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OPERATIONAL TEST REPORT FOR THE 241AN107 ENRAF ADVANCED TECHNOLOGY GAUGES

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ENGINEERING DATA TRANSMITTAL

Page 1 of 1

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16. KEY

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1	1	Cog.Eng. JL Dowell	JL Dowell	3.15.96	E6-21	KG Carothers	per telecon JL Dowell	9.19.96	R1-56	1	1
1	1	Cog. Mgr. GN Hanson	per telecon JL Dowell	9.9.96	S5-05	RS Nicholson	per telecon JL Dowell	9-23-96	S5-05	1	1
3		QA JJ Verderber			S1-57	MD Harding	per telecon JL Dowell	9.24.96	S5-03	1	1
3		Safety SU Zaman			R3-08						
		Env. N/A									

18.	19.	20.	21. DOE APPROVAL (if required) Ctrl. No.
JL Dowell 3.15.96 Signature of EDT Originator Date	Authorized Representative Date for Receiving Organization	9-25-96 Cognizant Manager Date	[] Approved [] Approved w/comments [] Disapproved w/comments

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Operational Test Report for the 241-AN-107 ENRAF Advanced Technology Gauges

JL DOWELL
for Westinghouse Hanford Co., Richland, WA 99352
U.S. Department of Energy Contract DE-AC06-87RL10930

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Abstract: The purpose of this report is to document that the two (2) ENRAF Advanced Technology Gauges function as intended as installed at 241-AN-107 tank farm.

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OPERATIONAL TEST REPORT

FOR THE

241-AN-107 ENRAF ADVANCED TECHNOLOGY GAUGES

February 1996

J. L. Dowell

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OPERATIONAL TEST REPORT FOR THE 241-AN-107 ENRAF ADVANCED TECHNOLOGY GAUGES

1.0 INTRODUCTION

The Operational Test Procedure for the 241-AN-107 ENRAF Advanced Technology Gauges (ATGs), WHC-SD-WM-OTP-187, was started on October 16, 1995, and was completed February 13, 1996. K. G. Carothers of Tank Waste Remediation Systems Engineering requested the test procedure; ICF Kaiser Engineers' Control Systems Engineering department wrote the test procedure and supported its performance at the 241-AN-271 Building of the Hanford Site.

2.0 DESCRIPTION OF TEST

The purpose of the test procedure was to verify the proper function of the major components of the vertical density profile data acquisition system as installed on Tank 241-AN-107 to support the Caustic Addition program. Testing was intended to verify that the functional, operational, and design requirements are met by the equipment as installed in its final inservice configuration. Each component was evaluated against the following criteria:

-- The Workstation/Computer Criteria:

- Boots up to DOS*.

- Communications to the ATGs via the Communications Interface Unit (CIU) using the LOGVR18 program.

- Runs "batch" files CYL_OTP.RQS and IP_OTP.RQS to collect vertical density profiles from both gauges simultaneously.

- Runs a "batch" file to individually lift a displacer 7 to 10 inches then stop.

-- ATG Criteria:

- Responds with an error code = 000 or 0000 (indicating no problems) for the XPU and SPU of the ATG.

- Gauge Transmission Address (TA) is correlated to the riser on which the gauge is installed on.

- Reports an I1 elevation within 1.5 inches of the accepted waste elevation.

*DOS (MS)-DOS is a trademark of Microsoft Corporation.

- Reports a density for the upper 3 feet of unmixed supernatant of 1.39 ± 0.05 sp.g. using the "batch" files CYL_OTP.RQS and IP_OTP.RQS.

-- Rinse Spool Assembly Spray Nozzle Criteria:

- Flow through each spray nozzle is 1.3 gpm or greater when 80 psi (minimum) is applied.

-- Digital Panel Meter Criteria:
- Each gauge will display 0 to 650 ± 20 inches for an input of 4 to 20 mA.

3.0 TEST METHOD AND TEST EQUIPMENT

The ENRAF gauges are installed per H-2-824486 and H-2-85573 on Tank 241-AN-107, risers 1C (101G) and 15A (131G). The gauges are connected to the computer workstation through the CIU. The gauges were also connected to the panel meters. The Portable ENRAF Terminal was connected to each gauge as needed.

4.0 TEST RESULTS

4.1 Summary of Test Results

A reproduction of the master control copy of the test procedure follows (Attachment 2). The data sheets containing all data taken are included as part of Attachment 2. Also included in Attachment 2 are printoits of the batch files CYL_OTP.RQS, IP_OTP.RQS, LIFT1C.RQS and LIFT15A.RQS.

Communication between the gauges, CIU, computer workstation and panel meters was without problems. When queried for an error code, both gauges responded with an error code = 000 or 0000 indicating there were no problems with the gauge XPU or SPU. The Rinse spool piece assembly performed satisfactorily. The gauge address was correlated to the riser number: the gauge at address 00 is on Riser 1C and the gauge at address 01 is on Riser 15A. While there were problems with the displacers not submerging into the waste, these problems were overcome and the batch files successfully used. Using the batch files the displacer was successfully controlled, and the waste level and density reported into the .RPL and .LOG files. Unfortunately, as the density values reported by the gauge on Riser 1C (see Section 9.0 graph of OTP Raw Density data, file CYL_OTP) are not within the specified range detailed in the criteria (1.39 ± 0.05 grams/cm^3) the test can only be described as a conditional success, rather than an unconditional success.

NOTE: For an explanation of how the 854 ATG works, see Section 8.1.
NOTE: Unless otherwise indicated all densities are expressed in units of specific gravity (water = 1.0).
NOTE: For all calculations the waste density is assumed to be 1.41.

4.2 Detailed Explanation of Test Results

On October 17, 1995 while attempting to submerge the displacers to measure the sediment levels, it was found the displacers would not completely submerge. Attempts to lower the displacer by altering the tension setpoint would lower the displacer slightly, but the displacer could not be completely submerged. Testing was halted for further inquiry. Investigation revealed that the displacers were the incorrect density (= 1.58) instead of density of 1.73 or greater. Calculations indicate these displacers will achieve neutral buoyancy with a wire tension of 25.8 grams. This wire tension setting is below the 40 grams tension setting attempted. Also, a wire tension setting to achieve neutral buoyancy is near or below the internal "wire broken" setting of about 30 grams, thus these displacers could not submerge into the waste using the 854 gauges.

The displacers were replaced and testing resumed (on December 14, 1995) at Section 1.9. Again attempting to submerge the displacer on Riser 15A [density = 1.90] in order to measure the sediment level, it was found the displacer would not completely submerge, but stopped about 4 inches below the waste surface (waste surface elevation = 384.5 inches). Calculations indicate the displacer will be neutrally buoyant with a tension setting of 60 grams. However, even with a tension setting of 40 grams the displacer would not sink into the waste. The displacer on riser 1C was not lowered into the waste at this time to avoid contaminating it in case it needed to be replaced.

At this time it was hypothesized a layer located about 4 inches below the waste surface provided mechanical support to the displacer. In order to confirm (or deny) this hypothesis a series of Tension versus Elevation measurements would be taken using the gauge on Riser 15A and compare this data to calculated values.

On February 10, 1996 a series of measurements was taken using the displacer on riser 15A: the tension setting was reduced in small increments and the stabilized elevation of the displacer was recorded. Calculations indicated the displacer should be neutrally buoyant at a tension of 60 grams; thus any lack of downward motion with lesser tensions would have to be attributed to a sub-surface layer or other phenomenon. However, when the tension was set at 60 and 50 grams, the displacer did not go below the 380 inch elevation. When the tension was set at 40 grams, the displacer did go below the 380" elevation and stopped at 79.67 inches (see Section 9.0, Tension vs Elevation data, Riser 15A - try 2). Given this unexpected result [passing below the 380" elevation] and the fact the flushing operations were cleaning the displacers extremely well, the measurements were repeated using the displacer at riser 1C. See Section 9.0, Tension vs Elevation data, Riser 1C.

Calculations indicated the displacer at Riser 1C would be neutrally buoyant at a tension of 86 grams; thus any lack of downward motion with lesser wire tension would have to be attributed to the sub-surface layer or other phenomenon. However, with the tension set at 80 and 70 grams, the displacer did not go below the 380 inch elevation. When the tension was set at 60 grams, the displacer did go below the 380" elevation and stopped at 83.59 inches.

Based on these two measurements, it appears the wire tension needs to be at least 15 to 25 grams lower than the (calculated) neutral buoyancy tension setting to submerge below the waste surface. Despite this unexpected success, the displacers were replaced with units weighing about 285 grams to provide a larger margin of tension available to "punch through" any potential sub-surface layer as it is possible that internal tank currents or the planned mixing operations could move a "stronger" sub-surface layer under the gauges.

Once the displacers were replaced the batch files successfully controlled the gauges and obtained the vertical density profile data. Each reply file was successfully converted into a .LOG file. Copies of the .LOG and .RQS files and spreadsheet compatible files are included in the Test Data Sheet section of Attachment 2.

The values obtained for the waste level were within the specified ± 1.5 inches of the accepted values. The current waste level in tank AN-107 [per the entry dated 2-13-96 in TF-OR-EF-AN] was stated at 384.8 inches. The gauge on Riser 1C measured the waste level at 384.50 inches [raw value]; to adjust for the amount of the displacer below the waste level add 0.79 inches to get a corrected waste level of 385.29 inches. The gauge on Riser 15A measured the waste level at 384.25 inches [raw value]; to adjust for the amount of the displacer below the waste level add 0.79 inches to get a corrected waste level of 385.04 inches.

The raw values obtained for the waste density [the upper 3 feet] were within the specified value [1.39 ± 0.05] for gauge on Riser 15A [1.36]. The raw values obtained for the upper 3 feet waste density were <u>not</u> within the specified value for gauge on Riser 1C [1.50]; the density measurements from the gauge on Riser 1C consistently show a positive 0.143 (8.4%) bias. A field check shows this bias is due to an erroneous parameter entered into the gauge; the DV parameter is entered as 135 instead of 147.32. To correct the raw data values are multiplied by 0.91637 (135/147.32) to yield the corrected value. The corrected data for Riser 1C is shown in Attachment 1.

While the raw results from gauge 1C do not met the criteria and the source of the error has been located, the gauge will be accepted "as is" because 1) the gauge to gauge correlation is excellent [using adjusted values is 0.99] and, 2) the raw data taken will be used to find a adjusted baseline to look for changes induced by the mixing test rather than absolute results, though those are available using the correction factor until the correct DV parameter is entered.

Also, the density data (from both gauges) shows a slight trend indicating the density of upper waste material is greater than the waste material below it. This apparent trend is attributed to the gauge using the default value for the wire volume compensation factor. This factor is dependent on the density of the material being measured and the values [0.0281 and 0.032] are for use in materials with a density less than 0.5. Despite repeated contacts and attempts, the gauge vendor did not supply the appropriate wire volume compensation factor for our installation.

5.0 DISCUSSION OF TEST EXCEPTIONS

During the course of the test 12 (twelve) test exceptions were generated. Most were to correct typos, to make minor changes to the test procedure or to document the difficulties with getting the displacers to submerge more than 4 (four) inches into the waste. These Test Exceptions are summarized and discussed here.

Test Exception #1: Used alternate method to correlate the gauge address to the riser location. Power at one of the gauges was OFF, and it was possible using LOGVR18 to determine which gauge address was not responding.

Test Exception #2: Corrected a typo on the data sheet; the values for AN and AM were reversed. Also note the location of AN and AM on Figures 1 and 2 in the OTP are reversed.

Test Exception #3: Corrected a typo on the data sheet; the value for DO should be 5 (not S).

Test Exception #4: Corrected a typo on the data sheet; the value for ER should be FRI3 (not FR13). [See Test Exception #6A.]

Test Exception #5: There was only 1 (one) connection point of the flush assembly instead of 3 (three). Revised minimum flow to be 3.9 gpm [3 X 1.3 gpm].

Test Exception #6A: Change ER parameter [Error Restart - instructs the gauge what to do if an error or power drop out occurs] to FRI2. This makes the setup of the gauges compatible with 6-TF-125. In the event of an error or power drop out, the displacer will either freeze in its current location or will descend down. The intent is to "fail safe" and avoid the possibility of wrapping wire covered with tank waste on the drum should an error or power drop out occur.

