UNCLASSIFIED

OAK RIDGE NATIONAL LABORATORY

Operated By

UNION CARBIDE NUCLEAR COMPANY

UCCPOST OFFICE BOX P
OAK RIDGE, TENNESSEE **ORNL**
CENTRAL FILES NUMBER

57-10-2

External Transmittal Authorized

COPY NO. 67

DATE: October 15, 1957

SUBJECT: Report of Slurry Blanket Test Run SM-3

TO: Distribution

FROM: L. F. Parsly, Jr.

DISTRIBUTION

1. HRP Director's Office	22. P. R. Kasten	44. J. A. Swartout
Rm. 259, 9204-1	23. V. L. Kenyon	45. E. H. Taylor
2. G. M. Adamson	24. R. B. Korsmeyer	46. D. G. Thomas
3. S. E. Beall	25. K. A. Kraus	47. D. S. Toomb
4. E. G. Bohlmann	26. N. A. Krohn	48. W. E. Unger
5. E. S. Bomar	27. R. E. Leuze	49. R. VanWinkle
6. F. R. Bruce	28. M. I. Lundin	50. C. E. Winters
7. W. D. Burch	29. R. N. Lyon	51. F. C. Zapp
8. R. H. Chapman	30. W. L. Marshall	52. ORNL Document Ref.
9. R. D. Cheverton	31. J. P. McBride	Lib., Y-12
10. E. L. Compere	32. H. F. McDuffie	53. Central Research Lib.
11. J. S. Culver	33. H. M. McLeod	54-55. REED Library
12. D. G. Davis	34. R. A. McNees	56-57. Laboratory Records
13. D. E. Ferguson	35. O. Menis	58. F. C. Moesel, AEC
14. C. H. Gabbard	36. L. F. Parsly	Washington, D. C.
15. W. R. Gall	37. F. N. Peebles	59. M. J. Skinner
16. J. C. Griess	38. R. C. Robertson	60-66. Westinghouse PAR Project
17. P. H. Harley	39. A. M. Rom	67-81. TISE-AEC
18. P. N. Haubenreich	40. H. C. Savage	
19. J. W. Hill	41. C. L. Segaser	
20. G. H. Jenks	42. I. Spiewak	
21. S. I. Kaplan	43. R. W. Stoughton	

NOTICE

This document contains information of a preliminary nature and was prepared primarily for internal use at the Oak Ridge National Laboratory. It is subject to revision or correction and therefore does not represent a final report.

UNCLASSIFIED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

LEGAL NOTICE

This report was prepared as an account of Government sponsored work. Neither the United States, nor the Commission, nor any person acting on behalf of the Commission:

- A. Makes any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may not infringe privately owned rights; or
- B. Assumes any liabilities with respect to the use of, or for damages resulting from the use of any information, apparatus, method, or process disclosed in this report.

As used in the above, "person acting on behalf of the Commission" includes any employee or contractor of the Commission to the extent that such employee or contractor prepares, handles or distributes, or provides access to, any information pursuant to his employment or contract with the Commission.

REPORT ON RUN SM-3

Summary.....	1
Introduction.....	1
Discussion of Run.....	2
Thorium Distribution Studies.....	6
Corrosion Experience.....	8

Appendix

1. Alterations to the Loop after Run SM-2.....	13
--	----

LIST OF FIGURES

Figure 1	Pump Power, Flow and Head Measurements 0-500 Hr.....	21
Figure 2	Temperature and Pressure 0-500 Hr.....	22
Figure 3	Pump Power, Flow and Head Measurements 500-947 Hr.....	23
Figure 4	Temperature and Pressure 500-947 Hr.....	24
Figure 5	Slurry Distribution at 238 g Th/kg H ₂ O and 170°C.....	25
Figure 6	Slurry Distribution at 250 g Th/kg H ₂ O and 200°C.....	26
Figure 7	Slurry Distribution at 490 g Th/kg H ₂ O and 170°C.....	27
Figure 8	Slurry Distribution at 510 g Th/kg H ₂ O and 200°C.....	28
Figure 9	Typical Gamma Surveys.....	29
Figure 10	Build-up of Dissolved Iron Originating from Carbon Steel and Dissolved Stainless Steel During Run SM-3.....	30
Figure 11	Bottom of Blanket Showing Attack on Pressure Vessel.....	31
Figure 12	Slurry in Bottom of Blanket after Dump.....	32
Figure 13	Slurry on Top of Core after Dump.....	33
Figure 14	Lower Bearing Assembly.....	34
Figure 15	Type 300A Impeller after Run SM-3.....	35
Figure 16	Gamma Survey Installation on Slurry Blanket Test.....	36

