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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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5 Proj /Prog /Dept /Div: AZ-101 Mixer Pump Test	6 Design Authority/Design Agent/Cog Engr: G T MacLean	7 Purchase Order No: N/A
8 Originator Remarks: This EDT is for document approval and release		9 Equip /Component No: AZ-101 Mixer Pump DAS
		10 System/Bldg /Facility: 241-AZ
		12 Major Assm Dwg No
11 Receiver Remarks	11A Design Baseline Document? ○ Yes ◉ No	13 Permit/Permit Application No: N/A
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1	RPP-5644		0	Mt Fury Suspended Solids Profiler - Application and Testing	SQ	1		

16 KEY

Approval Designator (F)	Reason for Transmittal (G)	Disposition (H) & (I)
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17 SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)

(G) Reason	(H) Disp	(J) Name	(K) Signature	(L) Date	(M) MSIN	(G) Reason	(H) Disp	(J) Name	(K) Signature	(L) Date	(M) MSIN
1	1	Design Authority GR Tardiff	[signature] for	01/05/00	S5-05	1	1	JR Bellomy	[signature] PDR	1/4/00	R1-56
1	1	Design Agent GT MacLean	MW Manderbach for GTM	1/3/00	B1-70	1	1	TW Staehr	[signature]	1/4/99 00	R3-74
1	1	Cog Eng WD Winkelman	[signature]	1/05/00	S5-05	3	N/A	MW MANDERBACH			G3-15
1	1	Cog Mgr DW Reberger	[signature] for DWR	1/5/00	S5-15	3	N/A	SUE ST MARY			G3-15
1	1	QA WL Adams	WL Adams	1/6/00	S5-15						
1	1	Safety RJ Fogg	Pamela Claridal for RJF	1/6/99	S5-12						
X	X	Env N/A									

18 MW Manderbach 1/3/00 — Signature of EDT Originator, Date	19 NA — Authorized Representative for Receiving Organization, Date	20 per Telecon G R Tardiff 1-6-00 — Design Authority/Cognizant Manager, Date	21 DOE APPROVAL (if required) Ctrl No ____ ○ Approved ○ Approved w/comments ○ Disapproved w/comments

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AZ-101 mixer pump test

MT FURY SUSPENDED SOLIDS PROFILER APPLICATION & TESTING

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FLUOR FEDERAL SERVICES
Richland WA 99352
U S Department of Energy Contract DE AC06 96RL13200

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Key Words Suspended solids profiler,AZ-101, mixer pumps, radiation testi ng, calibration

Abstract Describes the radiation testing and calibration of the AZ-101 ta nk suspended solids profiler unit mounted on 6 tank riser 24A

1/6/00

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RPP-5644 Rev 0

MT FURY SUSPENDED SOLIDS PROFILER

APPLICATION AND TESTING

FLUOR FEDERAL SERVICES

Mt Fury Suspended Solids Profiler – Application and Testing

Introduction

The Mt Fury Suspended Solids Profiler (SSP) is a microprocessor-controlled instrument that measures the turbidity of solid-liquid suspensions and sludges The profiler is used commercially for the monitoring and control of clarifiers and thickeners in waste treatment, mining, pulp and paper, and other industrial processing facilities The instrument includes a three inch diameter probe, a Kynar coated coaxial cable, a reel assembly with a clutch and drive shaft, a stepper motor, and electronics The instrument measures insoluble or suspended solids content in liquids by transmitting infrared energy at a wavelength of 935 nm and measuring the extent of backscatter This frequency is not affected by solution color There are two detectors that allow the instrument to operate over a broad range of concentrations, from clear liquids to light sludges

For use in Hanford storage tanks, the profiler has been modified so that the reel assembly is in a glove box, isolated from the stepper motor and electronics, which are in a NEMA 4 enclosure The reel shaft passes through a seal and is connected to the motor shaft with a coupling The probe, cable, clutch, and reel are exposed to the tank environment but the other parts of the instrument are not The glove box is designed so the probe can be easily replaced by disconnecting the coaxial cable on top of the probe A block valve and a washing assembly with four spray nozzles have been fabricated with the necessary piping to fit between the profiler and a six-inch tank riser flange