Test Exception #6B: The original displacers were replaced and on 12/14/95 the OTP was restarted. However the displacer on Riser 15A would not go below the 380" elevation. As this was unexpected, the test was again halted for troubleshooting. On 2/10/96 a displacer weighing 231 grams went below the 380" elevation and found the sludge level. In order to have a greater margin of downward force available, the 231 gram displacer was replacer with a 286 gram displacer. On 2/13/96 the OTP was restarted and all field work completed.

Test Exception #7: In order to save time and reduce water put into the tank, steps 1.9.1.7 through 1.9.1.10 [finding the sludge level using I2] were not performed as the sludge level had been found on 2/10/96. As the data sheet was "full" from previous attempts, data was recorded on the Test Exception Sheet.

Test Exception #8: Performed step 1.9.4.11 [exit the program] as the last step of section 1.9.4 to avoid leaving the program prematurely.

Test Exception #9: The LIFT1C.RQS and LIFT15A.RQS files were modified by:
1) Adding a !PAUSE 15 after several commands to allow them to take effect, otherwise one or more of the following commands are ignored.
2) Adding a command to exit the Maintenance mode; otherwise the Maintenance specific commands would be accepted after the file was executed.
3) Modifying the time the displacer is lifting (from 8 to 15 seconds) to lift the displacer per the requirements.

Test Exception #10: Deferred examination of data (step 1.9.3.12) to a later date. When the data were examined on 2/20/96, it was discovered the raw density data from the gauge on riser 1C is consistently higher than that reported by the gauge on riser 15A. [See details elsewhere in this report.] The intent of the density profile measurement in the OTP is to establish a baseline [before any mixing has occurred) for future comparison. Also the source of the error has been determined and the data can be adjusted.

Test Exception #11: No data was gathered (by either gauge) in the top third of the tank [10 measurements] as the gauge did not have enough time to establish a valid reading for the waste level; that reading is required as part of the Density profile command used in the batch file. Sufficent time had elapsed to establish a reading for the waste level for the following 20 measurements. The twenty good measurements taken are sufficient for a comparison to the data taken by the other batch file CYL_OTP.RQS. (See Attachment 1.)

6.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the Operational Test Procedure show that the gauges function as required for the 241-AN-107 Caustic Addition program.

7.0 REFERENCES

1. Instruction Manual Series 854 ATG Level Gauge, version 2.2, pg 40 by ENRAF Inc.
2. 6-TF-125, ENRAF SERIES 854 PREVENTIVE MAINTENANCE AND CALIBRATION.

8.0 GAUGE PRINCIPLES

8.1 854 Gauge Operation

The 854 gauges operates by lowering a displacer on a wire and monitoring the tension in the wire and the amount of wire reeled out. The displacer weight, displacer volume and a reference elevation (parameters DW, DV and RL respectively) are loaded into the 854 gauge when it is calibrated. A 854 gauge is calibrated every time a displacer is changed.

Note: for all measurements with the 854 gauge, the elevation reference point is the bottom of the displacer.

The 854 gauge has three wire tension settings the user can set: S1, S2 and S3, but for level monitoring purposes only S1 is of concern. At calibration S1 is set at the displacer weight minus 15 grams. When the 854 gauge is instructed to monitor the level, the 854 gauge lowers the displacer and monitors the wire tension and position. When the tension reaches the S1 value the 854 gauge stops displacer motion and reports the elevation. By knowing the amount of the displacer submerged into the liquid, an accurate value of the level can be determined.

To determine the density of the material the displacer is submerged completely to the position desired. The 854 gauge then measures the tension in the line and calculates the density of the material supporting the displacer; a denser material provides more buoyant support [thus the wire tension will be less] than a lighter material [thus the wire tension will be greater].

Note: The 854 gauge can <u>not</u> determine if there are outside influences on the displacer. If the material was a soft slushy material that provided some mechanical support, or was in a location with a general "up current"; the reported density would be biased high. In the same way if a "glob" of solidified material was attached to the displacer or was in a location with a general "down current"; the reported density would be biased low.

However, the 854 gauge also has two setpoints related to wire tension. The first is a tension setting of 350 grams and a tension equal to or above is interpreted by the 854 gauge as "displacer stuck" error; the 854 gauge ceases displacer motion and enters a fault mode. The second is a tension setting of 25 to 35 grams and a tension equal to or less than is interpreted by the 854 gauge as a "wire broken" error; the 854 gauge again ceases displacer motion and enters a fault mode.

There is another constraint on the 854 gauge: the DW, and all tension settings cannot exceed 300 grams. Values over 300 grams are not accepted by the 854 gauge as valid settings.

8.2 Displacer Calculations

Throughout this report there are references to calculations associated with the displacer (volume and weight) as well its' submergence and interaction with the wire tension. This section describes how the model for these calculations was created, how adjustments for different displacer volumes are handled and seperate hand calculations to show the model is working correctly.

8.3 Displacer Model: Assumptions and Equations

The displacer is modeled in 3 segments: the lower segment as an inverted cone, the middle segment as a right circular cylinder and the upper segment as a cone.

Assumptions:

1) The effects of the "rounded point" and eyelet are ignored.

2) The volume of the bottom segment and the volume of the upper segment are constant from displacer to displacer; variations in the overall displacer volume are made by adjusting the length of the middle segment.

3) The density of air is zero (compared to the waste density).

The equation for the volume of a circular cone is:

$$\text{Volume} = 1.047*H*R^2$$

where:
H is the height of the cone
R is the radius of the base of the cone

The equation for the volume of a right circular cylinder is:

$$\text{Volume} = 3.1415*H*R^2$$

where:
H is the height of the cylinder
R is the radius of the base of the cylinder

The radius of the base is specified at 1 11/16 inch diameter (converts to a radius of 2.143 cm), the cone height is measured at 0.75 inch (converts to 1.9 cm).

Note: The parameter for the distance the displacer sinks into the material (Z) is referenced from the bottom of the displacer.

Using this information the values for Va, Vb and Vc have been determined for displacers haveing overall volumes of 122, 135 and 150 cm^3 (pages 12+)

8.4 Displacer Model: Bouyancy Equations

To take into account the volume and weight of the displacer, the force/tension in the wire and the density of the waste the following equations are needed:

The general equation for displacer bouyancy is:

F = G - (V1*R1+V2*R2) (From Ref 1)

where:

F = Force or Tension in the wire
G = Weight of the displacer in air
R1 = Density of upper material (air)
V1 = Volume of displacer in upper material
R2 = Density of lower material (waste)
V2 = Volume of displacer in lower material

For measuring level, the upper material is air, whose density is approximated by zero. Thus the equation simplifies to:

F = G - (V*R)

and is re-arranged to solve for R:

R = (F - G)/V

where:

R = Density of material (waste)
F = Force or Tension in the wire
G = Displacer weight, in air
V = Volume of displacer

The above equations are combined with the displacer model allowing the performance of the displacer to be predicted.

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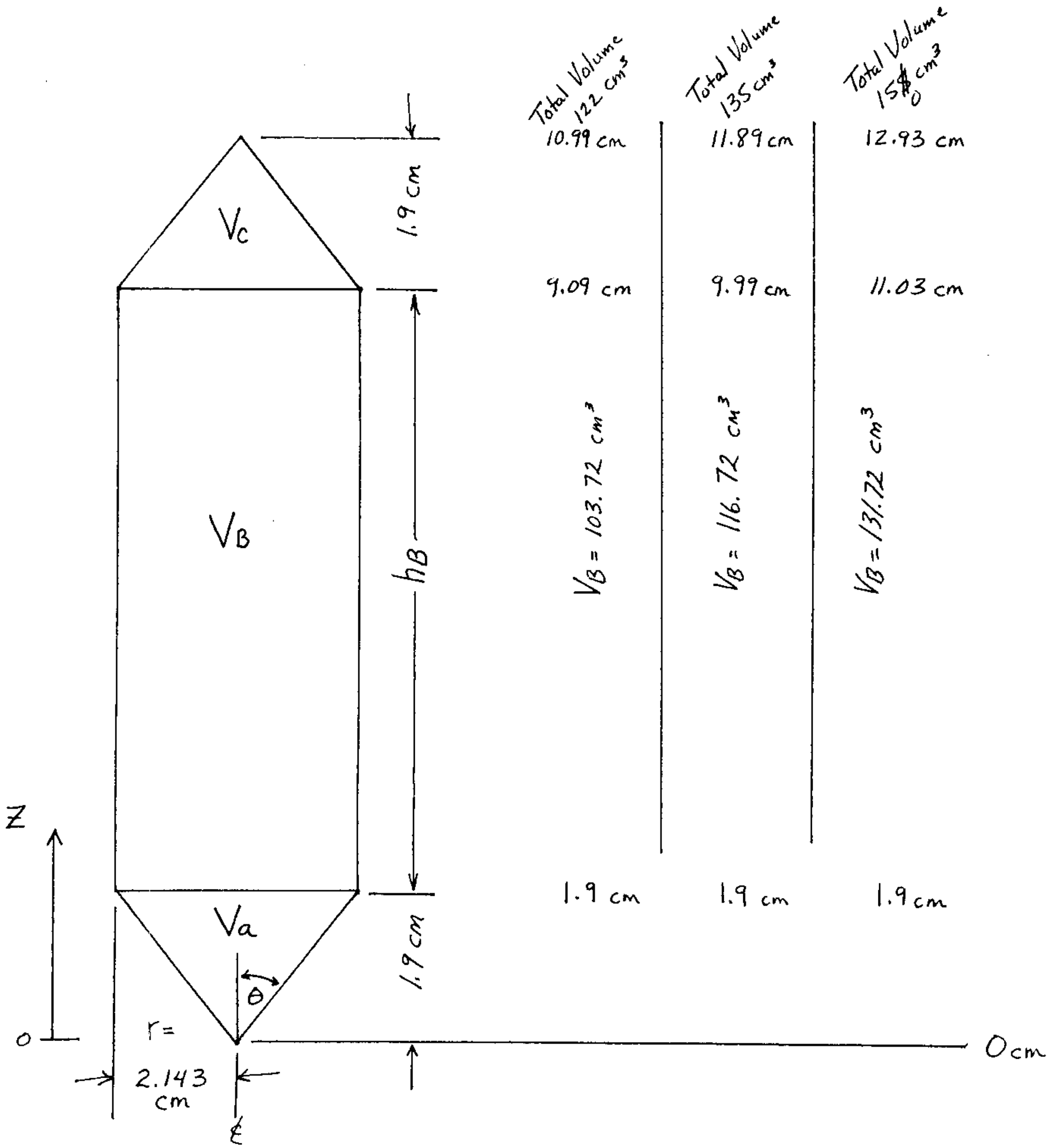

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For all displacers:

1) Top & bottom end cones are identical
2) Balance of total volume set by middle segment length.
3) Radius = 1 11/16" dia ⇒ 2.143 cm RADIUS
4) Cone height = 3/4" ⇒ 1.9 cm

Thus: cone volume = $\frac{\pi}{3} h r^2 \Rightarrow 1.047 * 1.9 * 2.143^2 \Rightarrow \underline{9.14\ cm^3}$

So - for a 122 cm³ displacer, the volume of the middle segment = 122 − 2(9.14) ⇒ 103.72 cm³

& for a 135 cm³ displacer, V_b = 116.72 cm³

& for a 150 cm³ displacer, V_B = 131.72 cm³

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Volume of a Rt circular cylinder $= \pi r^2 h$

Knowing V_B we can find h.... $h = \frac{V}{\pi r^2}$

For a 122 cm³ displacer

$$h_B = \frac{\cancel{122}\ 103.72\,cm^3}{\pi(2.143)^2} \Rightarrow \underline{7.189\,cm}$$

This length + 1.9 yields the distance to ~~the~~ where V_B & V_C meet; $7.19 + 1.9 = \underline{9.09\,cm}$

Add another 1.9 cm to this + the overall length of the displacer is found $\Rightarrow 1.9 + 9.09 \Rightarrow 10.99$ cm

For a 135 cm³ displacer,

$$h_B = \frac{116.72}{\pi(2.143)^2} \Rightarrow 8.09\text{ cm long}$$

V_C/V_B interface $= 8.09 + 1.9 = \underline{9.99\text{ cm}}$

Top of displacer $= 9.99 + 1.9 = \underline{11.89\text{ cm}}$

Similarly for a 150 cm³ displacer:

$h_B = \frac{131.72}{\pi(2.143)^2} \Rightarrow \underline{9.13\,cm}$ V_C/V_B interface $= 9.13 + 1.9 = \underline{11.03\text{ cm}}$

Top of displacer $= 11.03 + 1.9 = \underline{12.93\text{ cm}}$

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As the displacer is lowered into the waste, Va will change until it is fully submerged & the $9.14\ cm^3$ is in the waste. To calculate Va as a function of Z will require find the cone base (Ra) radius as a function of Z: (Cone height = Z).

$$Tan(\theta) = Ra / Z$$

But θ is a constant (as the cones are constant)

based on $\tan(\theta) = R / 1.9 \Rightarrow 2.143/1.9 = 1.128$

or $\theta = \cancel{.8769}$ .8454 radian (48.44 deg)

So, knowing Z (& θ), Ra can be found, and thus Va can be found.

