

NRC

AP 1001

Three Mile Island Nuclear Station

SIDE 1

Figure 1001-8

Special Operating Procedure

SOP No. SA-65
(From SOP Log Index)

NOTE: Instructions and guidelines in AP 1001 must be followed when completing this form.

Unit No. 2

Date _____

1. Title High Rad. Mon. Calib. (OLO P.C. # 2612-R4)

2. Purpose (include purpose of SOP)

To calibrate and repair selected liquid monitors.

3. Attach procedure to this form written according to the following format.

A. Limitations and Precautions

1. Nuclear Safety
2. Environmental Safety
3. Personnel Safety
4. Equipment Protection

Attaches (

B. Prerequisites

C. Procedure

4. Generated by V.P. Inlandi Date 4/6/79

5. Duration of SOP - Shall be no longer than 90 days from the effective date of the SOP or (a) or (b) below - whichever occurs first.

(a) SOP will be cancelled by incorporation into existing or new permanent procedure submitted by MA ☐

(b) SOP is not valid after _____ ☐
(fill in circumstances which will result in SOP being cancelled)

6. (a) Is the procedure Nuclear Safety Related?

If "yes", complete Nuclear Safety Evaluation. (Side 2 of this Form) Yes ☐ No ☐

(b) Does the procedure affect Environmental Protection?

If "yes", complete Environmental Evaluation. (Side 2 of this Form) Yes ☐ No ☐

(c) Does the procedure affect radiation exposure to personnel?

Yes ☐ No ☐

NOTE: If all answers are "no", the change may be approved by the Shift Supervisor. If any questions are answered "yes", the change must be approved by the Station Superintendent/Unit Superintendent.

7. Review and Approval

Approved - Shift Supervisor [Signature] 4/6/79

Reviewed - List members of PRC contacted W.C. [Signature] 4/6/79

W.C. [Signature]

Olav N.A. [Signature]

N.P. [Signature] 4/6/79

R.P. [Signature] 4/6/79

Anna [Signature]

Approved-Station Superintendent/Unit Superintendent [Signature] 4/6/79

8. SOP is Cancelled

Shift Supervisor/Shift Foreman

Date

"EVALUATION"

AP-1001

Three Mile Island Nuclear Station

SIDE 2

Figure 1001-8

Nuclear Safety/Environmental Impact Evaluation

SOP No. _____

1. Title _____

2. Nuclear Safety Evaluation

Does this SOP:

- * (a) increase the probability of occurrence or the consequences of an accident or malfunction of equipment important to safety? yes ☐ no ☐
- * (b) create the possibility for an accident or malfunction of a different type than any evaluated previously in the safety analysis report? yes ☐ no ☐
- * (c) reduce the margin of safety as defined in the basis for any technical specification? yes ☐ no ☐

Details of Evaluation (Explain why answers to above questions are "no". Attach additional pages if required.)

Evaluation By _____

Date _____

3. Environmental Impact Evaluation

Does this SOP:

- (a) possibly involve a significant environmental impact? yes ☐ no ☐
- * (b) have a significant adverse effect on the environment? yes ☐ no ☐
- * (c) involve a significant environmental matter or question not previously reviewed and evaluated by the N.R.C. yes ☐ no ☐

Details of Evaluation

Evaluation By _____

Date _____

* NOTE: If these questions are "yes", the change must receive N.R.C. approval.

4. Review (PORC review of evaluation is required only when requested by the Station Superintendent/Unit Superintendent. If this review is made, the PORC must consist of two off-site members.)

1. _____

2. _____

Off Site Members

PORC Chairman Signature

Date

131 268

5. Approval

Station Superintendent/Unit Superintendent

Date

THREE MILE ISLAND NUCLEAR STATION
UNIT #2 SURVEILLANCE PROCEDURE 2612-R4
LIQUID RADIATION MONITOR CALIBRATION

Table of Effective Pages

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2.0	10/13/77	0	27.0			52.0		
3.0	10/13/77	0	28.0			53.0		
4.0	10/13/77	0	29.0			54.0		
5.0	10/13/77	0	30.0			55.0		
6.0	10/13/77	0	31.0			56.0		
7.0	10/13/77	0	32.0			57.0		
8.0	10/13/77	0	33.0			58.0		
9.0	10/13/77	0	34.0			59.0		
10.0	10/13/77	0	35.0			60.0		
11.0	10/13/77	0	36.0			61.0		
12.0	10/13/77	0	37.0			62.0		
13.0	10/13/77	0	38.0			63.0		
14.0	10/13/77	0	39.0			64.0		
15.0	10/13/77	0	40.0			65.0		
16.0	10/13/77	0	41.0			66.0		
17.0	10/13/77	0	42.0			67.0		
18.0	10/13/77	0	43.0			68.0		
19.0			44.0			69.0		
20.0			45.0			70.0		
21.0			46.0			71.0		
22.0			47.0			72.0		
23.0			48.0			73.0		
24.0			49.0			74.0		
25.0			50.0			75.0		