The profiler assembly was originally purchased to measure supernatant clarity during a decant and refill demonstration test planned for 1994 This test was cancelled The current plan is to use the profiler during the Tank AZ-101 mixing pump testing for determining suspended solids distribution in the liquid, and as one of several measurements of the sludge interface level This is the only instrument available for measuring the relative liquid suspended solids concentration

A variety of tests were performed to determine the suitability of the profiler for use in nuclear waste storage tanks These included radiation testing of lens materials and the probe electronics as well as performance tests in simulated wastes and full scale installations The tests are described in the following sections

Radiation Testing

The probe lens material and the entire probe were tested for radiation resistance by exposing them to a Cobalt-60 source and measuring the effect The entire probe is cast in epoxy resin, including the window in the profiler probe through which the infrared beam passes The manufacture of the instrument, Mt Fury Co provided several lens samples with different epoxy formulations to test for radiation coloring The transmittance of the samples in a range from above to below 935 nm was measured by scanning the samples with a spectrophotometer The results at 935 nm are shown in the following table

Sample Number	Catalyst Number	Titanium Dioxide Fill	Gamma Radiation Dose	Transmittance Before Radiation	Transmittance After Radiation
1	18	Unfilled	100,000 R	15%	17%
2	70	Unfilled	100,000 R	9 5%	10%
3	18	12 wt %	100,000 R	1 2%	1 2%
4	70	12 wt %	100,000 R	2 2%	2 1%
5	18	12 wt %	750,000 R	19%	1 1%
6	50% 18/50% 70	12 wt %	750,000 R	12%	1 0%

Little change in transmittance was evident after 100,000 R of gamma radiation, but after 750,000 R significant darkening of the sample and a substantial decrease in transmittance was observed How much radiation beyond 100,000 R is tolerable was not determined

Radiation testing of the whole probe itself was carried out in the Bldg 326 gamma test facility operated by PNNL This facility has a number of tubes into which an item can be lowered to give a wide range of dose strengths over any duration Three series of test were performed (1) short-term tests to determine immediate effects at various dose rate levels, (2) longer duration tests at high fixed dose rates, and (2) longer duration tests at lower fixed dose rates The first tests showed no effects from short-term exposures up to 2000 R/hr During the second set irreversible damage to the probe occurred during the test at a level of 550,000 R/hr for one hour The results of these two series of tests are contained in the attached letter "Effect of Gamma Radiation on IR Probe of Suspended Solids Meter (SSM)" by Sharad P Pednekar, dated September 29, 1993

The third series of tests was commissioned after it was found the probe could not tolerate 550,000 R Another probe was obtained from the manufacturer for this series of tests Unfortunately, there is no written record available of the results, but the recollection is that the probe was expected to survived about 100,000 to 200,000 R Dan Pope, president of Mt Fury, believed the damage was to the power supply contained in the probe He did not feel the light emitting diode source was being damaged by the radiation

Conclusion

The Mt Fury Suspended Solids Profiler will have a limited life in radiation environments For this reason, the installation has been designed so the probe can be easily replaced by disconnecting the cap and connecting a new probe, or by replacing the cable and probe together by disconnecting the BNC-type connector at the reel At the time the Profiler was being tested, BTG, Inc was the only other known manufacturer of a similar profiling instrument (in fact, Dan Pope, a physicist, was a former employee of BTG) Their probe was tested and found to have about the same life in the radiation environment as the Mt Fury Profiler The SSP should provide a good indication of the relative clarity of tank wastes, but will need to be monitored for deterioration due to radiation damage

MSIN P8-44
376-8228
September 29, 1993

Jack Dowell
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SUBJECT **EFFECT OF GAMMA RADIATION ON IR PROBE OF SUSPENDED SOLIDS METER (SSM)**