Once the bottom cone is covered, the middle segment (V_B) Needs to be found as a function of Z:

$h_B = Z - 1.9$ over the range of Z = 1.9 to the V_B & V_C inter face.

~~In a similar manner, Rc can be found for the upper segment (Cone) except the equation for the volume will be for the frustrum of a cone ie.~~

$$\cancel{V_C = \frac{\pi}{3} h_C (r_1^2 + r_1 r_2 + r_2^2)}$$ JJD 12-28-95

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To find Vc - it is easiest to find how much is above the waste, subtract that volume from 9.14cm³ and the resultant is Vc.

$$V_c = 9.14 - \frac{\pi}{3} h \cancel{R_c^3} R_c^2$$

where $h = 12.93 - Z \quad (11.03 < Z < 12.93)$

$R_c = (12.93 - Z) * \tan\theta \quad (0 \cancel{Z} < R_c \leq \cancel{1.9}\ 2.143)$

Equation Summary for Displacer Volume Calculations

θ is determined by

$R / Z_{cone} = \tan\theta$

where:

Z_{cone} is ~~a~~ total cone height (1.9cm)

R is ~~overlal~~ overall displacer radius (2.143 cm)

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The radius for the lower segment / Cone ~~(VA)~~ (Ra) is known by:

$$\tan(\theta) = Ra/Z$$

where Ra is the cone base radius at elevation Z. The volume of the lower segment (Va) is found by:

$$Va = \frac{\pi}{3} Ra^2 Z$$ (with a maximum value of 9.14 cm³)

The volume of the middle segment (V_B) is found by:

$$V_B = \pi R^2 (Z - 1.9)$$ (with Z greater than 1.9 cm but less than the V_B/V_C interface)

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APPROVED		DATE	

Once all these have been determined, these are tied to the general equations for bouyancy, ~~derived~~ based on ~~from~~ the equations 8.8 in the ENRAF manual:

$$F = G - (V1 * R1 + V2 * R2)$$

Where F = Force / Tension in wire
G = Weight of displacer in air (DW)
V1 = Volume of displacer above waste
V2 = Volume of displacer below waste
R1 = Density of air
R2 = Density of waste

Also, $V1 + V2 = DV$ (overall displacer volume)

As R1 is approximated at 0 (zero), & $V2 = Va + Vb + Vc$ & G is also DW, we have:

$$F = DW - V2 * R2$$
$$DV = V1 + V2$$
$$V2 = Va + Vb + Vc$$

These 3 equations plus those previous allow the displacer parameters, shape of displacer & its' submergence to be calculated, based ~~on~~ on these parameters (ie Force in wire @ z = value).

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8.5 Displacer & Bouyancy Equations: Model Calculations

The model for the combined bouyancy and displacer equations was verified using hand calculations (next section). Each displacer (Volumes of 122, 135 and 150 cm^3) was checked at a different Z elevation to cross each segment (Va, Vb and Vc) of the displacer for a total of 9 cacluations. Hand calculations and model printouts for each scenario follow.

Note: Values for Ra is shown at a factor of 2.54 larger; the value used for other calculations "behind" the scene are correct. All results except for Ra are correct, as shown.

```
Equations to model a 122 cm3 displacer at various depths:
DD=DW/DV                         Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                       Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2                         Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                      Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)        Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),9.09)-1.9) Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(10.99,10.99-MAX(9.09,Z)))*Rc^2) Volume of upper di
TAN(Theta)=Ra/(MIN(Z,1.9))        Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone                Find cone angle
MIN(TAN(Theta)*(10.99-Z),R)=Rc            Find Rc=f(Z)
```

Variables for a 122 cm3 displacer at depth = .4 inch.

Input	Name	Output	Unit	Comment
	DD	1.8998279	g/cm^3	Disp. Density
231.779	DW		g	Dips. Weight
122	DV		cm^3	Disp. Volume
	F	229.80513	g	Force on wire/Tension setpoint
.4	Z		in	Distance disp submerged in waste
	V1	120.60009	cm^3	Volume of disp above waste
	V2	1.3999081	cm^3	Volume of disp below waste
	VA	1.3971212	cm^3	Vol of lower disp segment
	VB	0	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
	Ra	2.9106903	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
0	R1		g/cm^3	Density of air
1.41	R2		g/cm^3	Density of waste
	Theta	.84542983	Radians	Cone angle

Variables for a 122 cm3 displacer at depth = 2 inch.

Input----	Name---	Output---	Unit----	Comment----------------
	DD	1.8998279	g/cm^3	Disp. Density
231.779	DW		g	Dips. Weight
122	DV		cm^3	Disp. Volume
	F	154.19909	g	Force on wire/Tension setpoint
2	Z		in	Distance disp submerged in waste
	V1	66.978785	cm^3	Volume of disp above waste
	V2	55.021215	cm^3	Volume of disp below waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	45.878428	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
0	R1		g/cm^3	Density of air
1.41	R2		g/cm^3	Density of waste
	Theta	.84542983	Radians	Cone angle

Variables for a 122 cm3 displacer at depth = 4 inch.

Input----	Name---	Output---	Unit----	Comment----------------
	DD	1.8998279	g/cm^3	Disp. Density
231.779	DW		g	Dips. Weight
122	DV		cm^3	Disp. Volume
	F	60.816912	g	Force on wire/Tension setpoint
4	Z		in	Distance disp submerged in waste
	V1	.75029208	cm^3	Volume of disp above waste
	V2	121.24971	cm^3	Volume of disp below waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	103.73141	cm^3	Vol of middle disp segment
	VC	8.3782943	cm^3	Vol of upper disp segment
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	.93615263	cm	Radius of cone in Volume C (top)
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
0	R1		g/cm^3	Density of air
1.41	R2		g/cm^3	Density of waste
	Theta	.84542983	Radians	Cone angle

```
Equations to model a 135 cm3 displacer at various depths:
DD=DW/DV                           Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                         Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2                           Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                        Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)                      Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),9.99)-1.9) Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(11.89,11.89-MAX(9.99,Z)))*Rc^2) Volume of upper di
TAN(Theta)=Ra/(MIN(Z,1.9))          Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone                  Find cone angle
MIN(TAN(Theta)*(11.89-Z),R)=Rc             Find Rc=f(Z)
```

Variables for a 135 cm3 displacer at depth = .4 inch.

Input	Name	Output	Unit	Comment
	DD	2.0514815	g/cm^3	Disp. Density
276.95	DW		g	Dips. Weight
135	DV		cm^3	Disp. Volume
	F	274.97613	g	Force on wire/Tension setpoint
.4	Z		in	Distance disp submerged in waste
	V1	133.60009	cm^3	Volume of disp above waste
	V2	1.3999081	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste
	VA	1.3971212	cm^3	Vol of lower disp segment
	VB	0	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
	Ra	2.9106903	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
	Theta	.84542983	Radians	Cone angle

Variables for a 135 cm3 displacer at depth = 2 inch.

Input	Name	Output	Unit	Comment
	DD	2.0514815	g/cm^3	Disp. Density
276.95	DW		g	Dips. Weight
135	DV		cm^3	Disp. Volume
	F	199.37009	g	Force on wire/Tension setpoint
2	Z		in	Distance disp submerged in waste
	V1	79.978785	cm^3	Volume of disp above waste
	V2	55.021215	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	45.878428	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
	Theta	.84542983	Radians	Cone angle

Variables for a 135 cm3 displacer at depth = 4.25 inch.

Input	Name	Output	Unit	Comment
	DD	2.0514815	g/cm^3	Disp. Density
276.95	DW		g	Dips. Weight
135	DV		cm^3	Disp. Volume
	F	89.071938	g	Force on wire/Tension setpoint
4.25	Z		in	Distance disp submerged in waste
	V1	1.7531478	cm^3	Volume of disp above waste
	V2	133.24685	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	116.71587	cm^3	Vol of middle disp segment
	VC	7.3909779	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	1.2350447	cm	Radius of cone in Volume C (top)
	Theta	.84542983	Radians	Cone angle

```
Equations to model a 150 cm3 displacer at various depths:
DD=DW/DV                        Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                      Eq. 8.8 from ENRAF
DV=V1+V2                        Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                     Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)                   Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),11.03)-1.9) Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(12.93,12.93-MAX(11.03,Z)))*Rc^2) Volume of upper d
TAN(Theta)=Ra/(MIN(Z,1.9))       Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone               Find cone angle
MIN(TAN(Theta)*(12.93-Z),R)=Rc          Find Rc=f(Z)
```

Variables for a 150 cm3 displacer at depth = .4 inch.

Input	Name	Output	Unit	Comment
	DD	1.91126	g/cm^3	Disp. Density
286.689	DW		g	Dips. Weight
150	DV		cm^3	Disp. Volume
	F	284.71513	g	Force on wire/Tension setpoint
	V1	148.60009	cm^3	Volume of disp above waste
	V2	1.3999081	cm^3	Volume of disp below waste
1.41	R2		g/cm^1	Density of waste
	VA	1.3971212	cm^3	Vol of lower disp segment
	VB	0	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
.4	Z		in	Distance disp submerged in waste
	Ra	2.9106903	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
2.143	R		cm	Radius of displacer
	Theta	.84542983	Radians	Cone angle

Variables for a 150 cm3 displacer at depth = 2 inch.

Input	Name	Output	Unit	Comment
	DD	1.91126	g/cm^3	Disp. Density
286.689	DW		g	Dips. Weight
150	DV		cm^3	Disp. Volume
	F	209.10909	g	Force on wire/Tension setpoint
	V1	94.978785	cm^3	Volume of disp above waste
	V2	55.021215	cm^3	Volume of disp below waste
1.41	R2		g/cm^1	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	45.878428	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
2	Z		in	Distance disp submerged in waste
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
2.143	R		cm	Radius of displacer
	Theta	.84542983	Radians	Cone angle

Variables for a 150 cm3 displacer at depth = 4.75 inch.

Input	Name	Output	Unit	Comment
	DD	1.91126	g/cm^3	Disp. Density
286.689	DW		g	Dips. Weight
150	DV		cm^3	Disp. Volume
	F	76.404486	g	Force on wire/Tension setpoint
	V1	.8620466	cm^3	Volume of disp above waste
	V2	149.13795	cm^3	Volume of disp below waste
1.41	R2		g/cm^1	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	131.72014	cm^3	Vol of middle disp segment
	VC	8.2778134	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
4.75	Z		in	Distance disp submerged in waste
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	.97562895	cm	Radius of cone in Volume C (top)
2.143	R		cm	Radius of displacer
	Theta	.84542983	Radians	Cone angle

8.6 Displacer & Bouyancy Equations: Hand Calculations

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SUBJECT Displacer Calculation: 122 cm³, Z = .4 inch			
ORIGINATOR JL Dowell		DATE 1-10-96	
CHECKER-ENGINEER		DATE	
APPROVED		DATE	

For a displacer $DV = 122\ cm^3$, $DW = 231.779\ g$ &
$Z = 0.4$ inches, find $V_a, V_B, V_c, V1, V2$ & F.