Unit 1 Staff Recommends Approval

Approval NA Date
Cognizant Dept. Head

Unit 2 Staff Recommends Approval

Approval NA Date
Cognizant Dept. Head

Unit 1 PORC Recommends Approval

NA Date
Chairman of PORC

Unit 2 PORC Recommends Approval

JL Seelinger Date 9/27/77
Chairman of PORC

Unit 1 Superintendent Approval

NA Date

Unit 2 Superintendent Approval

[Signature] Date 10/13/77

Manager Generation Quality Assurance Approval

NA Date

THREE MILE ISLAND NUCLEAR STATION
UNIT #2 SURVEILLANCE PROCEDURE 2612-R4
LIQUID RADIATION MONITOR CALIBRATION

WARNING:

PRIOR TO PLACING THE RMS INTERLOCK DEFEAT SWITCH IN DEFEAT,
PERMISSION MUST BE GRANTED BY THE SHIFT FOREMAN/SHIFT SUPERVISOR,
THE DEFEAT SWITCH KEY OBTAINED FROM THE SHIFT FOREMAN, AND
ENTRY MADE IN THE CONTROL ROOM LOG.

1.0 PURPOSE

To insure that all radiation monitors not required by the Technical
Specifications are within calibration.

NOTE: This procedure does not apply to WDL-R-1311, which is
covered by 2322-Q2.

2.0 APPLICABLE SURVEILLANCE FREQUENCY AND MODES

- 2.1 Surveillance Frequency - at least once per 92 days.
- 2.2 Surveillance Modes - 1, 2, 3, 4, 5, and 6.

3.0 LIMITS AND PRECAUTIONS

- 3.1 If a high background exists precautions must be taken to reduce the
background level.
- 3.2 The radiation monitoring equipment has power supplies which produce
high internal and external voltages (up to 2500 volts). Care
should be taken when working near this equipment to avoid electrical
shock.
- 3.3 Exercise care in handling the detectors to prevent damage to:
 - 1. Pre-Amplifier Electronics.
 - 2. Detector Cable.
 - 3. Detector Cable Connectors.

3.4 Attached
3.5 attached

1.0

131 270

3.4 The following liquid monitors are the only ones to be worked by this procedure:

MUR-720 - letdown sample high and low range.

There are no interlocks associated with these monitors.

~~These monitors are~~ No

The samplers for these monitors are located in a high radiation area and will not be worked. The Control Room Readout electronics will be worked.

3.5 Notify the Shift Supervisor / Foreman prior to beginning work, and when work is complete. Readings will be erroneous while this work is in progress.

4.0 LOCATION OF ASSEMBLY

- 4.1 All ratemeters are located on Panel 12 except for WT-R-3894 and WT-R-3895.
- 4.2 MU-R-720 - Primary Coolant Letdown Monitor, 305' elevation of the Auxiliary Building.
- 4.3 IC-R-1091 - Intermediate Cooling Water Letdown - MU-C-1B, 282' elevation of the Reactor Building.
- 4.4 IC-R-1092 - Intermediate Cooling Water Letdown - MU-C-1A, 282' elevation of the Reactor Building.
- 4.5 IC-R-1093 - Intermediate Cooling Water Cooler Outlet, 305' elevation of the Auxiliary Building.
- 4.6 DC-R-3399 - Decay Heat Closed Cooling Water - Loop A, 282' elevation of the Fuel Handling Building.
- 4.7 DC-R-3400 - Decay Heat Closed Cooling Water - Loop B, 282' elevation of the Fuel Handling Building.
- 4.8 NS-R-3401 - Nuclear Services Closed Cooling Water, 305' elevation of the Auxiliary Building.
- 4.9 SF-R-3402 - Spent Fuel Cooling, 305' elevation of the Auxiliary Building.
- 4.10 WT-R-3894 - Water Treatment and Condensate Polishing, 282' elevation of the Turbine Building.
- 4.11 WT-R-3895 - Water Treatment and Condensate Polishing, 282' elevation of the Turbine Building.

5.0 EQUIPMENT REQUIRED

- 5.1 Pulse Generator (Hewlett-Packard Model 800 5A or equivalent).
- 5.2 ¹³³Ba (No. 177) Button Source.

5.3 Scaler (Hewlett-Packard Model 5201 L or equivalent).

5.4 Oscilloscope - (Textronic Model 466 or equivalent).

5.5 10:1 Scope Probe

6.0 PROCEDURE

- NOTE:
- a. Perform the following steps making no adjustments unless specifically required by the procedure step. Record the data on "As Found" Data Sheet 1 for 2612-R4.
 - b. Mark the applicable recorder points to indicate where the "Abnormal Levels" were imposed during this calibration.

