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Atmospheric Pressure Fluctuations and Oxygen Enrichment in Waste Tanks^(U)

R. J. Kurzeja
Allen H. Weber

SAVANNAH RIVER SITE

Westinghouse Savannah River Company
Savannah River Technology Center
Aiken, SC 29808

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Atmospheric Pressure Fluctuations and Oxygen Enrichment in Waste Tanks

Executive Summary

Oxygen enrichment in waste tanks can reach hazardous levels if normal purging is interrupted by power failures. In such cases it is necessary to estimate the time it would take for oxygen buildup to reach a critical concentration.

Mixing of outside air into closed tanks through small leaks will be slow without external forcing. One such external forcing mechanism is natural atmospheric pressure fluctuations, which can force air into tanks through small cracks or vent holes. The efficiency of this process is a function of the atmospheric pressure increases over time periods comparable to the in-tank mixing rate.

Two in-tank mixing rates were assumed (8 and 24 hours) and pressure measurements from Bush Field

and SRTC's Climatology Site were analyzed to determine the mean and maximum pressure increases in a 5-year period 1986-1990.

The mean pressure increase in an 8-hr period was found to be 1.7 mb and 5.0 mb for a 24-hr period. These pressure increases would induce an air enrichment of ~0.2% and ~0.5% for 8 and 24-hour periods, respectively. Since oxygen is 21% of air by volume the in-tank oxygen enrichment would be ~1/5 of the percentages listed above.

The above values over-estimate the enrichment rate because they do not include the reduction in efficiency as the in-tank oxygen level increases and because they assume complete mixing of oxygen entering the tank.

Introduction

During In-Tank Precipitation (ITP) processing radiolytic decomposition of tetraphenylborate and water can produce benzene and hydrogen, which, given sufficiently high oxygen concentrations, can deflagrate. To prevent accumulations of benzene and hydrogen and avoid deflagration, continuous nitrogen purging is maintained

If the nitrogen purging is interrupted by, for example, a power failure, outside air will begin to seep into the tank through vent holes and cracks. Eventually a flammable mixture of benzene, hydrogen, and oxygen will occur (deflagration). However, this process is slow under steady-state conditions (constant pressure) and mechanisms to increase the exchange rate with the outside atmosphere must be considered.

The most important mechanism of this kind is from natural atmospheric pressure fluctuations in which an increase in atmospheric pressure forces air into the tank which then mixes with the hydrogen-benzene mixture. The subsequent decrease in

atmospheric pressure causes venting from the tank of the *mixture* - the net effect being an increase in the tank's oxygen concentration. Thus, enrichment occurs when the atmospheric pressure increases but not when the pressure decreases. Moreover, this natural atmospheric "pumping" is only important if the pressure fluctuations take place on a time scale longer than the characteristic mixing time scale (CMT) of the tank. If pressure fluctuations have a significantly higher frequency than the CMT, outside air will be forced in to the tank and then out again before any significant mixing can occur. The CMT is not known for certain, but is estimated to be between 8 and 24 hours.

The purpose of this report is to analyze yearly pressure fluctuations for a five year period to determine their statistical properties over 8 and 24-hour periods. The analysis also includes a special breakdown into summer and winter seasons and an analysis of 15-minute data from the SRTC Climatology Site.

Summary of Tasks

The project involves three tasks:

- (1) A statistical analysis of a 5-yr (1986-90) data base of one hour data from Bush Field in Augusta, Ga.
- (2) Creation of a quality-assured, continuous, 2 month (Dec 92-Jan 93) data base of 15-minute data.
- (3) A statistical analysis like that of task (1) but for the 2-month data base created in Task (2)

Task 1

This task used 5 years of pressure data (1986-1990) from Bush Field in Augusta. The data were obtained by National Weather Service personnel every hour from an aneroid barometer, which is compared once per week with a mercury barometer. The precision is 0.01 inches of mercury. The data were obtained from the Southeast Regional Climate Center in Columbia, SC. The Environmental Technology Section cannot verify the accuracy of this data independently. However, it has been subject to National Weather Service QA checks.

