356	623118	761880	900642



D
EXST. CRATER
EL +3'
E. -5 HWL
BOTTOM
OF CRATER EL -25'
h
28'
166 φ
330' φ



D/2
X
D/2
166 φ
330' φ



VOL. OF LACROSSE ONLY WITH CAP @ +3'.
VOL. OF LACROSSE & CACTUS WITH CAPS AT ELEV. +3'
ARROWS INDICATE NO. OF BAGS OF CEMENT PER CU. YD. OF SLURRY JUST USING CRATERS
NUMBER OF BAGS OF CEMENT USED IN SLURRY BELOW ELEV. +5' (HWL) NOT USING LACROSSE
NOTE:- A PRICE OF $3.20 PER BAG OF CEMENT WAS USED WHICH DOES NOT INCLUDE ANY COST FOR HANDLING OR TRANSPORTATION.
TOTAL CEMENT COSTS IN MILLIONS OF DOLLARS.
HUNDRED THOUSANDS OF BAGS OF CEMENT REQ'D
DIA. OF 30' HIGH DOME
370
390
410
430
HEIGHT OF 370' DIA. DOME
LENGTH OF MIDSECTION REQ'D.
THOUSANDS OF CU. YDS ENCRYPTED (NOT USING LACROSSE)

FIG. No.

APPENDIX F

U.S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE Enewetak Atoll Cleanup SH NO. 1 OF ____ SHS
LOCATION ____ SECTION ____
DRAWING (S) NO. ____
COMPUTED BY KVK DATE 10/14/76 CHECKED BY ____ DATE ____

DESIGN ANALYSIS

Design Storm - assume 10 year storm

H_B = 10'

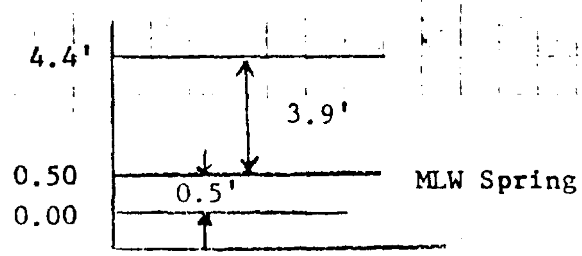
T = 12 seconds

Stillwater elev = Se + S + Sw + Sap = 7.6', wind setup ignored

Se + S_A	=	4.4'
Sap	=	1.5'
Sw	=	1.7'
		7.6'

Tidal Data

Range		
Mean	Denssed spring	M. Tide Level
2.7'	3.9'	2.6'



Reef surface approx + 2'
Depth of water = 7.6 -2 = 5.6'
H_b' = 5.6 ± 1.28 = 4.3'
Use 4' design wave height

Reef with zero slope extends about 1400' seaward of crater, therefore 1.28 used is in lieu of SPM Fig. 7-2 or 7-3.

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U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE Enewetak Atoll Cleanup SH NO. 2 OF ____ SHS
LOCATION ____ SECTION ____
DRAWING (S) NO. ____
COMPUTED BY KVK DATE 10/14/76 CHECKED BY ____ DATE ____

DESIGN ANALYSIS

Armor Stone Weight

$$W = \frac{Wr\ H^3}{K\ (Sr - 1)^3\ cote}$$ (from FM&S)

H = 4'
cote = 1.5
Wr = 150
$Sr = \frac{150}{64} = 2.34$

$$W = \frac{150 \times 4^3}{1.6\ (1.34)^3 \times 1.5} = 1700\#$$

KO = 1.6

use 0.75T to 1.5 ton stone
(1500# to 3000#)

KO = 1.6 selected for single layer not groin in SPM.

Runup

$$\frac{d}{L_o} = \frac{5.6}{5.12 \times 12^2} = 0.0076$$

$$\frac{H}{H_o^1} = 1.531 \qquad H_o^1 = \frac{4}{1.531} = 2.6'$$

$$\frac{H_o}{gT^2} = \frac{2.6}{32.2(12^2)} = 0.0056$$

$$\frac{ds}{H_o} = \frac{5.6}{2.6} = 2.15$$

$$\frac{R}{H_o^1} = 2.6$$

interpolated value = 2.4

$$\frac{R}{H_o^1} = 2.2$$

unconutid runup = 2.6 x 2.4 = 6.25'
K = 1.07 x 6.25 = 6.7'

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U. S. ARMY ENGINEER DIVISION, PACIFIC OCEAN
CORPS OF ENGINEERS

PROJECT TITLE Enewetak Atoll Cleanup SH NO. 3 OF 3 SHS
LOCATION ____ SECTION ____
DRAWING (S) NO. ____
COMPUTED BY KVK DATE 10/14/76 CHECKED BY ____ DATE ____

DESIGN ANALYSIS

Runup cont'd

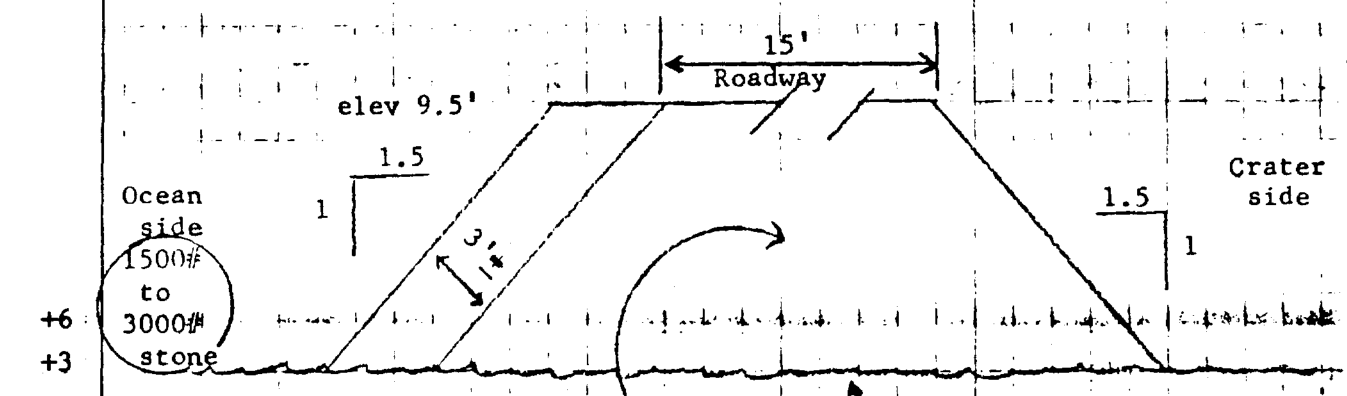
$\frac{R_1}{H_o}$ = 3.1 smooth

$\frac{R}{H_o}$ = 0.90 table 7 - 15

$\frac{0.90}{3.1}$ = 0.29

R = 6.25 x 0.29 = 1.8'

Crest elev = 7.6 + 1.8 = 9.4'
use 9.5'



Typical section
Reveted mole

(quarry run, larger pieces on outer slopes.)

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