LIST OF TABLES

Table I	Summary of Blanket Sampling Results.....	7
Table II	Summary of Analytical Data.....	17
Table III	Measurements on 300A Pump Serial No. 1-80F-455 Before and After Run SM-3.....	11

SUMMARY

Run SM-3 covered 947.4 hours of which 669.2 hours were on slurry. Behavior of the system with slurry concentrations of 200 and 400 g Th/l were explored. Modifications made to the loop since the end of run SM-2 gave a flow of 360 gpm vs 230 gpm previously, and the blanket inlet nozzles were cut down from 2" ID to 1-1/2" sch 80 pipe, giving a velocity of 35 ft/sec out of the nozzles. The slurry was found to be suspended apparently uniformly in the blanket under the operating conditions and also with the flow reduced to 300 gpm by reducing the alternating current frequency. A further reduction to 197 gpm appeared to give conditions similar to run SM-2,¹ with a much more marked concentration gradient in the blanket. The run was interrupted at 947.4 hr by a pump bearing failure.

INTRODUCTION

On the basis of the slurry suspension behavior found in run SM-2, it was concluded that more effective slurry suspension could be achieved by increasing the energy input to the blanket. Three changes were made which contributed to this effect: a) The nozzle size was reduced to increase the velocity through the nozzles for a given loop flow. b) The pump impeller diameter was increased, increasing both the head and flow from the pump. c) The loop piping was changed to reduce losses, thus tending to shift the operating point so as to increase flow. Run SM-3 was undertaken to investigate the effectiveness of slurry suspension in the revised loop. It was planned as an exploratory run, starting with water in the loop and gradually building up the slurry concentration. The objectives were to determine the feasibility of handling slurry at various concentrations in the HRT blanket and to find out if relatively uniform distribution could be maintained.

Description of the Run

The loop was started up on June 14, 1957 and was run without use of the loop heaters for 118 hours. Over this period it heated up slowly and the temperature ultimately reached 95°C. During this period calibration gamma surveys (See appendix for details of the gamma survey installation.) were made, and the sample system and the dump system were checked out. Then the temperature was raised to 170°C, more gamma surveys were taken; the temperature was raised to 200°C and the surveys repeated. An additional 160 hours were used in making gamma surveys at temperature and in straightening out some plugging trouble with the acid egg feed system.

Slurry feeding was started at 278 hr and loading of an initial charge of 337.3 kg of thorium was completed by 430 hr. During the charging period some difficulty was experienced in getting slurry into the "acid egg" and this was corrected by increasing the inlet valve size from $C_v = 0.16$ to $C_v = 1.5$. The loop operating conditions were held at 170°C and 290 psig until 570 hr. The calculated charge for this thorium loading and temperature is 230 g Th/kg H₂O. However, the circulating loop concentration was found by analysis to be 198 g Th/kg H₂O. During the period from 430 to 570 hr, samples were taken from the blanket and from the circulating loop and gamma surveys were made.

A brief pump stoppage occurred during this period when the pump fuses blew for no accountable reason. The pump was restarted 26 minutes after stopping, and the thorium was resuspended almost instantaneously.

Between 570 and 576 hr the loop was brought to 200°C, and it was held at 200°C until 635 hr while sampling was repeated. At 617 hr, the pump was shut down purposely for 45 minutes to observe settling and resuspension. On

shutdown, evidence of settling was shown on the gamma trace in 15 seconds and initial settling was complete in 2-3/4 minutes. The gamma survey equipment located the slurry-water interface quite easily, and the volume of the initial settled bed was estimated at 404 liters. The settled bed concentration, estimated from the volume and slurry charge was 770 g Th/l. A sample taken from the bottom of the blanket showed 830 g Th/l. On start-up, it is estimated that complete resuspension occurred within 20 seconds. Between 635 and 640 hr the temperature was reduced to 170°.