Find R_a, V_a:

$\tan\theta = R_a / Z$; $\theta = .8454$ rad

$Z = .4'' \times 2.54 \frac{cm}{in} = 1.02\ cm$

$1.02(\tan(.8454)) \Rightarrow 1.02\,(1.13) \Rightarrow \underline{R_a = 1.15\ cm.}$

$V_A = \frac{\pi}{3} Z R_a^2 \Rightarrow \frac{3.1415}{3}(1.02)(1.15)^2 \Rightarrow \underline{1.40\ cm^3 = V_a}$

As V_a is less than $9.14\ cm^3$; $\underline{V_B \ \& \ V_c = 0}$

$V_2 = V_A + V_B + V_C \Rightarrow \underline{V_2 = 1.40\ cm^3}$

$DV = V1 + V2 \Rightarrow V1 = 122 - 1.40 = \underline{120.6 = V1}$

But $F = DW - V2\,R2$ $\quad (R2 = 1.41\ g/cm^3)$

$F = 231.779 - (1.40)(1.41) \Rightarrow \underline{229.80\ g = F}$

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SUBJECT Displacer Calculations; DW=122, Z=2"

ORIGINATOR JL Dowell DATE 1-10-96

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For a displacer DV= 122 cm^3, DW= 231.779 g &

Z = 2 inches; Find V_a, V_B, V_c, V_1, V_2 & F.

Find R_a, V_a:

$\tan\theta = R_a/Z$ $\qquad$ $\theta = .8454$ rad

$Z = 2'' \times 2.54 \frac{cm}{inch} = 5.08$ cm

$(5.08)(1.13) = 5.73$ cm

As this exceeds the max. radius of this displacer, segment V_a is fully covered; then $\underline{V_a = 9.14\ cm^3}$. The segment V_B is submerged 5.08 - 1.9 cm ⇒ 3.18 cm^3 (h_B)

$V_B = \pi r^2 h_B = 3.14\,(2.143)^2(3.18) \Rightarrow \underline{45.88\ cm^3 = V_B}$

As Z is less than 9.99 cm, $\underline{V_c = 0}$

$V2 = V_A + V_B + V_c = 9.14 + 45.88 + 0 \Rightarrow \underline{V2 = 55.02\ cm^3}$

$V1 = DV - V2 \Rightarrow 122 - 55.02 \Rightarrow \underline{V1 = 66.98\ cm^3}$

But $\qquad F = DW - V2\,R2$ $\qquad$ ($R2 = 1.41$ g/cm^3)

$F = 231.779 - (55.02)(1.41)$

$\underline{F = 154.20\ g}$

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BUILDING 241-AN-107 REV. 0 JOB/ESR NO. ____

SUBJECT Displacer Calculations; DV=122, Z= 4"

ORIGINATOR JL Dowell DATE 1-10-96

CHECKER-ENGINEER ____ DATE ____

APPROVED ____ DATE ____

For a displacer $DV = 122\ cm^3$, $DW = 231.779\ g$ & $Z = 4$ inches, find V_a, V_B, V_c, V_1, V_2 & F. $Z = 4" \times \frac{2.54\ cm}{in} = 10.16\ cm$

Since Z exceeds 1.9 cm, $V_a = 9.14\ cm^3$

Also since Z exceed 9.09 cm, $V_B = 103.72\ cm^3$

Find Vc: find distance that Vc is submerged

$Z - 9.09 \Rightarrow 1.07\ cm$ (V_c - submerged ht)

The exposed height of $V_c = 1.9 - 1.07 = .83\ cm. = Ht_{exposed}$

The exposed volume of $V_c = \frac{\pi}{3} h R_c^2$

Find R for this situation:

$\tan\theta = R_c/H \Rightarrow (Ht_{exposed})(\tan\theta) = R_c$

$(.83)(1.13) = .94\ cm = R_c$

$V_{c\ exposed} = \frac{\pi}{3}(.83)(.94)^2 \Rightarrow .76\ cm^3$

$V_{c\ submerged} = 9.14 - V_{c\ exposed} \Rightarrow 9.14 - .76 = 8.38\ cm^3 = V_c$

$V_2 = V_1 + V_2 + V_3 = 9.14 + 103.72 + 8.38 = 121.24\ cm^3 = V_2$

$V_1 = 122 - 121.24 = .76\ cm^3 = V_1$

$F = DW - V2R2$ $(R2 = 1.41)$

$231.779 - (121.24)(1.41) \Rightarrow F = 60.83\ g$

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SUBJECT Displacer Calculation; DV=135 & Z=.4 inch

ORIGINATOR JL Dowell DATE 1-10-96

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For a displacer DV = 135 cm³, DW = 276.95 gram & Z = 0.4 inch find V_a, V_b, V_c, V_1, V_2 & F. $(Z = 0.4'' \times \frac{2.54\ cm}{IN} \Rightarrow 1.02\ cm)$

Find V_a: as the Z is less than 1.9 cm, the V_a is the same as for the displacer with DV = 122 cm³,

$V_a = 1.40\ cm^3$

By the same reasoning $V_b = V_c = 0.$

$V_2 = 1.40\ cm^3$ & $V_1 = 135 - 1.40 \Rightarrow V_1 = 133.60\ cm^3$

But $F = DW - V_2 R_2$ $(R_2 = 1.41\ g/cm^3)$

$F = 276.95 - (1.40)(1.41) \Rightarrow F = 274.98\ g$

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BUILDING 241-AN-107 REV. 0 JOB/ESR NO. ______

SUBJECT Displacer Calculations: DV= 135, Z= 2"

ORIGINATOR JL Dowell DATE 1-10-96

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For a displacer $DV = 135$, $DW = 276.95$ gram & $Z = 2''$, find V_a, V_B, V_c, V_1, V_2 & F. $\left(Z = 2'' \times 2.54 \frac{cm}{in} = 5.08 cm\right)$

Find V_a: as Z exceeds 1.9 cm, $\underline{V_a = 9.14\ cm^3}$

The distance segment V_B is submerged is $5.08 - 1.9 = 3.18 cm$.

From previous calculations, $\underline{V_B = 45.88\ cm^3}$.

Since Z is less than 9.99 cm; $\underline{V_c = 0}$

$$V_2 = V_a + V_b + V_c = 9.14 + 45.88 \Rightarrow \underline{V_2 = 55.02\ cm^3}$$

$$V_1 = DV - V_2 \Rightarrow 135 - 55.02 \Rightarrow \underline{V_1 = 79.98\ cm^3}$$

But $F = DW - V_2 R_2 \quad (R_2 = 1.41\ g/cm^3)$

$$= 276.95 - (55.02)(1.41)$$

$\underline{F = 199.37 \text{ grams}}$

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SUBJECT	Displacer Calculation; DV= 135, Z= 4.25"				
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For a displacer DV=135, DW= 276.95 g & Z = 4.25", find V_a, V_B, V_c, V_1, V_2 & F. (Z= 4.25 inches × 2.54 $\frac{cm}{IN}$ = 10.8 cm)

Find V_a & V_B: since Z is greater than 1.9 cm: $\underline{V_a = 9.14\ cm^3}$
and since Z is greater than 9.99 cm, $\underline{V_B = 116.72\ cm^3}$

To find V_c - determine the exposed ht of the upper segment

$$H_{c\,(exposed)} = 11.89 - Z = 11.89 - 10.80 = 1.1\ cm$$

then the exposed volume is: $\frac{\pi}{3}(h_{c\,exp})(r_{c\,exp})^2$

find $r_{c\,exposed}$ ⇒ $H_{c\,exp}\ \tan(\theta) = r_{c\,exp}$

$$(1.1)(1.13) \Rightarrow 1.24 = r_{c\,exp}$$

$$V_{c\,exposed} = \frac{\pi}{3}(1.1)(1.24)^2 \Rightarrow 1.76\ cm^3$$

$$V_{c\,(submerged)} = 9.14 - 1.76 \Rightarrow \underline{V_c = 7.38}$$

$$V_2 = V_a + V_b + V_c = 9.14 + 116.72 + 7.38 \Rightarrow \underline{133.24 = V_2}$$

$$\underline{V_1 = (V_{c\,exposed}) = 1.76\ cm^3}$$

And $F = DW - V_2\rho_2$ (ρ_2 = 1.41 g/cm³)

$$= 276.95 - (133.24)(1.41)$$

$$\underline{F = 89.08\ g}$$

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BUILDING 241-AN-107 REV. 0 JOB/ESR NO. ______

SUBJECT Displacer Calculations; DV = 150 cm³ & Z = 0.4 inch

ORIGINATOR JL Dowell DATE 1-10-96

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For a displacer DV = 150 cm, DW = 286.689 g & Z = 0.4 inch, find V_a, V_B, V_c, V_1, V_2 & F: ($Z = 0.4 \text{ inch} \times \frac{2.54 \text{ cm}}{\text{in}} = 1.02 \text{ cm}$)

Find V_a: since Z is less than 1.9, V_a is the same as the displacer with DV = 122 cm³,

$\underline{V_A = 1.40 \text{ cm}^3}$ and $\underline{V_B = V_c = 0}$

Thus $\underline{V_2 = 1.40}$ & $V1 = 150 - 1.4 = \underline{148.6 \text{ cm}^3}$

But $F = DW - V_2 R_2$ ($R_2 = 1.41 \text{ g/cm}^3$)

$F = \overset{286.689}{\cancel{150}} - (1.40)(1.41)$

$\underline{F = 284.72 \text{ g}}$

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SUBJECT	Displacer Calculation : DV=150 & Z=2"				
ORIGINATOR	JL Dowell			DATE	1-10-96
CHECKER-ENGINEER				DATE	
APPROVED				DATE	

For a displacer $DV = 150$, $DW = 286.689g$ & $Z = 2"$, find V_a, V_b, V_c, V_1, V_2 & F. $\left(Z = 2" \times 2.54 \frac{cm}{in} = 5.08 cm \right)$

Find V_a: as Z is greater than 1.9, $\underline{V_a = 9.14 \ cm^3}$

The middle segment is submerged $5.08 - 1.9 = 3.18$ cm.

From previous calculations, $\underline{V_B = 45.88 \ cm^3}$

Since Z is less than 11.03 cm, $\underline{V_c = 0}$

$V_2 = V_a + V_b + V_c \Rightarrow 9.14 + 45.88 \Rightarrow \underline{V_2 = 55.02 \ cm^3}$

$V_1 = DV - V_2 \Rightarrow 150 - 55.02 \Rightarrow \underline{V_1 = 94.98 \ cm^3}$

And

$F = DW - V2R2 \quad (R2 = 1.41 \ g/cm^3)$

$F = 286.689 - (55.02)(1.41)$

$\underline{F = 209.11}$

BD-6400-060.1 (10-86)

DESIGN ANALYSIS

DRAWING		SD-		PAGE	1/1
BUILDING	241-AN-107	REV.	0	JOB/ESR NO.	
SUBJECT	Displacer Calculations; DV= 150 & Z= 4.75 inches				
ORIGINATOR	JL Dowell			DATE	1-10-96
CHECKER-ENGINEER				DATE	
APPROVED				DATE	

For a displacer DV = 150, DW = 286.689 g & $Z = 4.\overset{7}{\cancel{8}}5$",
find Va, Vb, Vc, V1, V2 & F. ($Z = 4.\cancel{8}75" \times 2.54 \frac{cm}{inc} = 12.07 cm$)

Find Va & Vb: since Z is greater than 1.9, $\underline{Va = 9.14\ cm^3}$
& since Z is greater than 11.03, $\underline{Vb = 131.72\ cm^3}$

To find Vc – find the height & volume of the exposed portion of Vc: $Hc(exp) = 12.93 - 12.07 = .87\ cm$

Find $rc\ exp$ of exposed volume: $Hc(exp)\tan(\theta) = rc\ exp \Rightarrow$
$(.87)(1.13) \Rightarrow .98\ cm$ So $Vc\ exp = \frac{\pi}{3} hr^2 \Rightarrow$

$Vc(exp) = \frac{\pi}{3}(.87)(.98)^2 = 1.047(.83)$

$Vc\ exp = .87\ cm^3$

Vc submerged $= 9.14 - .87 \Rightarrow \underline{Vc = 8.27\ cm^3}$

$V2 = Va + Vb + Vc \Rightarrow 9.14 + 131.72 + 8.27 \Rightarrow \underline{149.13\ cm^3 = V2}$

$\underline{V1 = (Vc\ exp) = .87 cm^3}$

And $F = DW - V2R2$ ($R2 = 1.41\ g/cm^3$)

$F = 286.689 - (149.13)(1.41)$
$= 286.689 - (210.27)$
$\underline{F = 76.42}$

BD-6400-060.1 (10-86)

9.0 ATTACHMENT 1: DISPLACER INFORMATION, DATA ANALYSIS & OTHER CALCULATIONS

Summary for initial displacers

The initial displacers had the following values:

Displacer Serial number: 815-00-002
DW = 237.3 grams
DV = 150 cm^3
Density = 237.3/150 => 1.58 g/cm^3
Neutral Buoyancy Point: 25.8 grams.