6.1 Background Radiation Reading

- 6.1.1 Place the RMS Interlock Defeat Switch for the monitor being calibrated in the DEFEAT position, if applicable. See warning on page 1.0.
- 6.1.2 Attach the scaler (Section 5.4) to the binary of the Log Ratemeter Board (between R13 and R16 or R13 and R14). Attach the ground lead to the ratemeter chassis.
- 6.1.3 Place the readout module function selector switch in the "oper" position.
- 6.1.4 Obtain a copy of Data Sheet 1 for 2612-R4 and recorder monitor number being calibrated.
- 6.1.5 Measure the background level with a 10 minute run on the scaler. Multiply the measured binary counts by 2 and divide by 10 minutes to obtain the background CPM. Read the radiation level from the ratemeter module and applicable recorder point on and record these values along with the scaler background CPM in step 6.1.5 on Data Sheet 1 for 2612-R4.

6.2 Button Source Reading

- 6.2.1 Open the sampler well shield cover and slide the detector out of the detector well. Attach the ^{133}Ba (No. 177) button source, in the source holder, to the detector and replace the detector and close the sampler well shield cover.
- 6.2.2 Allow the indicated radiation level on the recorder and ratemeter module to stabilize. Then record the radiation level from the ratemeter module and the applicable recorder point in step 6.2.2 on Data Sheet 1.
- 6.2.3 Take a two minute scaler run and record the scaler CPM, with the button source on the detector, in step 6.2.3 on Data Sheet 1.
- 6.2.4 Remove the detector and ^{133}Ba (No. 177) button source from the sampler and take-off the ^{133}Ba button source holder, containing the button source.
- 6.2.5 Replace the detector in the sample well and close the sampler well shield cover.

6.3 Background Correction of Radiation Source Readings

- 6.3.1 Subtract the background readings obtained in step 6.1.5 from the associated button source readings obtained in steps 6.2.2 and 6.2.3. Enter these results in the "Actual Source Reading" in step 6.3.1 on Data Sheet 1 for 2612-R4.

6.4 Calculation of Expected Source Readings

- 6.4.1 Obtain the "Original Source Reading" and date of the "Original Source Reading" from the Isotopic Calibration Test Report Section of the Victoreen Technical Manual (See MTX-123), and record these on Data Sheet 1.

6.4.2 Calculate "t" to the nearest month. "t" is the time elapsed between the "Original CPM" date and the date of the source reading taken for this test.

6.4.3 Calculate the expected source reading using Table 1. Enter the expected source reading on Data Sheet 1.

6.5 Comparison of Actual and Expected Source Readings

6.5.1 Compare the "Actual Source Reading" with the "Expected Source Reading". The "Actual Source Reading" using the scaler value should be within $\pm 15\%$ of the "Expected Source Reading" value.

6.5.2 Compare the value obtained from the "Actual Source Reading" of the ratemeter with the value of the "Actual Source Reading" of the scaler. This reading should be within one minor division of the ratemeter reading. Record on Data Sheet 1 for 2612-R4.

NOTE: A minor division on the ratemeter is the distance between any "8" on the meter and the next higher mark.

6.5.3 Compare the value obtained from the "Actual Source Reading" of the recorder with the value of the "Actual Source Reading" of the scaler. The reading should be within one minor division of the recorder scale. Record on Data Sheet 1 for 2612-R4.

NOTE: A minor division on the recorder is the distance between any "9" on the scale and the next higher mark.

6.5.4 If the readings do not compare within the tolerance allowed, document this as a deficiency on the "E/D" Sheet. Deficiencies will be corrected per Section 6.8 of this procedure.

6.6 Verification of "Alert" and "High" Alarm Setpoints

6.6.1 Enter the required "Alert" and "High" alarm setpoints in step 6.6.1 on Data Sheet 1 for 2612-R4, from 2105-1.12.

6.6.2 Open the signal and 16V links at the rear of Panel 12 for the monitor being calibrated.

NOTE: This is done locally for WT-R-3894 and 3895.

6.6.3 Connect the pulse generator to the signal input connector and adjust the pulse generator for negative polarity with a 1.0 volt amplitude, zero repetition rate, and a 1.0 μ Sec. pulse width.

6.6.4 Slowly increase the pulse repetition rate until the "Alert" alarm light energizes. Record the ratemeter reading at which the "Alert" alarm was tripped in step 6.6.4 on Data Sheet 1 for 2612-R4. Acknowledge all associated alarms.

6.6.5 Continue to slowly increase the pulse repetition rate until the "High" alarm light energizes. Record the ratemeter reading at which the "High" alarm was tripped in step 6.6.5 on Data Sheet 1. Reset all associated alarms.