The statistical variable of interest is the sum of the pressure increases during a given period. This variable can be positive even if the pressure trend is downward during the period because only pressure increases are included. It is defined as the total pressure increase, TPI,

$$TPI = \sum_{i=1}^{i=8,24} \Delta P_i (+)$$

where, $\Delta P_i (+)$ = a positive pressure change and the sum is over 8 or 24 hours.

The mean TPI (MTPI) is defined as,

$$MTPI = \frac{1}{1095,365} \sum_{i=1}^{i=1095,365} TPI_i$$

where, 1095 and 365 are the number of 8 and 24-hr periods in a year.

Additional quantities were also determined, including the standard deviation, the maximum, and the minimum of the TPI.

The statistical analysis was carried out with the SAS program listed in Appendix 1. The output from this program is shown in Tables 1 and 2. In these tables

the line PR_SM_8 (or _24) refers to the pressure data while the line CNT_8 (or _24) refers to the number of 1-hr pressure increases in 8 or 24 hours. The variables are,

N = number of 8 or 24 hour periods

First line (PR_SM_8, PR_SM_24)

Mean = MTPI, mb

Std Dev = standard deviation about the MTPI, mb

Minimum = minimum TPI for the year, mb

Maximum = maximum TPI for the year, mb

Second line (CNT_8, CNT_24):

Mean = mean number of pressure increases in an 8 or 12-hour period.

Std Dev = standard deviation of the number of pressure increases.

Minimum = minimum number of pressure increases during any period.

Maximum = maximum number of pressure increases in any 8 or 24-hr period.

From Table 1 the mean pressure increases for the entire 5 year period can be found. In an 8-hr period the mean increase is 1.7 mb while for a 24-hr period it is 5.0 mb. The maximum pressure increases for any 8-hr period or 24-hr period were 11.3 mb and 20.1 mb, respectively.

One feature of the tables require further explanation. The average number of pressure increases in 8 and 24 hours is expected to be 4 and 12 respectively but this was not the case. For example, in 1986 (Table 1) the mean number of pressure increases in an 8-hour period was 3.09. This difference is due to the finite resolution of the pressure data (0.01 inches of mercury) which causes changes in pressure of less than 0.01 inch to be classified as neither an increase nor a decrease.

It is of practical interest to know whether the danger of deflagration is greater in one season than another. Seasonal dependence is expected since the greatest pressure fluctuations are caused by synoptic weather systems, which are relatively infrequent in summer. The statistics for winter and summer (January-February-December and June-July-August) were calculated separately for the 5 years and are shown in Table 2. As expected, larger pressure increases are seen in the winter than in the summer for both 8-hr and 24-hr periods. For an 8-hr period the winter mean

is 1.8 mb and the summer mean is 1.5 mb. For 24-hr period the winter mean is 5.5 mb and the summer mean is 4.6 mb.

Task 2

In this task a two-month data set of 15-minute averaged data was created from atmospheric pressure data collected at Environmental Technology's Climatology Site. This data is collected every 1.5 sec and archived on ET's VAX computers. The sensor is a Rosemont capacitance device S/N 20135 (MTE # L0046943) and is described in Table 3.

Quality assurance for this sensor is accomplished through twice-yearly calibration by ET personnel, periodic comparison to a mercury standard, and continuous comparison with Bush Field data. The sensor was calibrated by ET personnel on Nov 11, 1992.

A copy of the calibration sheet is shown in Appendix 2. The sensor was found to have a +1.02 mb bias with respect to Rosemont S/N 20136 and a -1.76 mb bias compared to elevation-adjusted Bush Field data. Since these differences are greater than the specifications for this sensor (Table 3) and the sensor was installed only one month previously, additional calibrations were initiated.

In December a mercury barometer Princo TE-586, S/N 0864 was calibrated by the SRTC Standards Lab, Appendix 3. This barometer was compared to the Rosemont S/N 20135 on December 18-22 of 1992. In this comparison, the Rosemont was found to have a bias of -0.7 mb.