Between 640 and 767 hr, additional charging brought the thorium loading to 683 kg, corresponding to a concentration of 415 g Th/l (approximately 480 g Th/kg H₂O at 170; 490 g Th/kg H₂O at 200°). At 784 hr, the pump was shut down for 3-1/2 hours to complete electrical tie-ins to a variable frequency power source and to reset the high power alarms on the pump. (The initial settings were too low for the higher flow rates developed by the 5" impeller used during this run.)

During this shutdown, initial settling was found to occur in approximately 2 minutes. The interface was masked by the girth flange. As the shutdown continued, the bed compacted and concentrations were found to be as follows:

<u>Time</u>	<u>By gamma survey determination of bed height</u>	<u>By analyses of samples from lowest point</u>
2 min.	785 g Th/l	
1-1/2 hr	1050 g Th/l	
2 hr		1220 g Th/l
3	1220 g Th/l	
3-1/4 hr		1400 g Th/l

At the end of the shutdown, a normal start-up was obtained. The gamma survey head was placed above the girth flange, monitoring clear water. Evidence of slurry passing the head was observed 30 seconds after the pump was energized and normal attenuation for the head location was achieved in another 10 seconds.

The loop was held at 170°C until 830 hr and a complete round of samples was taken. Between 831 and 837 hr the temperature was again brought to 200°C. Another complete round of samples was taken at 200°. The loop was shut down again, this time for 5-1/2 hours at 925 hr. The shut-down was for the purpose of installing ammeters and a frequency meter in the pump power supply. The loop was ready to start after 1-1/4 hours, and the additional delay was due to difficulty in raising pressure. Ultimately it was found that the condensate tank vent valve had not been closed tight after venting the tank and the resultant heavy demand on the pressurizer heaters caused the difficulty in maintaining pressure. More settling data were obtained early in the shutdown. The initial settled bed again was about 800 g Th/l with subsequent compaction to 945 g Th/l after 30 minutes and 1170 g Th/l after 1 hour.

Variable frequency operation was started at 940.3 hr and the pump was run at 49 cycles from 940.3 to 944.3 hr then at 40 cycles from 944.3 to 946.8 hr. Results of the variable frequency operation are tabulated below:

	60 cycles	49 cycles		40 cycles	
		Predicted from 60 cycle	Measured	Predicted from 60 cycle	Measured
Loop Flow	379 gpm	309 gpm	297 gpm	253 gpm	197 gpm
Pump Head	53 ft	36.3 ft	36.9 ft	23.5 ft	18.4 ft
Blanket loss	38.8 ft	25.8 ft	26.2 ft	15.1 ft	11.5 ft
Blanket inlet loss	21.4 ft	14.3 ft	13.4 ft	6.4 ft	3.5 ft
Pump Power	12.54 kw	--	8.0 kw	--	4.4 kw
Pump Internal Coolant Flow	81.5%	66.5%	64.8%	54.3%	45%
RPM inferred from internal coolant flow	3500	2860	2780	2330	1935

At 40 cycles the variable frequency generator would only produce 350 volts and the low flow indicates much increased motor slip due to the reduced voltage.

Gamma surveys at 49 cycles showed the same transmission pattern as at 60 cycles, indicating no significant change in the slurry distribution; at 40 cycles there was a noticeable change. Samples taken at 40 cycles showed a definite gradient from the top to the bottom of the blanket, and a reduction in circulating loop concentration.

At 947.4 hr, the pump froze and the run had to be terminated. Examination of the pump showed a longitudinal crack in the lower journal. The journal has been submitted to the metallurgy group for study. To date, the cause of failure has not been determined.

After the pump stopped, it was approximately 45 minutes before the loop was started dumping. The delay was caused in part because it was first necessary to determine that the pump stoppage was not due to blown fuses. The loop

was dumped for 4 minutes, removing approximately 50% of the liquid inventory. The balance of the loop was dumped the following morning, approximately 16 hours after the initial dump. At the end of the dump a slurry bed approximately 12-1/2 in. deep was left in the bottom of the pressure vessel. This had a volume of approximately 220 liters. The concentration was 1500 g Th/l so that the bed contained 332 kg of thorium or almost half the loop charge.

Figures 1-4 present graphically the history of certain of the loop operating variables with time. In the case of readings which are recorded in terms of head, such as the flow and the various head measurements, density corrections have been applied based on the temperature and the thorium charge.