6.6.6 Compare the tripped "Alert" and "High" alarm trip setpoints with the required setpoints which were entered in step 6.6.1 on Data Sheet 1. The observed setpoint should equal the required setpoint. The tolerance on these setpoints is plus zero, minus one minor division of the ratemeter scale. See NOTE in step 6.5.2 of this procedure.

6.6.7 Disconnect and remove the pulse generator, then reconnect the detector signal and 16V links.

- 6.6.8 Place the function selector switch on the readout module in the "CAL" position.
- 6.6.8.1 Depress the "Alert Alarm Pushbutton" and record the "Indicated Setpoint" ratemeter reading in step 6.6.8.1 on Data Sheet 1. Release the "Alert Alarm Pushbutton". Compare this reading with the ratemeter reading at which the "Alert" alarm tripped in step 6.6.4. The value obtained in this step must agree with the value obtained in step 6.6.4. The tolerance is minus one, plus zero minor division of the ratemeter scale; see NOTE in step 6.5.2 of this procedure. If the setpoint is not within the tolerance allowed, document this as a deficiency on an "E/O" sheet.
- 6.6.8.2 Depress the "High Alarm Pushbutton" and record the "Indicated Setpoint" ratemeter reading in step 6.6.8.2 on Data Sheet 1. Release the "High Alarm Pushbutton". Compare this reading with the ratemeter reading at which the "High" alarm tripped in step 6.6.5. The value obtained in this step must agree with the value obtained in step 6.6.5. The tolerance is minus one, plus zero minor division of the ratemeter scale; see NOTE in step 6.5.2 of this procedure. If the setpoint is not within the tolerance allowed, document this as a deficiency on an "E/O" Sheet.
- 6.6.9 Return the function selector switch to the "Oper" position.
- 6.7 Determination of Check Source Readings.
- 6.7.1 Depress the "CS" pushbutton. After the reading has stabilized determine the number of counts per minute that the reading increased above background. Record this value in step 6.7.1 on data sheet 1 for 2612-R4.

NOTE: If the indicated radiation level is greater than twice the radiation level which the check source should exhibit, it is unreasonable to expect to see a significant increase from the check source actuation. If the situation arises, step 6.7.1 on the Data Sheet shall be marked "N/A".

6.7.2 Return the RMS Interlock Defeat Switch from the DEFEAT to the NORMAL position on Panel 12, if applicable.

6.8 Deficiency Correction

NOTE: If any deficiencies were found, they must be corrected using the calibration procedures of Appendix A, using the applicable sections described below:

- 6.8.1 If the scaler CPM does not agree with the required CPM within the tolerance specified, perform Section A.1 through A.6.
- 6.8.2 If the recorder of the panel meter does not agree with the scaler CPM within the tolerance specified, perform Section A.7 and A.8.
- 6.8.3 If the alert and high alarm test results are out of tolerance, perform Section A.8.
- 6.8.4 If any adjustments were made, repeat Sections 6.1 through 6.8. Record final values on another copy of Data Sheet 1 marked as "As Left". Provide copies of these Data Sheets and "E/D" Sheets, for the deficiencies found to the I&C Foreman, H.P. Supervisor and to the I&C Engineer.

7.0 ACCEPTANCE CRITERIA

7.1 The acceptance criteria is stated on the Data Sheet.

SURVEILLANCE PROCEDURE 2612-R4
LIQUID RADIATION MONITOR
DATA SHEET 1

2612-R4
Revision 0
10/13/77

Procedure Step	MONITOR		☐ AS FOUND ☐ AS LEFT		RECORDER TRACE MARKED YES/NO	INT	
6.0	DESCRIPTION		SCALER	INIT.	READINGS RATEMETER	INIT.	RECORDER
6.2.3							
6.2.2	Source		CPM		CPM		CPM
6.1.5	Background		-		CPM		CPM
6.3.1	Actual Source Readings		CPM		CPM		CPM
6.4.1	Original Reading		CPM				
6.4.1	Original Reading Date						
6.4.2	Expected Reading		CPM		CPM		CPM
6.5.1	+15% of Expected Reading		CPM		CPM		CPM
6.5.1	-15% of Expected Reading		CPM		CPM		CPM
6.5.1	Actual Source Reading with 15% of Expected? Yes/No		*		Comparison of Expected Source Reading with Ratemeter and Recorder Reading Per 6.5.2 & 3 Yes/No Setpoint Data		
6.5.2 & 6.5.3	Comparison of Expected Source Reading with Ratemeter and Recorder Reading Per 6.5.2 & 3 Yes/No				*		*
6.5.3	Setpoint Data						
6.6.1	Required Setpoint		ALERT		INT.	HIGH	
AL-6.6.8.1	Indicated						
HI-6.6.8.2	Setpoint		CPM				CPM
AL-6.6.4	"Tripped"						
HI-6.6.5	Setpoint		CPM				CPM
6.6.6	Tripped Setpoint within one Minor Division of Required Yes/No		*		*		
			CPM				CPM
6.7.1	Check Source, Recorder, Acceptance Criteria, Sign-Off						
6.7.1	Observed Increase in Reading Due to Check Source						
	Recorder Trace Marked		Yes/No		*	INT.	
	* Acceptance Criteria: All Yes/No Blanks Indicate "Yes"						
	** Record "Pegged" if Meter Pegs High Due to Background.						
	PERFORMED BY AND DATE:				APPROVED BY AND DATE:		

TABLE NO. 1
UNIVERSAL DECAY TABLE

NOTE: The following table gives the fraction of activity of a ~~radio~~ remaining, from 0.001 half-life to 1.000 half-life.