The Rosemont was compared to Bush Field data (corrected for elevation differences). A plot of this comparison is shown in Fig. 1. This Figure shows good correlation between the sensors, with a 1 - 2 mb negative bias of Rosemont 20135 with respect to the Bush Field data. Part of this difference is due to uncertainty about the precise elevation of the Climatology Site.

From these tests we draw the following conclusions. Since the Rosemont sensors S/N 20135 and 20136 differ by more than the specified accuracy (0.3mb), the vendor's factory calibration is rejected and the November 11 calibration is therefore not complete. Instead, the December calibration with the mercury barometer is accepted. Furthermore, since S/N 20135 was found to correlate well with Bush Field data, we accept the vendor's specification for repeatability (0.03mb). Thus, the December and January data are assumed to have a -0.7 mb absolute bias and to satisfy the manufacturer's specified precision. No instrument drift was seen during the period.

During December and January ~24 hours of pressure data (1.8%) were missing due to VAX downtimes. These data were replaced (filled-in) by linear interpolation or (for periods longer than 2 hours) by interpolation based on microbarograph data located in Building 773-A. The interpolated periods have the correct trends but lack some of the high frequency structure present in the complete data. The beginning time and date of the longer data gaps are listed below.

11 Dec 1992	21:30 GMT	16 periods
8 Jan 1993	21:15 GMT	15 periods
19 Jan 1993	16:45 GMT	38 periods
21 Jan 1993	16:45 GMT	8 periods

Plots of all the data are shown in Figs. 2-9. As can be seen from the Figures, the filled periods cannot be easily distinguished from the other data.

Task 3

This task repeated the analysis of Task 1, but with the Climatology data created in Task 2. The results are shown in Table 4. The line labeled CNT_8 contains entries roughly 4 times the entries in Table 1 because there are 4 times as many periods per 8 or 24-hour period. The results are otherwise consistent with the results of Table 1 if the difference in data series length is considered.

Discussion

The results of this study can be applied to waste tanks which are internally well mixed but which exchange gas slowly with the outside atmosphere. Under these conditions the slow steady-state diffusive exchange will be greatly accelerated by natural atmospheric "pumping" from pressure fluctuations.

An approximate indication of the efficiency of this process can be inferred from the average pressure increases. The average total pressure increases were found to be 1.7 mb and 5.0 mb for 8 and 24-hr periods respectively. For a mean pressure of 1000mb this corresponds to a dilution rate of 0.2% and 0.5% for the first 8 and 24 hour periods.

On March 13, 1993 the lowest pressure ever recorded at Bush Field in Augusta was measured. This minimum was due to a major winter storm called the "storm of the century". The extreme pressure changes observed for this storm at SRS were 28 mb in an 8-hr period and 51 mb in a 24-hr period. These values are over twice as large as the maximum values seen in the 5 year data base 1986-1990. Since they occurred with the lowest pressure ever recorded at Bush Field, they are a good estimate of the "100-year" pressure change.

A rigorous solution to the problem would require a differential equation for the oxygen concentration

which includes the effects of inflow, outflow and internal mixing. A careful analysis would also consider the frequency dependence of the pressure fluctuations since time periods comparable to or larger than the CMT are most efficient.

The frequency dependence of the process is why conventional measures of variability, such as the standard deviation, are not suitable for this study. However, a variance spectrum of the pressure fluctuations would provide all the information necessary to solve this problem for any tank.

Summary

This study has determined the mean pressure increase for 8 and 12-hour periods for 5 years of Bush Field data. The mean 8-hr increase was 1.7 mb and for 24 hours it was 5.0 mb. The maximum values seen in the 5 year period were 11.3 mb for 8 hours and 20.2 mb for 24 hours.

The same quantities were obtained for summer and winter seasons. The mean winter values were larger - 1.8 mb and 5.5 mb respectively, while the mean

summer values were smaller - 1.5 mb and 4.5 mb respectively. This result was expected, considering the greater frequency of weather systems in the winter.

The analysis was repeated using data collected from SRTC's Climatology Site for January and December of 1992-1993. The mean increases in pressure were found to be 2.4 mb and 7.1 mb.