Slurry Distribution Studies

Distribution of the thorium in the system was studied in two ways: by sampling and by gamma surveys. Complete sets of samples were obtained at temperatures of 170°C and 200°C and at thorium loadings of 250 g Th/kg H₂O and of 500 g Th/kg H₂O. The results of these samplings are presented in Figures 5-8 and are summarized in Table I.

Although the results are quite scattered, the following conclusions seem justified:

1. There was a vertical concentration gradient of 10-20%.
2. There may have been a radial concentration gradient of approximately 5%.

The gamma surveys were utilized during the run largely to look for gross variations in the slurry distribution. Some typical survey results are shown in Figure 9. The shape of the curves obtained with circulating slurry and water is a function of the vessel construction and possibly of the survey

Table I

SUMMARY OF BLANKET SAMPLING RESULTS

Test No.	Date	Run Hr.	Temp.	Concentration Calculated from Charge g Th/kg H ₂ O	Concentration in Circulating Loop g Th/kg H ₂ O	Concentration in blanket Overall avg. based on sp. gr. g Th/kg H ₂ O	Concentration in blanket Overall avg. based on Chem. Analysis g Th/kg H ₂ O
1	7/3	455	170	229	206	143	---
2	7/9	590	200	238	164	148	160
3	7/18	800	170	477	485 (433)	342	351
4	7/22	900	200	495	440	367	---

Table I (continued)

Test No.	Radial Thorium Distribution			Vertical Thorium Distribution			
	Samples at outer wall	Samples 6" into blanket	Samples 12" into blanket	55° above center	30° above center	30° below center	55° below center
	g Th/kg H ₂ O	g Th/kg H ₂ O	g Th/kg H ₂ O	g Th/kg H ₂ O	g Th/kg H ₂ O	g Th/kg H ₂ O	g Th/kg H ₂ O
1	133	170	118	131	134	168	163
2	183	147	148	132	165	160	169
3	353	358	340	322	315	339	390
4	375	362	364	363	363	340	402

track installation. The girth flange accounts for the dip in the center of the scans. It has not been possible to account for the drop-off found at the ends of the track.

Attempts have been made to estimate the slurry concentration from the relative transmission through slurry and water. However, it has been determined that the emission from the thorium and its daughter products constitutes a significant fraction (10-20%) of the signal received and that it will be necessary to have surveys with the source removed to obtain quantitative results.

The gamma surveys therefore have been useful primarily in establishing that under the flow conditions used in this run, there was no bed of dense slurry at the bottom of the vessel while the pump was running. During the several periods when the pump was shut down, the survey equipment proved valuable in locating the slurry-water interface in the pressure vessel. Except when the interface was in the girth flange area, the inner and outer edges of the settled bed could be located and in all cases the height of these points as determined from the survey head position agreed with each other within one inch or better.

Corrosion Experience

Figure 10 shows the build-up of corrosion products in the loop as determined by analysis of samples withdrawn during the run. The stainless steel corrosion was determined from the build-up of chromium in the slurry. The carbon steel rate was determined by correcting the iron in the slurry for iron picked up from stainless steel. Each point represents the average of at least three samples from different locations taken at approximately the same time.

As with run SM-2, examination of the loop after the run indicated that generalized corrosion rates are rather meaningless. Much of the carbon steel

came from rather limited areas in the pressure vessel in which rates of approximately 0.5 in. per year apparently occurred. The heavily attacked areas were located in the bottom of the vessel in the region where the high-velocity stream from the inlet nozzles would be expected to impinge on the vessel wall. Figure 11 shows the attack on half of this region.

In the case of the stainless steel, approximately 60% of the total pick-up came from the impeller. It is interesting to note that much of the attack appeared to occur during the final 150 hours of the run.

Coupon corrosion specimens were installed in the loop piping between the pressurizer and pressure vessel and stressed specimens were installed in the pressurizer, so placed that one set would normally be just below the vapor-liquid interface and one set just above. The specimens exposed were type 347 stainless steel, RC-55 titanium, zircaloy-2 and A-212 grade B steel in the in-line holder and type 347 stainless, AM-350 stainless, zircaloy-2 and titanium AV (6% Al, 4%V) in the stress specimen holder. The results are given in a separate report.² In general, only the carbon steel was appreciably corroded; this was attacked at a rate of 500 mpy.