The tests that you requested to be performed on the SSM have been completed, and the present document is our final report on those tests

A brief description of procedures followed in each type of test and complete results are given below

1 **Pre-Test Calibration** The calibration was performed after verifying that the unit raised or lowered the probe to the appropriate levels set using WATER LEVEL and DEPTH OF WATER controls As per your instructions, the probe was then lowered and immersed into a 4000 NTU solution, the dipswitches were set to the CALIBRATION mode, and the output current was measured The current was 12 7 mA indicating that the unit was working satisfactorily

2 **Pre-Irradiation Tests** As per your instructions, the SSM unit was then placed in the DIAGNOSTIC mode (Manual control in STOP position, dipswitches set appropriately) and the voltages V_{L1} and V_{R32} were measured with the top three dipswitches placed alternately in closed or open position in each of eight possible combinations and the probe still in 4000 NTU solution The readings obtained using Fluke® models 70 and 8060A hand-held digital multimeters are shown in Table 1

3 **Measurements under Radiation** In the next set of measurements, the probe was lowered into different tubes above the gamma radiation source to subject it to increasing strengths of gamma radiation Voltages were measured as before, with the probe suspended in air inside the tube and the SSM unit in DIAGNOSTIC mode Measurements made under these conditions are given in Tables 2 through 7

TABLE 1 Voltage Measurements with SSM in Diagnostic Mode and Probe in 4000 NTU Solution

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	Switch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	0	0 276	0 246
OPEN	OPEN	SHUT	0	0 276	1 240
OPEN	SHUT	OPEN	0	0 276	1 227
OPEN	SHUT	SHUT	0	0 276	5 440
SHUT	OPEN	OPEN	0	0 458	1 460
SHUT	OPEN	SHUT	0	0 460	5 490
SHUT	SHUT	OPEN	0	0 460	5 480
SHUT	SHUT	SHUT	0	0 460	5 590

TABLE 2 Voltage Measurements Under Gamma Radiation, Diagnostic Mode, Probe in Air, Tube 29A, 8 mrad/hour

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	Switch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	0 008	0 858	0 127
OPEN	OPEN	SHUT	0 008	0 860	0 641
OPEN	SHUT	OPEN	0 008	0 860	0 636
OPEN	SHUT	SHUT	0 008	0 860	3 200
SHUT	OPEN	OPEN	0 008	0 460	0 030
SHUT	OPEN	SHUT	0 008	0 460	0 146
SHUT	SHUT	OPEN	0 008	0 460	0 144
SHUT	SHUT	SHUT	0 008	0 460	0 718

TABLE 3 Voltage Measurements Under Gamma Radiation, Diagnostic Mode, Probe in Air, Tube 34A, 3 in from bottom, 106 rad/hour

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	Switch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	106	0 854	0 097
OPEN	OPEN	SHUT	106	0 854	0 490
OPEN	SHUT	OPEN	106	0 854	0 490
OPEN	SHUT	SHUT	106	0 854	2 46
SHUT	OPEN	OPEN	106	0 460	0 023
SHUT	OPEN	SHUT	106	0 460	0 115
SHUT	SHUT	OPEN	106	0 460	0 115
SHUT	SHUT	SHUT	106	0 460	0 572

TABLE 4 Voltage Measurements Under Gamma Radiation, Diagnostic Mode, Probe in Air, Tube 31A, 5 in from bottom, 199 rad/hour

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	Switch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	199	1 180	0 155
OPEN	OPEN	SHUT	199	1 185	0 784
OPEN	SHUT	OPEN	199	1 186	0 780
OPEN	SHUT	SHUT	199	1 190	3 92
SHUT	OPEN	OPEN	199	0 461	0 0185
SHUT	OPEN	SHUT	199	0 461	0 0923
SHUT	SHUT	OPEN	199	0 461	0 091
SHUT	SHUT	SHUT	199	0 461	0 458

TABLE 5 Voltage Measurements Under Gamma Radiation, Diagnostic Mode, Probe in Air, Tube 35A, 3 in from bottom 520 rad/hour