To use this table:

1. Divide elapsed time by the half-life ($t/T_{1/2}$). Time must be the same units.
2. With the answer obtained in Step 1, enter appropriate row along the side and the column at the top. The number obtained is the fraction of original activity remaining.
3. Multiply the original activity by this figure to obtain the present activity (or the amount remaining).

NOTE: The half-life of ^{133}Ba is 126 months.
Decay ^{133}Ba to the nearest month only.

Example: If a ^{133}Ba source was cross calibrated on 4/72, what would the decay factor be on 9/74 (it has decayed 29 months).

$$\frac{29}{126} = \frac{0.2301}{25.2} = 0.230$$

25.2
3.80
3.78
.02

Checking the Universal Decay Table, one would multiply the original activity of the ^{133}Ba source on 4/72 by 0.85266 to obtain the activity value on 9/74.

	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
000	00000	00001	00002	00003	00004	00005	00006	00007	00008	00009
010	00010	00011	00012	00013	00014	00015	00016	00017	00018	00019
020	00020	00021	00022	00023	00024	00025	00026	00027	00028	00029
030	00030	00031	00032	00033	00034	00035	00036	00037	00038	00039
040	00040	00041	00042	00043	00044	00045	00046	00047	00048	00049
050	00050	00051	00052	00053	00054	00055	00056	00057	00058	00059
060	00060	00061	00062	00063	00064	00065	00066	00067	00068	00069
070	00070	00071	00072	00073	00074	00075	00076	00077	00078	00079
080	00080	00081	00082	00083	00084	00085	00086	00087	00088	00089
090	00090	00091	00092	00093	00094	00095	00096	00097	00098	00099
100	00100	00101	00102	00103	00104	00105	00106	00107	00108	00109
110	00110	00111	00112	00113	00114	00115	00116	00117	00118	00119
120	00120	00121	00122	00123	00124	00125	00126	00127	00128	00129
130	00130	00131	00132	00133	00134	00135	00136	00137	00138	00139
140	00140	00141	00142	00143	00144	00145	00146	00147	00148	00149
150	00150	00151	00152	00153	00154	00155	00156	00157	00158	00159
160	00160	00161	00162	00163	00164	00165	00166	00167	00168	00169
170	00170	00171	00172	00173	00174	00175	00176	00177	00178	00179
180	00180	00181	00182	00183	00184	00185	00186	00187	00188	00189
190	00190	00191	00192	00193	00194	00195	00196	00197	00198	00199
200	00200	00201	00202	00203	00204	00205	00206	00207	00208	00209
210	00210	00211	00212	00213	00214	00215	00216	00217	00218	00219
220	00220	00221	00222	00223	00224	00225	00226	00227	00228	00229
230	00230	00231	00232	00233	00234	00235	00236	00237	00238	00239
240	00240	00241	00242	00243	00244	00245	00246	00247	00248	00249
250	00250	00251	00252	00253	00254	00255	00256	00257	00258	00259
260	00260	00261	00262	00263	00264	00265	00266	00267	00268	00269
270	00270	00271	00272	00273	00274	00275	00276	00277	00278	00279
280	00280	00281	00282	00283	00284	00285	00286	00287	00288	00289
290	00290	00291	00292	00293	00294	00295	00296	00297	00298	00299
300	00300	00301	00302	00303	00304	00305	00306	00307	00308	00309
310	00310	00311	00312	00313	00314	00315	00316	00317	00318	00319
320	00320	00321	00322	00323	00324	00325	00326	00327	00328	00329
330	00330	00331	00332	00333	00334	00335	00336	00337	00338	00339
340	00340	00341	00342	00343	00344	00345	00346	00347	00348	00349
350	00350	00351	00352	00353	00354	00355	00356	00357	00358	00359
360	00360	00361	00362	00363	00364	00365	00366	00367	00368	00369
370	00370	00371	00372	00373	00374	00375	00376	00377	00378	00379
380	00380	00381	00382	00383	00384	00385	00386	00387	00388	00389
390	00390	00391	00392	00393	00394	00395	00396	00397	00398	00399
400	00400	00401	00402	00403	00404	00405	00406	00407	00408	00409
410	00410	00411	00412	00413	00414	00415	00416	00417	00418	00419
420	00420	00421	00422	00423	00424	00425	00426	00427	00428	00429
430	00430	00431	00432	00433	00434	00435	00436	00437	00438	00439
440	00440	00441	00442	00443	00444	00445	00446	00447	00448	00449
450	00450	00451	00452	00453	00454	00455	00456	00457	00458	00459
460	00460	00461	00462	00463	00464	00465	00466	00467	00468	00469
470	00470	00471	00472	00473	00474	00475	00476	00477	00478	00479
480	00480	00481	00482	00483	00484	00485	00486	00487	00488	00489
490	00490	00491	00492	00493	00494	00495	00496	00497	00498	00499
500	00500	00501	00502	00503	00504	00505	00506	00507	00508	00509