Table 1. Output from SAS program for 1986-90. The lines labeled PR_SM_8 and PR_SM_24 are in mb, except for N. The lines labeled CNT_8 and CNT_24 are in number of periods.

1986 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	1095	1.6814568	1.3290675	0	8.4660439
CNT_8	1095	3.0940639	1.8684603	0	8.0000000

1986 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_24	365	5.0443705	2.6964310	0	15.9161626
CNT_24	365	9.2821918	3.6419165	0	20.0000000

1987 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	1095	1.6819207	1.3642457	0	9.3126483
CNT_8	1095	3.1442922	1.9153001	0	8.0000000

1987 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_24	365	5.0457622	2.9433449	0	19.8105428
CNT_24	365	9.4328767	3.7282724	0	24.0000000

1988Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	1098	1.6716196	1.3763875	0	10.4978945
CNT_8	1098	3.1293260	1.8679360	0	8.0000000

1988Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_24	366	5.0148588	2.6615211	0	14.9002373
CNT_24	366	9.3879781	3.4912443	0	20.0000000

1989Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	1095	1.6424898	1.3018849	0	11.3444988
CNT_8	1095	3.2000000	1.8328707	0	8.0000000

1989Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_24	365	4.9274695	2.7143222	0	19.6412219
CNT_24	365	9.6000000	3.5025893	0	22.0000000

1990Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	1095	1.7216609	1.4194222	0	10.1592527
CNT_8	1095	3.3744292	1.9251259	0	8.0000000

1990Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_24	365	5.1649826	2.9609116	0	20.1491845
CNT_24	365	10.1232877	3.7326345	0	20.0000000

Table 2. Output from SAS program for summer and winter of 1986-1990. The first two sections are for summer (June, July and August). The second two sections are for winter (January, February, and March). The lines labeled PR_SM_8 and PR_SM_24 are in mb, except for N. The lines labeled CNT_8 and CNT-24 are in number of periods.

Summer

1986 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	276	1.5858495	1.1250971	0	6.7728351
CNT_8	276	2.9601449	1.6006380	0	7.0000000

1986 Data

PR_SM_24	92	4.7575486	1.7405630	1.3545670	9.8206109
CNT_24	92	8.8804348	2.6179532	4.0000000	16.0000000

Winter

1986 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	270	1.9979864	1.6957624	0	8.4660439
CNT_8	270	3.3444444	2.1770744	0	8.0000000

1986 Data

PR_SM_24	90	5.9939591	3.6503556	0	15.9161626
CNT_24	90	10.0333333	4.6481844	0	18.0000000

Summer

1987 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	276	1.4232769	0.9030636	0	4.2330220
CNT_8	276	2.9239130	1.5717994	0	7.0000000

1987 Data

PR_SM_24	92	4.2698308	1.2848163	2.0318505	7.7887604
CNT_24	92	8.7717391	2.2193121	5.0000000	15.0000000

Winter

1987 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	270	2.0682232	1.7554968	0	9.3126483
CNT_8	270	3.3629630	2.1800290	0	8.0000000

1987 Data

PR_SM_24	90	6.2046695	4.0549173	0	19.8105428
CNT_24	90	10.0888889	4.7985120	0	24.0000000

Table 2. (Continued)

Summer

1988 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	276	1.4846251	1.1728743	0	8.1274022
CNT_8	276	2.9927536	1.6203092	0	8.0000000

1988 Data

PR_SM_24	92	4.4538753	1.9015732	0.6772835	11.6831406
CNT_24	92	8.9782609	2.8592563	2.0000000	16.0000000

Winter

1988 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	273	1.9140082	1.6129903	0	10.4978945
CNT_8	273	3.2417582	2.0418813	0	8.0000000

1988 Data

PR_SM_24	91	5.7420245	3.2257638	0	14.7309164
CNT_24	91	9.7252747	4.0001831	0	20.0000000

Summer

1989 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	276	1.4404544	0.9300458	0	4.5716637
CNT_8	276	3.0833333	1.4784308	0	8.0000000