Particle Degradation or Growth

Particle size determinations were made on samples taken from the loop at various times during the run, starting at 450 hr, after the loading to the initial target concentration of 250 g Th/kg H₂O was complete. No significant variation in particle size was found, as indicated by the mean values shown in Table II. In addition, microscope slides were prepared and examined. The slides prepared from samples taken at the very end of the run showed a few

very large (15-20 μ) particles but it is not clear these were spheres and the particle size analyses apparently do not confirm the presence of a significant number of large particles.

Examination of the Loop After Shutdown

As soon as the loop was shut down and cooled an inspection port was opened on the pressure vessel. Figures 12 and 13 show the appearance of the slurry in the bottom of the blanket and on tip of the core tank, respectively. By the time the photograph could be taken, the slurry on top of the core had dried; initially this slurry appeared as a thin layer of concentrated slurry which appeared to have settled onto the core surface.

The pump was taken out and disassembled shortly thereafter. Examination of the pump and connecting lines showed no evidence of caking. The pipe walls were free of any adherent slurry film. Accumulations of slurry in the pump--in the O-ring groove provided in the stator for room-temperature tests and on top of the thermal barrier--were quite fluid.

When the pump was taken out, the rotor was frozen tight and could neither be rotated or moved axially. After removing the impeller, top plug and top bearing assembly, it was possible to drive the rotor out by tapping gently with a plastic hammer. When this was done, the lower journal remained in the pump and a crack perhaps 1/32 in width could be seen running the length of the journal.

Figures 14 and 15 show the appearance of the lower bearing assembly and the impeller at the end of the run. Table III shows the measurements made on assembly of the pump prior to the run and after shutdown. This shows that the impeller had a substantial weight loss due to the abrasive attack experienced. The thrust runner had worn appreciably, but the radial bearings were still practically untouched.

Table III

MEASUREMENTS ON 300A PUMP, SERIAL NUMBER 1-80F-455BEFORE AND AFTER RUN SM-3

<u>Date</u>	<u>4/11/57</u>	<u>7/26/57</u>
Operating hours on water	0	278.6
Operating hours on slurry	0	669.2
Total operating hours	0	947.8
End play	0.034"	---
Height of graphitar on thrust runner	0.067"	.049
O.D. of stellite on lower journal	1.500"	---
I.D. of graphitar on lower radial bearing	1.5035"	1.505"
O.D. of stellite on upper journal	1.500"	1.500"
I.D. of graphitar on upper radial bearing	1.504"	1.503"
O.D. of shaft sleeve at labyrinth	1.500"	1.500"
I.D. of labyrinth	1.5075"	1.508"
O.D. of top impeller hub	2.86"	2.871"
I.D. of labyrinth	2.885"	2.887"
I.D. of wear rings	3.248"	3.263"
O.D. of impeller	5.0"	4.991"
Weight of impeller, g	1747.2	1644.9

Conclusions

This run demonstrated that slurry of up to 400 g Th/l can be handled in a vessel of the HRT configuration using a flow rate of 360 gpm and 1-1/2 in. inlet nozzles if completely uniform dispersion is not required. Limited operation at reduced frequency indicated that a flow rate of 300 gpm would perhaps be adequate but that 197 gpm is too low. Much additional work at reduced frequency is needed to define the limits of satisfactory operation.

Observations made with the gamma survey apparatus with the pump stopped indicate that the rapid settling found for concentrations below 800 g Th/l may lead to rapid reactivity increase in a two-region reactor. This may give a lower limit of slurry concentration for a reactor blanket.

The experience in dumping the loop both at the end of this run and at the end of the preceding run indicates that some means of preventing formation of the heavy compacted slurry bed is needed with this design of blanket vessel, in order to permit complete dumping of the system.

APPENDIX I

Alterations Made to System Prior to Present Run

A detailed description of the slurry blanket test system up to the start of run SM-2 is given in the run SM-2 report.¹ As a result of the experience gained during run SM-2 a number of changes were made. These are described below.