Displacer Serial number: 815-00-003
DW = 237.1 grams
DV = 150 cm^3
Density = 237.1/150 => 1.58 g/cm^3

Since the displacers are only 0.2 gram difference in weight, Displacer 002 was used for the following calculations.

Equations to model a generic, submerged displacer:

DD=DW/DV	Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2	Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2	Volume of disp=Vol. above line + Vol below

Variables:

Input	Name	Output	Unit	Comment
	DD	1.582	g/cm^3	Disp. Density
237.3	DW		g	Disp. Weight
150	DV		cm^3	Disp. Volume
	F	**25.8**	**g**	**Force on wire/Tension setpoint**
0	V1		cm^3	Volume of disp above waste
	V2	150	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste

Summary for second set of displacers

The second displacer on Riser 15A had the following values:
DW = 231.78 grams
DV = 122 cm^3
Density = 231.78/122 => 1.90 g/cm^3
Neutral Buoyancy Point = 59.8 grams.

Equations to model for a generic, submerged displacer

DD=DW/DV	Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2	Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2	Volume of disp=Vol. above line + Vol below

Variables

Input	Name	Output	Unit	Comment
	DD	1.8998361	g/cm^3	Disp. Density
231.78	DW		g	Disp. Weight
122	DV		cm^3	Disp. Volume
	F	**59.76**	**g**	**Force on wire/Tension setpoint**
0	V1		cm^3	Volume of disp above waste
	V2	122	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste

The second displacer on Riser 1C had the following values:
DW = 276.16 grams
DV = 135 cm^3
Density = 276.16/135 => 2.05 g/cm^3
Neutral Buoyancy Point = 85.8 grams.

Equations to model for a generic, submerged displacer

DD=DW/DV	Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2	Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2	Volume of disp=Vol. above line + Vol below

Variables

Input	Name	Output	Unit	Comment
	DD	2.0456296	g/cm^3	Disp. Density
276.16	DW		g	Disp. Weight
135	DV		cm^3	Disp. Volume
	F	**85.81**	**g**	**Force on wire/Tension setpoint**
0	V1		cm^3	Volume of disp above waste
	V2	135	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste

Analysis of Riser 15A (try 1) Tension vs Elevation data

On the first attempt to gather tension vs elevation data, it turned out that the tension setting was not really changing, thus the gauge was lowering the displacer to the same elevation. This data can be evaluated for repeatability.

Note: Statistical values were determined using the built in statistical functions of a handheld calculator.

Case 1: All data points are used
Number of points = 27
Average = 380.680 inches
Standard Deviation = ± 0.0229 inches

Case 2: All data points are used except for maximum and minimum
Number of points = 25
Average = 380.682 inches
Standard Deviation = ± 0.0133 inches

Tension vs Elevation calculations for Riser 15A

The model for a displacer [volume = 122 cm^3, weight = 231.779 grams] was used to calculate the elevation of the displacer for various wire tension settings. Given the amount of the displacer below the waste, the force in the wire is calculated. All calculations are in metric units. The displacer is divided up into 3 segments: the lower segment (VA) [modeled as an inverted cone], the middle segment (VB) [modeled as a right circular cylinder] and the upper segment (VC) [modeled as a cone].

For the various wire tensions using a 122 cm^3 displacer the following lists the calculated displacer depth into the waste, the adjusted displacer elevation and the measured displacer elevation.

Note: The calculated elevation at a wire tension of 230 grams was set equal to the first measured elevation so both data sets could easily compared.

Tension (grams)	Depth (calc)	Calc Elevation	Measured Elevation
230	0.386	384.430	384.43
228	0.497	384.319	384.40
226	0.572	384.244	384.32
224	0.632	384.184	384.25
222	0.682	384.134	384.21
220	0.726	384.090	384.13
217	0.785	384.031	384.09
215	0.823	383.993	384.05
210	0.920	383.896	383.94
200	1.114	383.702	383.75
190	1.307	383.509	383.56
180	1.500	383.316	383.37
170	1.694	383.122	383.18
160	1.888	382.928	382.98
150	2.081	382.735	382.79
140	2.275	382.541	382.60
130	2.468	382.348	382.40
120	2.662	382.154	382.21
110	2.855	381.961	382.01
100	3.049	381.767	381.81
90	3.242	381.574	381.61
80	3.436	381.380	381.42
70	3.633	381.183	381.22
60	4.124	380.692	381.02
59.8	NBP	N/A	N/A
50	SSL	SSL	380.73
40	SSL	SSL	79.67

NBP = Neutral Buoyancy Point
SSL = Sink to Sludge Level

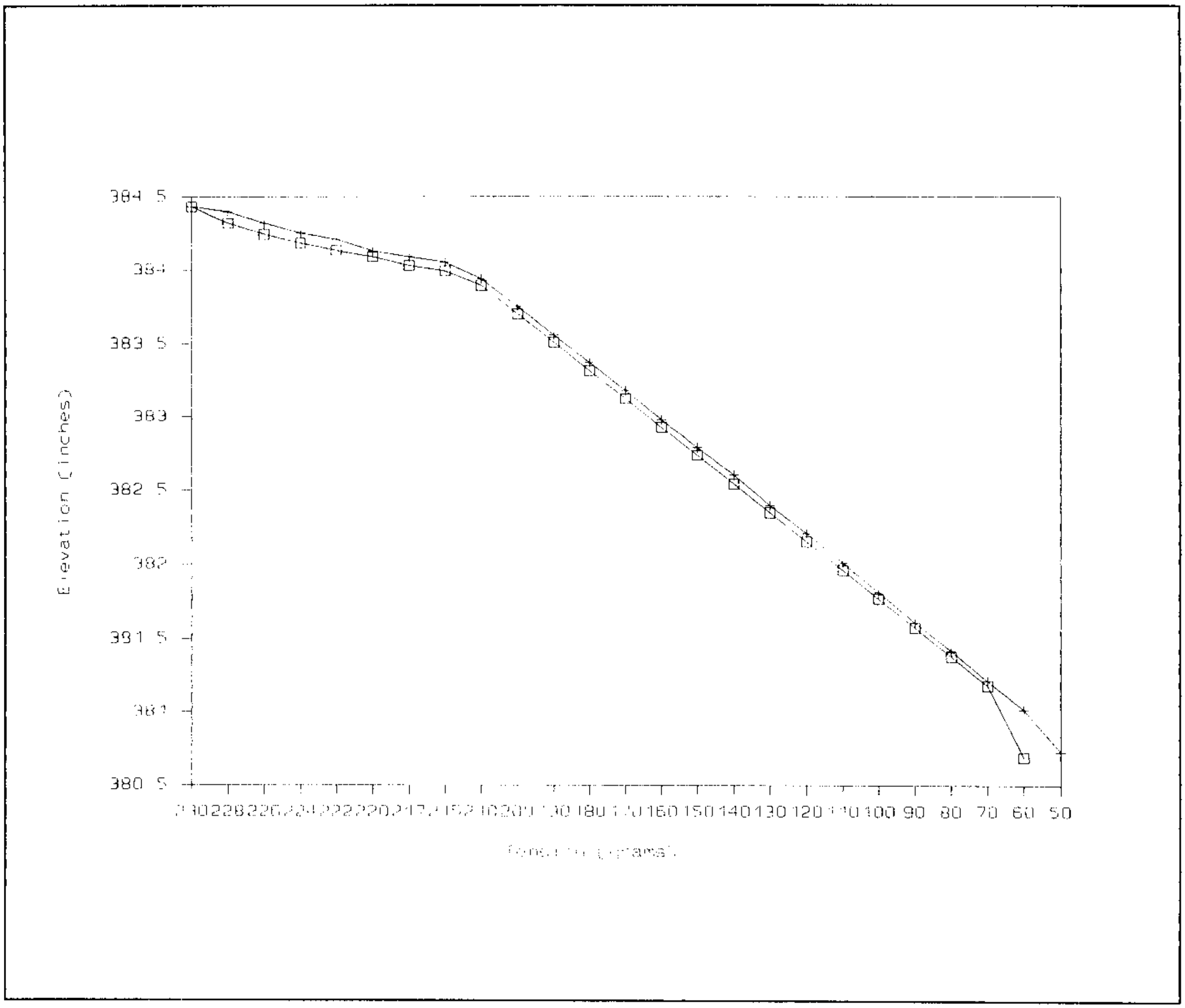
Equations to model a 122 cm3 displacer:

```
DD=DW/DV                        "Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                      "Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2                        "Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                     "Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)       "Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),9.09)-1.9) "Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(10.99,10.99-MAX(9.09,Z)))*Rc^2) "Volume of upper di
TAN(Theta)=Ra/(MIN(Z,1.9))       "Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone               "Find cone angle
MIN(TAN(Theta)*(10.99-Z),R)=Rc           "Find Rc=f(Z)
```

Variables

Input	Name	Output	Unit	Comment
	DD	1.8998279	g/cm^3	Disp. Density
231.779	DW		g	Dips. Weight
122	DV		cm^3	Disp. Volume
60	F		g	Force on wire/Tension setpoint
	Z	**4.1238761**	**in**	**Distance disp submerged in waste**
	V1	.17092199	cm^3	Volume of disp above waste
	V2	121.82908	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	103.73141	cm^3	Vol of middle disp segment
	VC	8.9576644	cm^3	Vol of upper disp segment
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	.58126581	cm	Radius of cone in Volume C (top)
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
0	R1		g/cm^3	Density of air
	Theta	.84542983	Radians	Cone angle

Graph of Tension vs Elevation data, Riser 15A



□ = Calculated
\+ = Measured

Analysis of Riser 15A (try 2) Tension vs Elevation data

Overall the calculated values matched the measured values quite well. The difference between the calculated elevation and the measured elevation spanned 0.07 to -0.006 inches; this could have been reduced to about ±0.04 inches by "correctly" choosing an appropriate initial elevation for tension = 230 grams.

The slope of the measured response [for the tension settings of 200 to 70 grams] is quite linear. This slope is also proportional to the density of the material the displacer is going into. Thus knowing the tension settings, the elevations and diameter of the displacer, the density of the surrounding material can be found.

For Tension = 200 grams, Elevation = 383.75 inches
For Tension = 70 grams, Elevation = 381.22 inches
Displacer diameter = 1 11/16 inches = 4.286 cm
[in the middle segment is a right circular cylinder]

So:
Differential Tension = 200 - 70 = 130 grams (corresponds to mass)
Differential Elevation = 383.75 - 381.22 inches = 2.53 inches = 6.426 cm
Differential Volume = 6.426*(3.1415*4.286^2)/4 = 92.725 cm^3

Thus:
Density = Mass / Volume
or 130 grams / 92.725 cm^3 = <u>1.402</u> grams/cm^3

Tension vs Elevation calculations for Riser 1C

The model for a displacer [volume = 135 cm^3, weight = 276.95 grams] was used to calculate the elevation of the displacer for various wire tension settings. The displacer was modeled as before.

Note: The calculated elevation at a wire tension of 273 grams was set equal to the first measured elevation so both data sets could easily compared; the elevation at tension setting of 275 grams was not used as the measured elevation point is considered a "flier" and not included in the analysis or graph.