1989 Data

PR_SM_24	92	4.3213633	1.4798309	1.5238879	9.3126483
CNT_24	92	9.2500000	2.4161772	5.0000000	19.0000000

Winter

1989 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	270	1.7803777	1.4111918	0	8.2967230
CNT_8	270	3.1185185	1.8814368	0	8.0000000

1989 Data

PR_SM_24	90	5.3411330	2.8389776	1.0159253	12.8683868
CNT_24	90	9.3555556	3.6205131	3.0000000	16.0000000

Table 2. (Continued)

Summer

1990 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	276	1.5692855	1.0367567	0	6.2648725
CNT_8	276	3.2355072	1.6444861	0	7.0000000

1989 Data

PR_SM_24	92	4.7078566	1.6075421	1.3545670	8.6353648
CNT_24	92	9.7065217	2.5442806	4.0000000	15.0000000

Winter

1990 Data

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	270	1.9177157	1.7379172	0	9.4819692
CNT_8	270	3.4444444	2.1302099	0	8.0000000

1990 Data

PR_SM_24	90	5.7531472	3.9608529	0.6772835	20.1491845
CNT_24	90	10.3333333	4.5071728	2.0000000	21.0000000

Table 3. Rosemont Pressure Sensor Data

Model	1332A10
Serial Number	20135, MTE 0046943
Purchase Date	September, 1992
Installation Date	October, 1992
Accuracy	0.3 mb
Repeatability	0.03mb
Time constant	0.01 sec
Calibration Dates	(1) Routine calibration Nov 11, 1992 (2) Calibration against mercury barometer TE-586. Instrument TE-586 was calibrated 12/3/92, traceable to NIST standard.

Table 4. Output from SAS program for December and January of 1992-93. The lines labeled PR_SM_8 and PR_SM_24 are in mb, except for N. The lines labeled CNT_8 and CNT_24 are in number of periods.

1992-93 Data

1

14:52 Tuesday, February 16, 1993

Variable	N	Mean	Std Dev	Minimum	Maximum
PR_SM_8	186	2.3857527	1.4197304	0.1500000	6.5500000
CNT_8	186	16.1612903	6.5854718	3.0000000	30.0000000

1992 Data

2

14:52 Tuesday, February 16, 1993

PR_SM_24	62	7.1572581	2.4923293	0.7100000	11.4900000
CNT_24	62	48.4838710	12.9091935	10.0000000	72.0000000

APPENDIX 1: SAS program for Tables 1 and 2.

The SAS System
18:36 Tuesday, February 9, 1993

NOTE: Copyright (c) 1989 by SAS Institute Inc., Cary, NC USA.

NOTE: SAS (r) Proprietary Software Release 6.07 TS301

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NOTE: Running on VAX Model 8550 Serial Number 06840E15.

Welcome to the new SAS System, Release 6.07.

ENVIRONMENTAL TECHNOLOGY SECTION

```
X 'SET DEFAULT SHADOW6: [SAS_WORK.PRESSURE]';

OPTIONS NOCENTER ERRORS=2;
FILENAME IN1 'DISK6: [KURZEJA] MORIN . DAT';

DATA NWS_92 CNT_8 CNT_24; INFILE IN1;
INPUT @2 FINETIM DATETIME15. @22 P_MB 7.2;
FORMAT FINETIM DATETIME13. P_MB 7.2;

TITLE FONT=SIMPLEX '1992-93 DATA';

RETAIN CNT_8;
KEEP FINETIM P_MB P_HR DIF WEEK
      CNT_8 CNT_24 REM_8 REM_24 PR_SM_8 PR_SM_24;
FORMAT FINETIM DATETIME10. PR_SM_8 6.2 PR_SM_24 6.2 CNT_8 4. CNT_24 4.;

IF MOD (N , 672) = 1 THEN DO; WEEK+1; END;
P_HR_DIF=P_MB-LAG (P_MB);

REM_8=MOD ( N_, 24);
REM_24=MOD ( N_, 96);
IF REM_8=1 THEN DO; IF P_HR_DIF>0.0 THEN DO;
                                CNT_8=1; PR_SM_8=P_HR_DIF;
                                END;
                                IF P_HR_DIF<=0.0 THEN DO;
                                CNT_8=0; PR_SM_8=0.0;
                                END;
                                END;
IF REM_8^=1 THEN DO; IF P_HR_DIF>0.0 THEN DO;
                                CNT_8+1; PR_SM_8+P_HR_DIF;
                                END;
                                IF REM_8=0 THEN OUTPUT CNT_8;
                                END;
IF REM_24=1 THEN DO; IF P_HR_DIF>0.0 THEN DO;
                                CNT_24=1; PR_SM_24=P_HR_DIF;
                                END;
                                IF P_HR_DIF<=0.0 THEN DO;
                                CNT_24=0; PR_SM_24=0.0;
                                END;
                                END;
IF REM_24^=1 THEN DO; IF P_HR-DIF>0.0 THEN DO;
                                CNT_24+1; PR_SM_24+P_HR-DIF;
                                END;
                                IF REM_24=0 THEN OUTPUT CNT_24;
                                END;
OUTPUT NWS_92;
```