	.000	.001	.002	.003	.004	.005	.006	.007	.008	.009
.510	.70227	.70115	.70110	.70032	.70033	.59524	.59026	.59537	.69537	.69781
.520	.69722	.69554	.69540	.69117	.69000	.68511	.68255	.68504	.68536	.68500
.530	.69261	.69113	.69155	.68620	.68500	.68021	.67973	.68225	.68371	.68310
.540	.68796	.68735	.68637	.68155	.68000	.67515	.67497	.67750	.67895	.67825
.550	.68307	.68250	.68155	.67620	.67500	.67071	.67021	.67275	.67420	.67350
.560	.67823	.67762	.67672	.67155	.67000	.66501	.66451	.66707	.66852	.66782
.570	.67337	.67280	.67174	.66620	.66500	.66021	.65971	.66225	.66370	.66300
.580	.66850	.66793	.66693	.66155	.66000	.65511	.65461	.65707	.65852	.65782
.590	.66364	.66304	.66204	.65620	.65500	.65021	.64971	.65225	.65370	.65300
.600	.65878	.65818	.65718	.65155	.65000	.64511	.64461	.64707	.64852	.64782
.610	.65392	.65332	.65232	.64620	.64500	.64021	.63971	.64225	.64370	.64300
.620	.64906	.64846	.64746	.64155	.64000	.63511	.63461	.63707	.63852	.63782
.630	.64420	.64360	.64260	.63620	.63500	.63021	.62971	.63225	.63370	.63300
.640	.63934	.63874	.63774	.63155	.63000	.62511	.62461	.62707	.62852	.62782
.650	.63448	.63388	.63288	.62620	.62500	.62021	.61971	.62225	.62370	.62300
.660	.62962	.62902	.62802	.62155	.62000	.61511	.61461	.61707	.61852	.61782
.670	.62476	.62416	.62316	.61620	.61500	.61021	.60971	.61225	.61370	.61300
.680	.61990	.61930	.61830	.61155	.61000	.60511	.60461	.60707	.60852	.60782
.690	.61504	.61444	.61344	.60620	.60500	.60021	.59971	.60225	.60370	.60300
.700	.61018	.60958	.60858	.60155	.60000	.59511	.59461	.59707	.59852	.59782
.710	.60532	.60472	.60372	.59620	.59500	.59021	.58971	.59225	.59370	.59300
.720	.60046	.60000	.59896	.59155	.59000	.58511	.58461	.58707	.58852	.58782
.730	.59560	.59500	.59396	.58620	.58500	.58021	.57971	.58225	.58370	.58300
.740	.59074	.59014	.58910	.58155	.58000	.57511	.57461	.57707	.57852	.57782
.750	.58588	.58528	.58424	.57620	.57500	.57021	.56971	.57225	.57370	.57300
.760	.58102	.58042	.57938	.57155	.57000	.56511	.56461	.56707	.56852	.56782
.770	.57616	.57556	.57452	.56620	.56500	.56021	.55971	.56225	.56370	.56300
.780	.57130	.57070	.56966	.56155	.56000	.55511	.55461	.55707	.55852	.55782
.790	.56644	.56584	.56480	.55620	.55500	.55021	.54971	.55225	.55370	.55300
.800	.56158	.56098	.55994	.55155	.55000	.54511	.54461	.54707	.54852	.54782
.810	.55672	.55612	.55508	.54620	.54500	.54021	.53971	.54225	.54370	.54300
.820	.55186	.55126	.55022	.54155	.54000	.53511	.53461	.53707	.53852	.53782
.830	.54700	.54640	.54536	.53620	.53500	.53021	.52971	.53225	.53370	.53300
.840	.54214	.54154	.54050	.53155	.53000	.52511	.52461	.52707	.52852	.52782
.850	.53728	.53668	.53564	.52620	.52500	.52021	.51971	.52225	.52370	.52300
.860	.53242	.53182	.53078	.52155	.52000	.51511	.51461	.51707	.51852	.51782
.870	.52756	.52696	.52592	.51620	.51500	.51021	.50971	.51225	.51370	.51300
.880	.52270	.52210	.52106	.51155	.51000	.50511	.50461	.50707	.50852	.50782
.890	.51784	.51724	.51620	.50620	.50500	.50021	.49971	.50225	.50370	.50300
.900	.51298	.51238	.51134	.50155	.50000	.49511	.49461	.49707	.49852	.49782
.910	.50812	.50752	.50648	.49620	.49500	.49021	.48971	.49225	.49370	.49300
.920	.50326	.50266	.50162	.49155	.49000	.48511	.48461	.48707	.48852	.48782
.930	.49840	.49780	.49676	.48620	.48500	.48021	.47971	.48225	.48370	.48300
.940	.49354	.49294	.49190	.48155	.48000	.47511	.47461	.47707	.47852	.47782
.950	.48868	.48808	.48704	.47620	.47500	.47021	.46971	.47225	.47370	.47300
.960	.48382	.48322	.48218	.47155	.47000	.46511	.46461	.46707	.46852	.46782
.970	.47896	.47836	.47732	.46620	.46500	.46021	.45971	.46225	.46370	.46300
.980	.47410	.47350	.47246	.46155	.46000	.45511	.45461	.45707	.45852	.45782
.990	.46924	.46864	.46760	.45620	.45500	.45021	.44971	.45225	.45370	.45300
1.000	.46438	.46378	.46274	.45155	.45000	.44511	.44461	.44707	.44852	.44782