Tension (grams)	Depth (calc)	Calc Elevation	Measured Elevation
275	0.398	384.670	412.32
273	0.504	384.670	384.67
271	0.578	384.596	384.67
269	0.637	384.537	384.62
267	0.686	384.488	384.58
265	0.729	384.445	384.53
262	0.788	384.386	384.48
250	1.02	384.154	384.26
240	1.214	383.96	384.07
230	1.407	383.767	383.89
220	1.601	383.573	383.69
210	1.794	383.38	383.51
200	1.988	383.186	383.32
190	2.181	382.993	383.12
180	2.375	382.799	382.93
170	2.568	382.606	382.74
160	2.761	382.413	382.54
150	2.955	382.219	382.34
140	3.149	382.025	382.15
130	3.343	381.831	381.96
120	3.536	381.638	381.78
110	3.73	381.444	381.59
100	3.923	381.251	381.40
90	4.201	380.973	381.22
86.6	NBP	N/A	N/A
80	SSL	SSL	381.00
70	SSL	SSL	380.60
60	SSL	SSL	83.59
50	SSL	SSL	83.59
40	SSL	SSL	83.59

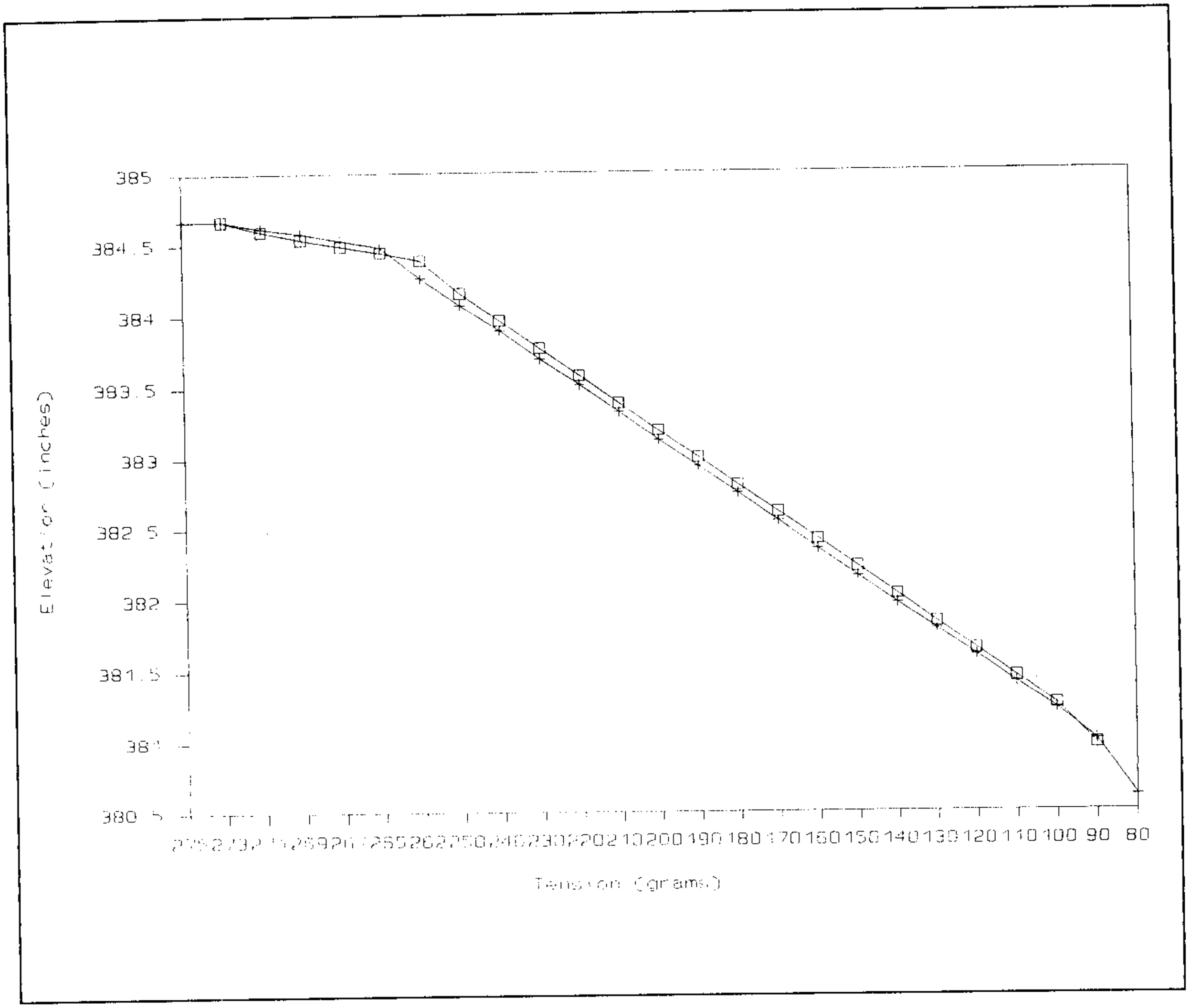
NBP = Neutral Buoyancy Point
SSL = Sink to Sludge Level

```
Equations to model a 135 cm3 displacer:
DD=DW/DV                          "Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                        "Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2                          "Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                       "Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)                    "Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),9.99)-1.9) "Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(11.89,11.89-MAX(9.99,Z)))*Rc^2) "Volume of upper di
TAN(Theta)=Ra/(MIN(Z,1.9))         "Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone                 "Find cone angle
MIN(TAN(Theta)*(11.89-Z),R)=Rc             "Find Rc=f(Z)
```

Variables

Input	Name	Output	Unit	Comment
	DD	2.0514815	g/cm^3	Disp. Density
276.95	DW		g	Dips. Weight
135	DV		cm^3	Disp. Volume
90	F		g	Force on wire/Tension setpoint
	Z	**4.201567**	**in**	**Distance disp submerged in waste**
	V1	2.4113475	cm^3	Volume of disp above waste
	V2	132.58865	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	116.71587	cm^3	Vol of middle disp segment
	VC	6.7327781	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
2.143	R		cm	Radius of displacer
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	1.3737983	cm	Radius of cone in Volume C (top)
	Theta	.84542983	Radians	Cone angle

Graph of Tension vs Elevation data, Riser 1C



☐ = Calculated
\+ = Measured

Analysis of Riser 1C Tension vs Elevation data

Overall the calculated values matched the measured values quite well. The difference between the calculated elevation and the measured elevation spanned 0.09 to 0.23 inches; this could have been reduced to about±0.16 inches by "correctly" choosing an appropriate initial elevation for tension = 273 grams.

The slope of the measured response [for the tension settings of 250 to 110 grams] is quite linear. This slope is also proportional to the density of the material the displacer is going into. Thus knowing the tension settings, the elevations and diameter of the displacer, the density of the surrounding material can be found.

For Tension = 250 grams, Elevation = 384.26 inches
For Tension = 110 grams, Elevation = 381.59 inches
Displacer diameter = 1 11/16 inches = 4.286 cm
[the middle segment is a right circular cylinder]

So:

Differential Tension = 250 - 110 = 140 grams (corresponds to mass)
Differential Elevation = 384.26 - 381.59 inches = 2.67 inches = 6.782 cm
Differential Volume = 6.782*(3.1415*4.286^2)/4 = 97.845 cm^3

Thus:

Density = Mass / Volume
or 140 grams / 97.845 cm^3 = <u>1.431</u> grams/cm^3

Summary for final set of displacers

The final displacer in Riser 1C had the following values:
DW = 284.177 grams
DV = 147.32 cm^3
Density = 284.177/147.32 => 1.929 g/cm^3
Neutral Buoyancy Point = 76.5 grams

Equations to model a generic, submerged displacer

DD=DW/DV	Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2	Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2	Volume of disp=Vol. above line + Vol below

Variables

Input	Name	Output	Unit	Comment
	DD	1.9289777	g/cm^3	Disp. Density
284.177	DW		g	Dips. Weight
147.32	DV		cm^3	Disp. Volume
	F	**76.4558**	**g**	**Force on wire/Tension setpoint**
0	V1		cm^3	Volume of disp above waste
	V2	147.32	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste

The final displacer in Riser 15A had the following values:
DW = 286.689 grams
DV = 151.14 cm^3
Density = 286.689/151.14 => 1.897 g/cm^3
Neutral Buoyancy Point = 73.6 grams

Equations to model a generic, submerged displacer

DD=DW/DV	Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2	Eq. 8.8 from ENRAF (R1=0, so it was removed)
DV=V1+V2	Volume of disp=Vol. above line + Vol below

Variables

Input	Name	Output	Unit	Comment
	DD	1.896844	g/cm^3	Disp. Density
286.689	DW		g	Disp. Weight
151.14	DV		cm^3	Disp. Volume
	F	**73.5816**	**g**	**Force on wire/Tension setpoint**
0	V1		cm^3	Volume of disp above waste
	V2	151.14	cm^3	Volume of disp below waste
1.41	R2		g/cm^3	Density of waste

Calculate submergence distance of displacer at Riser 1C

When Enraf gauges are calibrated (Reference 2) the S1 parameter (I1 wire tension setting) is set at 15 grams less than the displacer weight. Since the gauge measures the elevation based on the absolute location of the displacer bottom, there is a difference between the reported level and the actual level. This difference is the distance the displacer goes into the material until there are 15 grams of buoyant force on the displacer. This distance can be found using the following models:

For the displacer at Riser 1C:

```
Equations to model a 150 cm^3 displacer
DD=DW/DV                          Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                        Eq. 8.8 from ENRAF
DV=V1+V2                          Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                       Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)                 Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),11.03)-1.9) Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(12.93,12.93-MAX(11.03,Z)))*Rc^2) Volume of upper d
TAN(Theta)=Ra/(MIN(Z,1.9))        Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone                Find cone angle
MIN(TAN(Theta)*(12.93-Z),R)=Rc             Find Rc=f(Z)
```

Variables

Input	Name	Output	Unit	Comment
	DD	1.9289777	g/cm^3	Disp. Density
284.177	DW		g	Dips. Weight
147.32	DV		cm^3	Disp. Volume
269.177	F		g	Force on wire/Tension setpoint
	V1	136.6817	cm^3	Volume of disp above waste
	V2	10.638298	cm^3	Volume of disp below waste
1.41	R2		g/cm^1	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	1.4955109	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
	Z	**.78884224**	**in**	**Distance disp submerged in waste**
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
2.143	R		cm	Radius of displacer
	Theta	.84542983	Radians	Cone angle

Calculate submergence distance of displacer at Riser 15A

In a similar manner for the displacer at Riser 15A:
Equations to model a 150 cm^3 displacer

```
DD=DW/DV                        Disp Density = Disp Weight / Disp Volume
F=DW-V2*R2                      Eq. 8.8 from ENRAF
DV=V1+V2                        Volume of disp=Vol. above line + Vol below
V2=VA+VB+VC                     Volume of disp in waste per physical model
VA=MIN(9.14,(PI/3)*Ra^2*Z)              Volume of lower disp segment
VB=PI*R*R*(MIN(MAX(1.9,Z),11.03)-1.9) Volume of middle disp segment
VC=MAX(0,9.14-(PI/3)*(MIN(12.93,12.93-MAX(11.03,Z)))*Rc^2) Volume of upper d
TAN(Theta)=Ra/(MIN(Z,1.9))       Find Ra=f(Z) for VA calculation
TAN(Theta)=R/Zcone               Find cone angle
MIN(TAN(Theta)*(12.93-Z),R)=Rc          Find Rc=f(Z)
```

Variables

Input	Name	Output	Unit	Comment
	DD	1.896844	g/cm^3	Disp. Density
286.689	DW		g	Dips. Weight
151.14	DV		cm^3	Disp. Volume
271.689	F		g	Force on wire/Tension setpoint
	V1	140.5017	cm^3	Volume of disp above waste
	V2	10.638298	cm^3	Volume of disp below waste
1.41	R2		g/cm^1	Density of waste
	VA	9.14	cm^3	Vol of lower disp segment
	VB	1.4955109	cm^3	Vol of middle disp segment
	VC	.00278693	cm^3	Vol of upper disp segment
3.1415	PI			PI, a constant
	Z	**.78884224**	**in**	**Distance disp submerged in waste**
	Ra	5.44322	cm	Radius of cone in Volume A (bottom)
1.9	Zcone		cm	Cone section height (same for Va&Vb)
	Rc	2.143	cm	Radius of cone in Volume C (top)
2.143	R		cm	Radius of displacer
	Theta	.84542983	Radians	Cone angle