Blanket Scanning Facilities

Since it appeared that useful results were obtained from measurements of the gamma ray absorption in the blanket, facilities for scanning the blanket were substantially extended. A semicircular track with a mechanical drive for the dolly carrying the scintillation head was set on a great circle inclined approximately $17-1/2^{\circ}$ to the vertical and oriented roughly north-northeast as the equator of the vessel. The location was selected to avoid inspection ports and supporting structure on the pressure vessel. The drive reduction ratio was set to give a head speed of approximately 8 in. per minute. In addition, manual survey tracks were placed east-southeast and west-southwest on the upper hemisphere and south-southeast and south-southwest on the lower hemisphere. The scintillation head output was fed through appropriate amplifying equipment to a standard millivoltmeter recorder so that the results were automatically recorded, and in the case of the mechanical drive track a transmission profile was automatically obtained as the head traveled from the top to the bottom of the vessel and vice-versa. A general view of the installation is shown in Figure 16:

Blanket Sampling Facilities

In order to obtain more information than had been previously available on the slurry distribution in the blanket, the blanket sampling facilities were

expanded appreciably. The pressure vessel has twelve hand holes arranged in four rows of three. Three sample connections were installed in each of the twelve flanges closing these ports. One is flush with the outer wall; a second extends inward 6", and the third, 12". These are manifolded together with suitable valving and brought out through a common let-down cooler. In this way, it was hoped that either radial or vertical concentration gradients, if they existed, could be observed.

Blanket Inlet Nozzles

It was concluded that slurry suspension in run SM-2 was inadequate. Since earlier tests on an 18" model at temperatures up to 170°C had indicated adequate suspension, it was felt that by changing the scale-up method, it should be possible to duplicate the performance in a larger system. The original scale-up had been based on maintaining the same upward velocity at the vessel equator. Since the problem involved seemed analogous to obtaining uniformity in an agitated tank, it was decided to try scaling in accordance with mixing criteria. An accepted scaling factor for mixing is application of equal power per unit of volume, and it was assumed that the kinetic energy developed in the blanket inlet nozzles would represent the energy expended for mixing in the blanket. Therefore the nozzle size was reduced to give greater velocity through the nozzles. The nozzles finally installed were 1-1/2 in. sch 80 long radius ells. The center of the ells is approximately 1-3/4 in. above the inner wall of the vessel. The nozzle orientation was left unchanged; the nozzles are installed to give clockwise rotation looking down and are rotated 30° inward from the tangent at the nozzle.

Circulating Pump

The circulating pump was reassembled for the present run with a 5 in. diameter stainless steel impeller, giving a substantial capacity increase over the original 230 gpm impeller. The pump was found to give 350 gpm at 56 ft on room temperature water.

A vent tank was installed on top of the pump to permit venting gas without drawing slurry from the loop into the pump motor during venting. The tank is arranged so that it can be prefilled with water and pressurized. Then the tank is valved to the pump and any gas in the pump flows into the vent tank and displaces water from the tank. The tank is then isolated from the pump and the gas is let down.

A variable frequency power supply was connected so that the pump could be supplied with 40 to 70 cycle variable frequency power as well as with 60 cycle fixed frequency power.

Flow Metering Nozzle

In order to avoid the attack previously experienced, the nozzle throat diameter was increased to 2.05 in., giving a velocity of 29.3 ft/sec at 300 gpm and 35 ft/sec at 360 gpm.

Instrument Changes

The differential pressure cell measuring level in the condensate tank was relocated. In the new arrangement, the reference leg is at the top of the purge condenser and the variable leg is at the bottom of the condensate tank. The level range is such that the liquid level is indicated even when the

interface is located in the condenser.

In addition, three conductivity-type level probes were installed in the condensate tank.

A differential pressure cell was installed across the circulating pump to measure head. Also a differential pressure cell was installed across the blanket inlet nozzles.

The ranges of the various d/p cells were changed as required for the anticipated operating conditions.