APPENDIX A

CALIBRATION OF WOL-R-1311

WARNING: Prior to placing the RMS interlock defeat switch in defeat, permission must be granted by the Shift Supervisor/Foreman, the defeat switch key obtained from the Shift Foreman, and entry made in the Control Room Log.

NOTE: If proper results cannot be obtained in the steps below, troubleshoot and repair the instrument using an approved Work Request, and repeat all steps of this calibration.

A.1.0 TEST SETUP

- 1.1 Inform Shift Supervisor/Shift Foreman of work to be accomplished.
- 1.2 Obtain and warm-up equipment. Fast rise oscilloscope, pulse generator (low output impedance), DVM and scaler are needed.
- 1.3 Turn applicable Bypass Switch to DEFEAT.
- 1.4 Turn ratemeter function switch to OPER.
- 1.5 Slide ratemeter from Panel 12 far enough to make internal connections.

NOTE: This is done locally for WT-R-3894 and 3895.

A.2.0 DISCRIMINATOR VOLTAGE ADJUSTMENT

- 2.1 Open 16V link and signal link to the detector (located at rear of Panel 12).

NOTE: This is done locally for WT-R-3894 and 3895.

- 2.2 Connect oscilloscope ground lead to ratemeter chassis. Connect signal lead to ratemeter function switch blue wire (front deck, terminal No. 12).

NOTE: This is done locally for WT-R-3894 and 3895.

- 2.3 Connect pulse generator ground lead to ratemeter chassis.
Connect signal lead to ratemeter function switch blue wire.
Set up the pulse generator as follows:

Repetition rate - Approximately 10,000 pps

Polarity - negative pulse

Pulse Width - 1 μ sec

Amplitude - refer to applicable Calibration Data Sheet
in the Victoreen Technical Manual, "ISOTOPIC
CALIBRATION TEST REPORT". This voltage is
identified as "CLIP".

NOTE: Set this voltage as accurately as possible
using the oscilloscope.

- 2.4 Adjust Discriminator Adjust potentiometer R3 on the log ratemeter board until the ratemeter just begins to count.

- 2.5 Disconnect pulse generator and oscilloscope and reconnect 16V and signal links for the detector.

A.3.0 BACKGROUND MEASUREMENT

- 3.1 Connect scaler input, using high impedance probe, (Section 5.5) to binary of log ratemeter board (842 - 1 - 30) between R13 and R16 or between R18 and R14. Connect scaler ground lead to ratemeter chassis.

- 3.2 Reset scaler to zero and count for 10 minutes. Multiply binary counts obtained by 2 and divide by 10 to obtain CPM. Record this value for later use.

A.4.0 CALIBRATION SOURCE MEASUREMENT

- 4.1 Use the ¹³³Ba (No. 177) button source.