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	witch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	520	1 253	0 106
OPEN	OPEN	SHUT	520	1 253	0 531
OPEN	SHUT	OPEN	520	1 253	0 528
OPEN	SHUT	SHUT	520	1 253	2 660
SHUT	OPEN	OPEN	520	0 462	0 053
SHUT	OPEN	SHUT	520	0 462	0 267
SHUT	SHUT	OPEN	520	0 462	0 266
SHUT	SHUT	SHUT	520	0 462	1 326

TABLE 6 Voltage Measurements Under Gamma Radiation, Diagnostic Mode, Probe in Air, Tube 33A, 3 in from bottom, 990 rad/hour

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	Switch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	990	0 572	0 106
OPEN	OPEN	SHUT	990	0 572	0 531
OPEN	SHUT	OPEN	990	0 572	0 528
OPEN	SHUT	SHUT	990	0 572	2 660
SHUT	OPEN	OPEN	990	0 459	0 053
SHUT	OPEN	SHUT	990	0 459	0 267
SHUT	SHUT	OPEN	990	0 459	0 266
SHUT	SHUT	SHUT	990	0 459	1 326

TABLE 7 Voltage Measurements Under Gamma Radiation, Diagnostic Mode, Probe in Air, Tube 27A, 3 in from bottom 2050 rad/hour

Dipswitch Setting			Dose Rate, rad/hour	Measurement, V	
Switch 1	Switch 2	Switch 3		V_{L1}	V_{R32}
OPEN	OPEN	OPEN	2050	1 092	0 138
OPEN	OPEN	SHUT	2050	1 092	0 691
OPEN	SHUT	OPEN	2050	1 092	0 689
OPEN	SHUT	SHUT	2050	1 092	3 460
SHUT	OPEN	OPEN	2050	0 462	0 019
SHUT	OPEN	SHUT	2050	0 462	0 099
SHUT	SHUT	OPEN	2050	0 462	0 098
SHUT	SHUT	SHUT	2050	0 462	0 493

The total radiation dose experienced by the SSM probe during the tests describe above was calculated to be 476 rad based on the radiation fluxes and exposure times in each tube

4 Cumulative Dose Tests The objective of these tests was to determine the effect of successively larger cumulative radiation dose on the functioning of the SSM The procedure was to expose the SSM probe to a given total dose, after exposure place the probe in a standard (4000 NTU) solution, and then determine the current output in CALIBRATION mode The probe and the cable of the probe were examined for radiation damage after each exposure

The probe was placed in a tube above the gamma source at a location where it received radiation at the rate of $550X10^3$ rad/hour After it received a total dose of $500X10^3$ rad, the probe was withdrawn from the tube and immersed into a 4000 NTU solution The probe was then placed in the CALIBRATION mode, and the output current was measured with Model 1080A hand-held, digital Fluke® multimeter The current was found to be 4 36 mA This value was much lower than the value of about 12 0 mA expected in the 4000 NTU solution and indicated that the probe had suffered radiation damage Visual examination of the probe and the cable evinced no visible damage

The probe was then lowered into the same position as for the earlier exposure and exposed to a further dose of $250X10^3$ rad It was then, as before, withdrawn from the tube above the gamma source, placed in the 4000 NTU solution, and put in CALIBRATION mode The output current was measured and found to be 3 97 mA instead of about 12 0 mA that is given by a sound probe in a 4000 NTU solution Again, the probe and cable showed no visible damage

As the output current value indicated that the probe had suffered radiation damage, the exposures to gamma radiation were terminated even though a total exposure of $2500X10^3$ rad had been planned for the program

The SSM probe and machine were returned to you for other evaluations

Please call me at 376-8228, or Stan Pitman at 376-0356 if you have questions or need further information

It was our pleasure to work for you on this project, and we look forward to working for you again

Sincerely,

Sharad P Pednekar
Research Scientist
Materials Sciences Department

SPP cvm