Appendix 1 (Continued)

NOTE: The infile IN1 is:

File=\$1SDUS75: [KURZEJA] MORIN.DAT

NOTE: 6624 records were read from the infile IN1.

The minimum record length was 28.

The maximum record length was 31.

NOTE: Missing values were generated as a result of performing an operation on missing values.

Each place is given by: (Number of times) at (Line): (Column).

1 at 23:14

NOTE: The data set WORK.NWS_92 HAS 6624 observations and 10 variables.

NOTE: The data set WORK.CNT_8 has 276 observations and 10 variables.

NOTE: The data set WORK.CNT_24 has 69 observations and 10 variables.

DATA SUM_8; SET CNT_8;

KEEP FINETIM WEEK CNT_8 PR_SM_8;

NOTE: The data set WORK.SUM_8 has 276 observations and 4 variables.

DATA SUM_24; SET CNT_24;

KEEP FINETIM WEEK CNT_24 PR_SM_24;

NOTE: The data set WORK.SUM_24 has 69 observations and 4 variables.

PROC MEANS DATA=SUM_8;

VAR PR_SM_8 CNT_8;

NOTE: The PROCEDURE MEANS printed page 1.

PROC MEANS DATA=SUM_24;

VAR PR SM_24 CNT_24;

TITLE "1992 DATA";

ENDSAS;

NOTE: The PROCEDURE MEANS printed page 2.

The SAS System

18:36 Tuesday, February 9, 1993

NOTE: SAS Institute Inc., SAS Campus Drive Cary, NC USA 27513-2414

Appendix 2. Calibration data for the Rosemont pressure sensor S/N 20135.

BAROMETRIC PRESSURE ACCURACY Procedure ETSP T105.2

FORM OP-BP

Area: CCS Date: 11-17-92 Operator: Holland/Hamilton
Equipment to be tested: Rosemont Pressure Transducer Model 1332
Processor card: Teledyne Amplifier Module 21.62
Field instrument Rosemont S/N: 20135 Calib. data 22.132 in HG 0 1.5 volts
Standard inst. Rosemont S/N: 20136 Calib. data 22.132 in HG 0 1.5 volts
Voltmeter Fluke S/N: 3130773

Calibration begin time: 4:18 p.m.

AS FOUND							
Obs	Fluke volts (Standard)	Fluke volts (Field unit)	MAC volts (Field unit)	Pres., mb (Standard)	Pres., mb (Field unit)	Diff. mb (Std-Field)	Diff. volts = (MAC-Exp)
1	3.915	3.931	3.937	1010.16	1011.25	-1.09	.006
2	3.915	3.929	3.934	1010.16	1011.11	-.95	.005
3	3.913	3.928	3.934	1010.03	1011.04	-1.01	.006
average =						-1.02	.006
tolerance =						0.5mb	0.005v

AS LEFT							
Obs	Fluke volts (Standard)	Fluke volts (Field unit)	MAC volts (Field unit)	Pres., mb (Standard)	Pres., mb (Field unit)	Diff. mb (Std-Field)	Diff. volts = (MAC-Exp)
1							
2							
3							
average =							
tolerance =						0.5mb	0.005v

Bush Field (mb) = 1023.60 at time 5:00 p.m. Bush field (mb, corrected) = 1012.4
Climatology (mb) = 1010.64 at time 4:50 p.m.