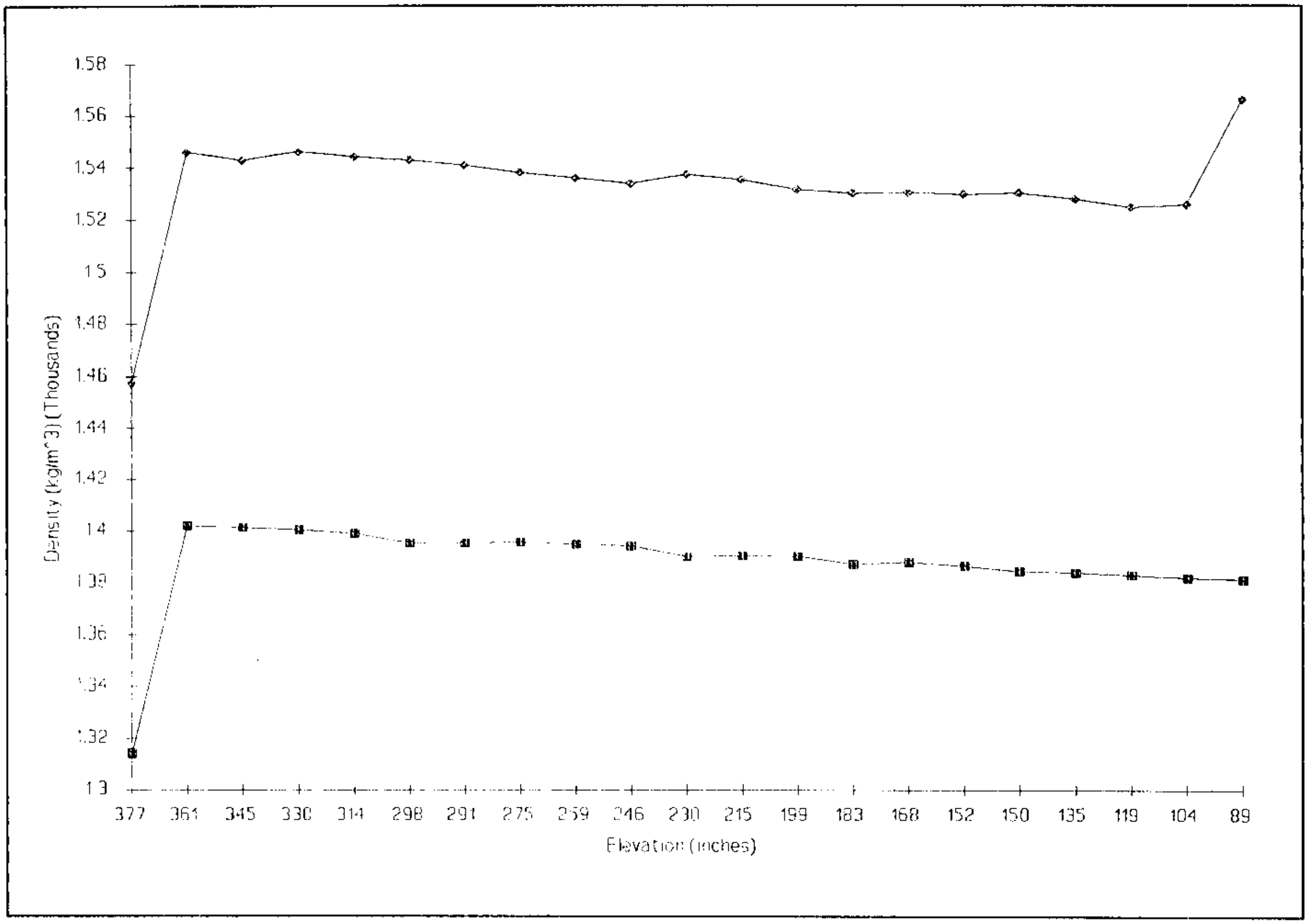
Analysis of Density Data for upper 3' of waste

The following density measurements are for the uppermost 3 feet of the waste. (Units are kg/m^3; divide by 1000 to convert to specific gravity.) The waste elevation during the test was 384.8 inches; so the data for uppermost 3 feet would be at elevation 348.8 or higher. (Data points from FEB13_1.LOG, Attachment 2.)

Elevation (inches)	Riser 1C (Raw)	Riser 1C (Adjstd)	Riser 15A (Raw)
376.50	1457.44	1335.56	1314.09
360.89	1545.90	1416.62	1401.93
345.28	1543.03	1413.99	1401.30

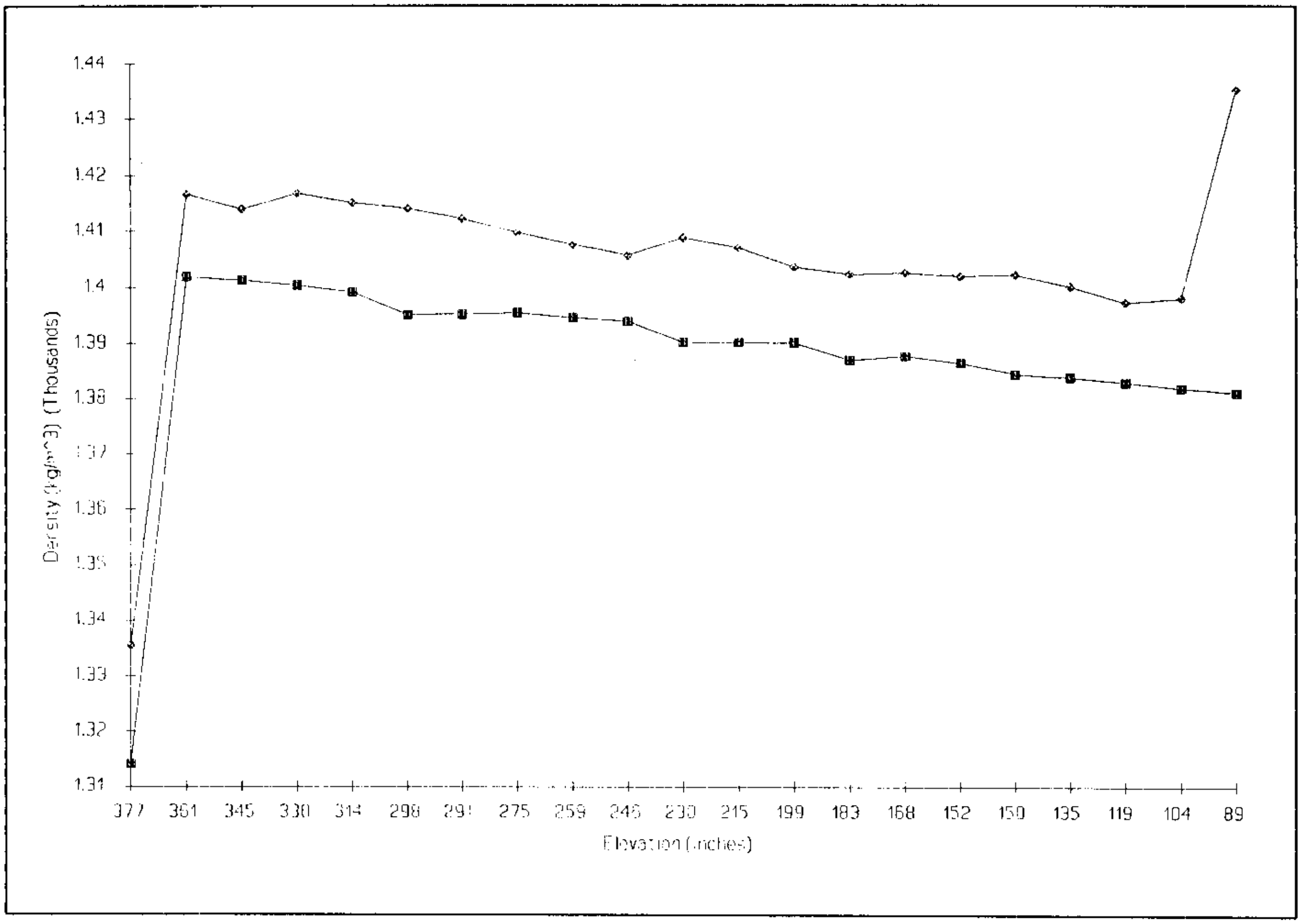
The raw density measurements from the Riser 1C gauge shows a consistent 143.02 (8.4%) bias over the data from the Riser 15A gauge not only for these 3 data points, but for all measurements. A field check showed this bias is due to an erroneous parameter entered into the gauge; the DV parameter is entered as 135 instead of 147.32. To correct the raw data multiply it by 0.91637 (135/147.32) to yield the corrected value.

Graph of OTP Raw Density Data (file CYL_OTP)



◆ = Riser 1C
■ = Riser 15A

Graph of Corrected Density Data (file CYL_OTP)



◆ = Riser 1C (Corrected Data)
■ = Riser 15A

Analysis of Density Data (file CYL_OTP)

Viewing the data file FEB13_1 clearly shows two items of interest: the offset of the Riser 15A data from the Riser 1C data and a slight, yet consistent downward slope to the right. Note: the rightmost data point for riser 1C will not be included as it is believed to be influenced by the sludge layer partially supporting the displacer, giving a "false high" reading.

The density measurements from the Riser 1C gauge shows a consistent 143.02 (8.4%) bias over the data from the Riser 15A gauge. A field check shows this bias is due to an erroneous parameter entered into the gauge; the DV parameter is entered as 135 instead of 147.32. To adjust the raw data multiply it by 0.91637 (135/147.32) to yield the corrected value. The data for Riser 1C has been corrected to account for this and is listed on the next page.

Performing a correlation function (using the built in statistic function on a handheld calculator) between the riser 15A data and the Riser 1C data (corrected) yields a result of 0.99. A value of 1 would indicate a perfectly linear relationship between the two data sets, a value of 0 would indicates the relationship cannot be expressed as a linear function. Thus it appears there is an excellent linear correlation between the adjusted Riser 1C data and the raw Riser 15A data.

The density data (from both gauges) shows a slight trend indicating the density of upper material is greater than the material below it - a scenario difficult to believe. This apparent trend is attributed to the gauge using the default value for the wire volume compensation factor. This factor is dependent on the density of the material being measured. The WV value for Riser 1C [0.0281] is set for water [density = 1.0]. The value for Riser 15A [0.032] is for materials with a density less than 0.5. Despite repeated contacts and attempts, the gauge vendor did not supply the appropriate wire volume compensation factor for our installation, nor the magnitude of the effect of this variable on the reported density.

Overall it appears a liquid layer of slightly lighter material (density about 1.32) sets upon the balance of the liquid waste which has a uniform density of about 1.40.

Density Data from file CYL_OTP

Elev (inches)	Riser 1C (Raw)	Riser 1C (Adjstd)	Riser 15A (Raw)
376.5	1457.44	1335.557	1314.09
360.89	1545.9	1416.620	1401.93
345.28	1543.03	1413.990	1401.3
329.67	1546	1416.711	1400.44
314.05	1544.22	1415.080	1399.13
298.44	1543.12	1414.072	1395.1
282.83	1538.82	1410.132	1395.25
267.22	1537.58	1408.996	1395.74
251.61	1534.39	1406.072	1393.45
246	1533.8	1405.532	1393.92
235.99	1537.54	1408.959	1389.31
235.56	1534.63	1406.292	1390.1
225.11	1537.06	1408.519	1390.08
214.67	1535.3	1406.906	1390.15
204.22	1534.41	1406.091	1390.25
193.78	1528.79	1400.941	1389.85
183.33	1530.19	1402.224	1386.9
172.88	1529.51	1401.600	1389.08
162.44	1531.34	1403.277	1386.14
151.99	1529.78	1401.848	1386.35
150	1530.16	1402.196	1384.23
134.67	1527.9	1400.125	1383.71
119.33	1524.8	1397.284	1382.78
104	1525.54	1397.962	1381.7
88.66	1566.13	1435.158	1380.95