Table II

ANALYTICAL RESULTS - RUN SM-3

Sample Designation	Run Hr	Sample Location	SLURRY ANALYSIS				Sulfate ppm based on Thorium	pH	Mean Particle Size Microns
			Thorium g/kg H ₂ O	Iron ppm	Chromium ppm	Nickel ppm			
J-13	304	Circulating loop	48	39	<5	<5	---	---	---
K-13	304	Circulating loop	55	32	<5	<5	---	---	---
11A-19	450	Sphere-top level	198	215	15	8	---	---	---
12B-19	450	Sphere-second level	85	94	6	<5	---	---	---
22A-19	450	Sphere-second level	215	213	15	8	--	--	---
13B-19	450	Sphere-top level	135	98	7	6	3050	5.8	1.1
31B-19	450	Sphere-third level	160	162	9	8	4000	5.0	1.7
22C-19	450	Sphere-second level	145	129	8	7	5250	5.2	1.1
A-21	495	Circulating loop	195	221	14	8	---	5.1	1.4
J-21	495	Circulating loop	195	216	14	10	3310	5.2	1.3
K-21	495	Circulating loop	190	219	14	10	3870	5.1	0.95
B-21	495	Pressurizer bottom	---	---	---	---	---	---	---
C-21	495	Pressurizer top	---	---	---	---	---	---	---
41A-25	591	Sphere-lowest level	190	239	13	10	4090	4.6	1.35
32B-25	591	Sphere-third level	130	164	7	7	4290	4.6	1.20
21C-25	591	Sphere-second level	70	97	<5	<5	4650	---	1.05
A-26	613	Circulating loop	197	245	15	11	3860	5.7	0.95
B-26	613	Pressurizer bottom	0.4	---	---	---	---	---	---
J-26	613	Circulating loop	162	217	10	9	3880	5.5	1.15
K-26	613	Circulating loop	148	203	11	14	4230	5.9	1.20
41A-26	613	Sphere-lowest level	1020*	750	44	29	3880	6.0	1.40

* Settled bed.

Table II. ANALYTICAL RESULTS - RUN SM-3 (continued)

Sample Designation	Run Hr	Sample Location	SLURRY ANALYSIS				Sulfate ppm based on Thorium	pH	Mean Particle Size Microns
			Thorium g/kg H ₂ O	Iron ppm	Chromium ppm	Nickel ppm			
32B-26	613	Sphere-third level	17	41	14	<5	---	4.3	---
41B-34	802	Sphere-lowest level	380	358	23	9	3950	6.0	1.2
12C-34	802	Sphere-top level	355	341	21	10	3820	5.9	1.0
31C-34	802	Sphere-third level	410	385	26	13	3890	6.0	1.15
A-35	822	Circulating loop	590	488	33	15	3530	5.9	1.0
B-35	822	Pressurizer bottom	---	---	---	---	---	---	---
C-35	822	Pressurizer top	---	---	---	---	---	---	---
J-35	822	Circulating loop	420	378	21	12	3410	5.9	1.4
K-35	822	Circulating loop	445	409	23	16	3990	5.9	1.15
22C-39	901	Sphere-second level	400	437	20	14	3830	5.8	---
13B-39	901	Sphere-top level	290	342	15	11	3980	5.9	0.9
42A-39	901	Sphere-bottom level	515	505	22	13	3890	6.1	1.3
A-40	920	Circulating Loop	440	477	25	13	3560	5.9	---
B-40	920	Pressurizer bottom	---	---	---	---	---	---	---
C-40	920	Pressurizer top	---	---	---	---	---	---	---
D-40	920	Back of pump	---	---	---	---	---	---	---
J-40	920	Circulating loop	470	419	22	15	3530	5.8	---
K-40	920	Circulating loop	410	490	23	17	3670	5.8	1.05

Table II. ANALYTICAL RESULTS - RUN SM-3 (continued)

<u>Sample Designation</u>	<u>Sulfate ppm</u>	<u>Chloride ppm</u>	<u>Conductivity mho/cm x 10²</u>	<u>pH</u>
J-13	---	---	---	---
K-13	---	---	---	---
11A-19	---	---	---	---
12B-19	---	---	---	---
22A-19	---	---	---	---
13B-19	13	---	8.1	6.6
31B-19	13	<2	7.5	5.8
22C-19	14	<2	8.0	5.8
A-21	17	<2	8.6	5.8
J-21	20	<2	9.7	5.8
K-21	14	<2	8.5	5.9
B-21	10	4	33.0	5.4
C-21	43	9	6.0	5.8
41A-25	12	<2	7.2	6.0
32B-25	11	<2	6.1	6.2
21C-25	11	3	6.9	5.7
A-26	15	<2	7.7	5.9
B-26	12	5	4.3	5.1
J-26	15	2	7.5	5.6
K-26	13	2	7.2	5.9
41A-26	22	<2	11	7.4
32B-26	8	<2	4.5	6.0
41B-34	17	<2	9.6	6.3
12C-34	15	<2	9.3	6.3
31C-34	15	<2	9.6	6.3
A-35	16	<2	10.0	6.3
B-35	9	3	6.5	5.4
C-35	44	6	27.0	5.9
J-35	16	4	9.8	6.3
K-35	17	3	9.9	6.2