Panel Calibration Switch										
Condition	Panel set	Voltage	Fluke Pass	Fluke Fail	Previous As Left MAC	Difference (Prev-MAC)	Expected Volts	Error (Exp-MAC)	OK	Adjust
As found	LO	Fluke = .001 MAC = -.001 Fluke-MAC = .002	✓		N/A *	N/A *	0.0	.001	✓	
As found	HI	MAC = 4.999			N/A *	N/A *	5.0	.001	✓	
As left	LO	MAC =					0.0			
As left	HI	MAC =					5.0			

Calibration end time: 5:05 p.m.

Comments: The climatology custodian has directed us to leave the old barometric pressure sensor installed until he can determine which sensor is operating properly. Neither instrument compares with Bush Field like it should.

Appendix 3. Calibration data for the Princo mercury barometer.

SAVANNAH RIVER STANDARDS LABORATORY
CALIBRATION CERTIFICATE

M&TE ID# : TE-586

Description : MERCURY BAROMETER

Manufacturer: PRINCO

Model#/Name :

Serial# : 0864

Calibrated: 12/03/92

Frequency: 60 Months

Expires : 12/97

Cal. Procedure: 328, REV.0

Alternator : N

Category : 1

NIST Traceable Standard(s) used, (Expiration Date) : SL-875 (03/93)

The measurements made on TE-586 were obtained at 21 ± 1.0 °C with a Relative Humidity between 35% and 50%.

Metrologist : T.N. ROBERTS

Appendix 3. Calibration Data for the Princo Mercury Barometer. (Continued)

Calibration Data for TE-586

Applied Pressure mBAR	TE-586 Reading mBAR	TE-586 Corrected mBAR
1000.265	1005.5	1000.901
1000.265	1005.8	1001.199
1000.265	1005.8	1001.199
1000.198	1005.8	1001.199
999.998	1005.6	1001.000
1006.499	1011.75	1007.122
1006.379	1011.7	1007.072
1005.299	1010.8	1006.176
1005.339	1010.8	1006.176
1003.166	1008.6	1004.151
1003.282	1008.5	1004.051

Note: The readings above were corrected for gravity and temperature using the equation supplied by the customer. The average difference of the corrected values above from the pressures applied must also be subtracted, which is 0.84 mBAR.

So, the final correction to any readings taken from TE-586 is:

$$\text{Corrected pressure} = (\text{Reading} * \text{Local Gravity} / 980.665 * (1 - 0.000163 * \text{Temp.})) - 0.84$$

where local gravity is in Cm/S/S and temp. is in degrees Celsius.

The estimated uncertainty of the standard(s) and measurement process at SRSL is $\pm 0.02\%$ RDG.

Figure 1. Plot of barometric sensor data at the Climatology Site in mb. The dashed line is Bush Field data. Vertical line segments show missing data.

Figure 2. Climatology pressure data for week 1, December 1-8, 1992.

Figure 3. Climatological pressure data for week 2, December 8-15, 1992.

Figure 4. Climatology pressure data for week 3, December 15-21, 1992.

Figure 5. Climatology pressure data for week 4, December 22-28, 1992.

Figure 6. Climatological pressure data for week 5, December 29, 1992 - January 4, 1993.

Figure 7. Climatological pressure data for week 6, January 5 -11, 1993

Figure 8. Climatology pressure data for week 7, January 12-18, 1993.

Figure 9. Climatology pressure data for week 8, January 19-25, 1993

Figure 10. Climatological pressure data for week 9, January 26 - February 2, 1993

Figure 11. Climatological pressure data for week 10, February 2-8, 1993

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