- 4.2 Refer to "CAL. SOURCE DATA" section of the Victoreen Technical Manual. Connect calibration source per applicable illustration.
- 4.3 Reset scaler to zero and count for 2 minutes. Record CPM for later use.
- A.5.0 CALCULATION OF EXPECTED AND REQUIRED CPM.
- 5.1 Refer to "ISOTOPIC CALIBRATION TEST REPORT" section of the Victoreen Technical Manual. Use the applicable Calibration Data Sheet to determine original CPM for the calibration source in the sampler and original date.
- NOTE: Determine decay time to the nearest month and use Table No. 1 to determine current "expected" CPM. Add the background counts obtained in Section A.3.0 to determine "required" CPM. Record "expected" and "required" CPM for later use.
- A.6.0 HIGH VOLTAGE CORRECTION
- 6.1 Alternately adjust high voltage (using High Voltage Adjust Potentiometer R115 on the Power Supply Board) and take 0.2 minute scaler runs until measured CPM readings are repeatable with $\pm 3\%$ of the "required" CPM from Section A.5.0. Take a 2 minute scaler run to verify results.
- CAUTION: DO NOT EXCEED 1400 VDC.
- 6.2 Remove calibration source and take a 10 minute background run to ensure the H.V. adjustments have not altered background CPM enough to invalidate the $\pm 3\%$ agreement.
- A.7.0 LOG RATEMETER BOARD CALIBRATION
- 7.1 Open 16V and signal links at rear of Panel 12.
- NOTE: This is done locally for WT-R-3894 and 3895.

- 7.2 Adjust the Zero Set Potentiometer R36 until the panel meter reads approximately 1/4" below the 10 CPM mark.
- 7.3 Connect pulse generator ground lead to ratemeter chassis. Connect signal lead to function switch blue wire.
- 7.4 Connect oscilloscope ground lead to ratemeter chassis. Connect signal lead to function switch blue wire.

- 7.5 Set pulse generator as follows:

Repetition Rate: 10^5 cpm
Amplitude: 1 volt
Pulse Width: 1 μ sec.
Pulse Polarity: Negative (-)

NOTE: The scaler should be used to ensure proper setting of the pulse generator throughout this section.
Connect ground lead to ratemeter chassis. Connect signal lead to function switch blue wire.

- 7.6 Adjust the output control R38 until the meter reads 10^5 CPM.
- 7.7 Adjust the pulse generator repetition rate to 10^3 CPM.
- 7.8 Slightly adjust the zero control R36 until the meter reads 10^3 CPM.
- 7.9 Adjust the pulse generator repetition rate to 10^6 CPM.
- 7.10 Adjust C19, 10^6 CPM control until the meter reads 10^6 . Due to the interaction it may be necessary to switch between 10^3 , 10^5 and 10^6 several times, adjusting their respective controls until the optimum span is achieved.
- 7.11 Decade all ranges from 10 through 10^6 to insure proper spanning.
- 7.12 Adjust the pulse generator for one (1) KHZ pulse repetition rate and check Log Ratemeter for proper operation, the reading should fall on the black "CAL" mark at 6×10^4 CPM.

- 7.13 Connect oscilloscope to the junction of R39 and R40, which is the output of the calibration oscillation.
- 7.14 Adjust calibration frequency control R45 for 1 msec between pulses.
- 7.15 Turn the function switch to the "Cal." position. The meter indication should be on the "Cal." mark of the scale.
- A.8.0 ALARM BOARD CALIBRATION
- 8.1 Reset the pulse generator for zero amplitude.
- 8.2 Set R205 and R214 to the extreme clockwise position.
- 8.3 Adjust R234 until both alarms (High and Alert) energize, then slowly back off until one or both just de-energize.
- 8.4 Set R205 and R214 to the extreme counter-clockwise position.
- 8.5 Set the Pulse Generator for:
- | | |
|------------------|--------------|
| Repetition Rate: | 10^5 CPM |
| Amplitude: | 1 volt |
| Pulse Polarity: | negative (-) |
| Pulse Width: | 1 μ sec. |
- 8.6 Decrease in a clockwise direction the settings of R205 (High) and R214 (Alert) alarm set-point controls until alarms energize.
- 8.7 Decrease the repetition rate of the signal generator slightly to de-energize the alarm(s) then slowly increase, noting that the alarm(s) energize at precisely 10^5 CPM on the meter scale.
- 8.3 Set the signal generator for a count rate below the alarm set-point to de-energize the alarms.
- 8.9 Switch the Function Selector to the "CAL" position.

- 8.10 Depress the front panel pushbutton for the HIGH and ALERT alarms alternately, and adjust R209 (High) and R229 (Alert) alarm meter calibration control for a meter reading of exactly 10^5 CPM on the scale.
- 8.11 Due to slight loading effects, it may be necessary to repeat Steps 5 through 10 for optimum calibration of the alarms.
- 8.12 To make ALARM SET POINT adjustments, proceed as follows:
- a. Reset the input signal generator to zero amplitude.
 - b. Switch the Function Selector to the "CAL" position.
 - c. Depress the HIGH alarm pushbutton and adjust the High alarm set-point control (R205) until the meter indicates the desired CPM on the scale.
 - d. Depress the ALERT alarm pushbutton and adjust the Alert alarm set-point control (R214) until the meter indicates the desired CPM on the scale.
 - e. The HIGH and ALERT alarm adjustments are complete.