Table II. ANALYTICAL RESULTS - RUN SM-3 (continued)

<u>Sample Designation</u>	<u>Sulfate ppm</u>	<u>Chloride ppm</u>	<u>Conductivity mho/cm x 10⁵</u>	<u>pH</u>
22C-39	15	<2	9.0	6.3
13B-39	13	<2	8.4	6.2
42A-39	16	<2	9.2	6.1
A-40	24	--	10.0	6.3
B-40	12	<2	4.9	5.3
C-40	29	4	23	5.8
D-40	<5	<2	2.7	4.8
J-40	15	--	9.2	6.0
K-40	20	--	9.5	6.2

20 X 20 TO THE INCH 359.10 1/2 LG
KEUFFEL & ESSER CO. MADE IN U. S. A.

Fig. 1

ORNL-IA-70-25339
ENCLOSURE I

20 X 20 TO THE INCH 359-10 1/2 LG
KEUFFEL & ESSER CO. MADE IN U.S.A.

Temperature and Pressure 500-947 Hr

Fig. 4

CONFIDENTIAL
UNCLASSIFIED

25

RUN No. SM-3

SAMPLING PERIOD.

DATE 7/3/57 - 7/5/57

RUN Hrs. 450 to 492

THORIUM CHARGE 350 Kg.

CALCULATED CONCENTRATION 238 gth/kg H₂O

SYSTEM Pr. 270 PSIG

SYSTEM Temp. 170 °C

SLURRY BLANKET TEST

RESULTS OF BLANKET
SAMPLING

TD-B-3242

26

RUN No. 5M-3

SAMPLING PERIOD.

DATE 7/9/57

RUN Hrs. 586 to 592

THORIUM CHARGE 350 Kg.

CALCULATED CONCENTRATION 246 gth/kg H₂O

SYSTEM Pr. 318 PSIG

SYSTEM Temp. 200 °C

SLURRY BLANKET TEST

RESULTS OF BLANKET
SAMPLING

TD-B-3242

RUN No. 514-3

SAMPLING PERIOD.

DATE 7/18/57

RUN Hrs. 798 to 803

THORIUM CHARGE 216 Kg.

CALCULATED CONCENTRATION 500 gth/kg H₂O

SYSTEM Pr. 290 PSIG

SYSTEM Temp. 170 °C

SLURRY BLANKET TEST

RESULTS OF BLANKET

SAMPLING

TD-B-3242

RUN No. SM-3

SAMPLING PERIOD.

DATE 7/22/57

RUN Hrs. 893 to 899

THORIUM CHARGE 710 Kg.

CALCULATED CONCENTRATION 520 gth/kg H₂O

SYSTEM Pr. 318 PSIG

SYSTEM Temp. 200 °C

SLURRY BLANKET TEST

**RESULTS OF BLANKET
SAMPLING**

TD-B-3242

PHOTO 29382
UNCLASSIFIED

LOOP TEMP. 200 °C

Fig. 9 - Typical Gamma Surveys

PHOTO 29382
UNCLASSIFIED

LOOP TEMP. 200 °C

Fig. 9 - Typical Gamma Surveys

EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO 340 -20 DIETZGEN GRAPH PAPER
20 X 20 PER INCH

Total Pick-up in Slurry - Grams

• Iron from carbon steel
△ Stainless steel

Build-up of Dissolved Iron Originating from Carbon Steel
and Dissolved Stainless Steel During Run SM-3

Fig. 10

PHOTO 29459
UNCLASSIFIED

Fig. 11. - Bottom of Blanket Showing Attack or Pressure Vessel

Fig. 12 - Slurry in Bottom of Blanket After Dump

PHOTO 29452
UNCLASSIFIED

Fig. 13 - Slurry on Top of Core After Dump

UNCLASSIFIED
PHOTO 29447

Fig. 14. Lower Bearing Assembly.

PHOTO 29450
UNCLASSIFIED

Fig. 15 - Type 300A Impeller After Run SM-3

UNCLASSIFIED
PHOTO 29331

Fig. 16. Gamma Survey Installation on Slurry Blanket Test.