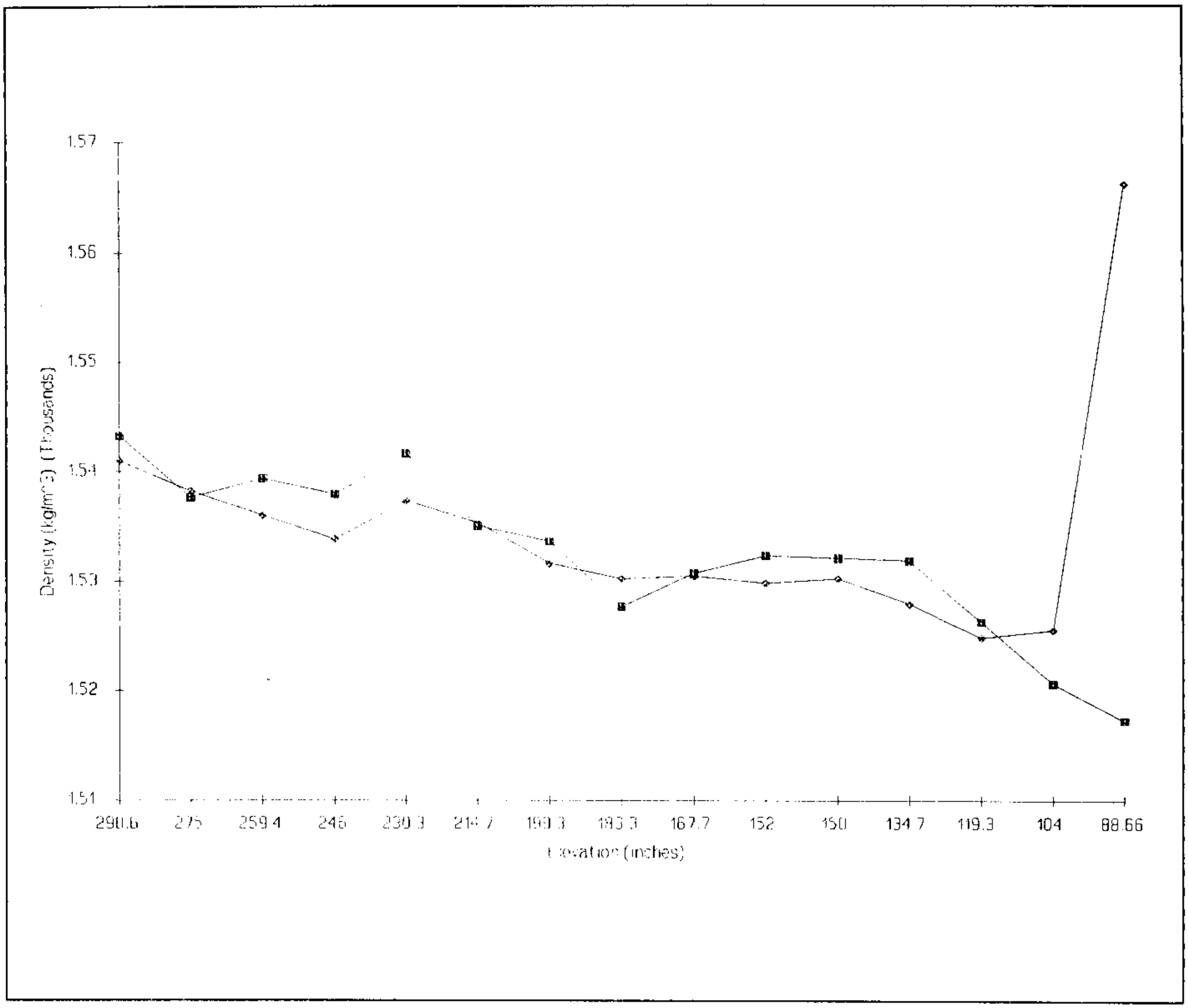
Analysis of Density Data (files CYL_OTP and IP_OTP)

Performing a correlation function (using the built in statistic function on a handheld calculator) between the data (taken by the batch file CYL_OTP) and the data by the file IP_OTP yields a result of 0.87 for Riser 1C and a result of 0.91 for Riser 15A. A value of 1 indicates a perfectly linear relationship between the two data sets, a value of 0 indicates the relationship cannot be expressed as a linear function. Thus it appears that results of the two batch files show excellent correlation.

Note: The batch file IP_OTP did not provide 30 density measurement points as did CYL_OTP; only 12 point were used for the correlation calculation. Elevations had to be within 2 inches of each other; or, an average of 2 measurements from file CYL_OTP that were immediately above and below the measurement from file IP_OTP and that average was also within 2 inches of the measurement from file IP_OTP.

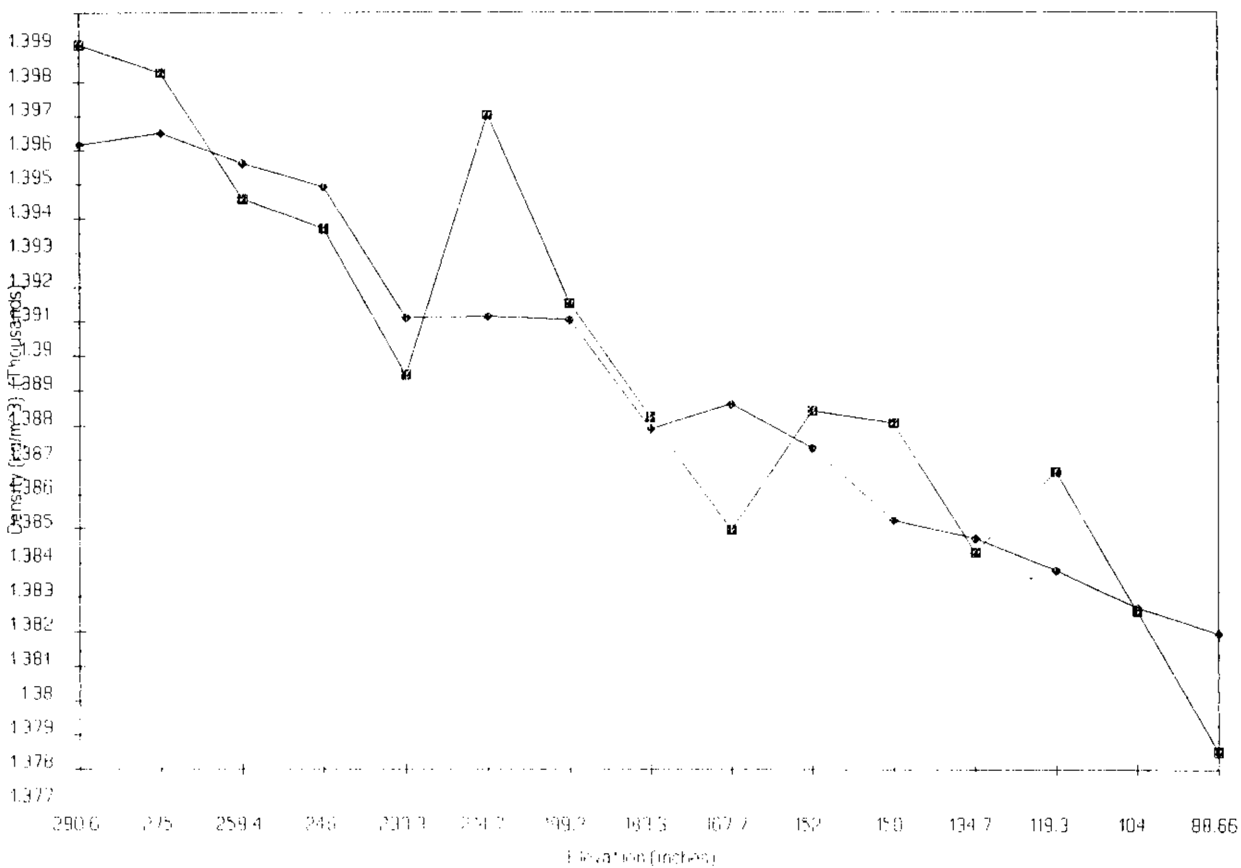
Note: The rightmost data point for riser 1C was not included in the calculations as it is believed to be influenced by the sludge layer partially supporting the displacer, giving a "false high" reading.

Graph Comparing Density Data at Riser 1C (files: CYL_OTP & IP_OTP)



◆ = Riser 1C, file CYL_OTP
■ = Riser 1C, file IP_OTP

Graph Comparing Density Data at Riser 15A (files: CYL_OTP & IP_OTP)



◆ = Riser 15A, file CYL_OTP
■ = Riser 15A, file IP_OTP

Data sheet for Tension vs Elevation at Tank AN-107

DATE: 2-10-96	RISER: 15-A		TRY #1
DV = 122.00	DW = 231.78		
S2/TENSION	ELEVATION	CONDITION	COMMENTS
N/A		Initial Ref Elevation	696.28
WQ = 230.24		DISPLACER IN RISER	660.72
WQ = 232.72	413.69	DISP @ 412-420 INCHES	BASELINE DISP WEIGHT
S2 = BASELINE-2 GR	380.59		230.
S2 = BASELINE-4 GR	380.71		
S2 = BASELINE-6 GR	380.72		
S2 = BASELINE-8 GR	380.68		
S2 = BASELINE-10 GR	380.69		
S2 = BASELINE-12 GR	380.69		
S2 = BASELINE-15 GR	380.66		
S2 = 215 GR	380.67		
S2 = 210 GR	380.68		
S2 = 200 GR	380.69		
S2 = 190 GR	380.68		
S2 = 180 GR	380.68		
S2 = 170 GR	380.69		
S2 = 160 GR	380.65		
S2 = 150 GR	380.68		
S2 = 140 GR	380.68		
S2 = 130 GR	380.68		
S2 = 120 GR	380.69		
S2 = 110 GR	380.70		
S2 = 100 GR	380.65		
S2 = 90 GR	380.68		
S2 = 80 GR	380.69		
S2 = 70 GR	380.69		
S2 = 60 GR	380.66		
S2 = 50 GR	380.68		
S2 = 40 GR	380.70		INITIAL VALUE
S2 = 40 GR	380.71		AFTER 10 MINUTES
WQ =		DISP @ 412 -420 INCHES	WT W/WASTE
WQ =		DISPLACER IN RISER	WT AFTER WASHING
N/A		FINAL REF ELEVATION	

Data sheet for Tension vs Elevation at Tank AN-107

DATE: 2-10-96	RISER: 15-A		TRY #2
DV = 122.0	DW = 231.78		
S2/TENSION	**ELEVATION**	**CONDITION**	**COMMENTS**
N/A	696.28	Initial Ref Elevation	
WQ = 230.24	660.72	DISPLACER IN RISER	
WQ = 232.72	413.69	DISP @ 412-420 INCHES	BASELINE DISP WEIGHT
S2 = BASELINE-2 GR	384.43		230
S2 = BASELINE-4 GR	384.40		
S2 = BASELINE-6 GR	384.32		
S2 = BASELINE-8 GR	384.25		
S2 = BASELINE-10 GR	384.21		
S2 = BASELINE-12 GR	384.13		
S2 = BASELINE-15 GR	384.09		
S2 = 215 GR	384.05		
S2 = 210 GR	383.94		
S2 = 200 GR	383.75		
S2 = 190 GR	383.56		
S2 = 180 GR	383.37		
S2 = 170 GR	383.18		
S2 = 160 GR	382.98		
S2 = 150 GR	382.79		
S2 = 140 GR	382.60		
S2 = 130 GR	382.40		
S2 = 120 GR	382.21		
S2 = 110 GR	382.01		
S2 = 100 GR	381.81		
S2 = 90 GR	381.61		
S2 = 80 GR	381.42		
S2 = 70 GR	381.22		
S2 = 60 GR	381.02		
S2 = 50 GR	380.73		
S2 = 40 GR	79.67		INITIAL VALUE
S2 = 40 GR			AFTER 10 MINUTES
WQ =		DISP @ 412 -420 INCHES	WT W/WASTE
WQ =		DISPLACER IN RISER	WT AFTER WASHING
N/A		FINAL REF ELEVATION	

Data sheet for Tension vs Elevation at Tank AN-107

DATE: 2-10-96	RISER: 12		
DV = 135	DW = 276.16g		
S2/TENSION	ELEVATION	CONDITION	COMMENTS
N/A	699.80	Initial Ref Elevation	
WQ = 273.10 g	697.52	DISPLACER IN RISER	
WQ = 276.95g	412.34	DISP @ 412-420 INCHES	BASELINE DISP WEIGHT
S2 = BASELINE-2 GR	412.32		275 = S2
S2 = BASELINE-4 GR	384.67		
S2 = BASELINE-6 GR	384.67		
S2 = BASELINE-8 GR	384.62		
S2 = BASELINE-10 GR	384.58		
S2 = BASELINE-12 GR	384.53		
S2 = BASELINE-15 GR	384.48		262 = S2
S2 = 315 GR	N/A		
S2 = 310 GR			
S2 = 300 GR			
S2 = 290 GR			
S2 = 280 GR			
S2 = 270 GR			
S2 = 260 GR	N/A		
S2 = 250 GR	384.26		
S2 = 240 GR	384.07		
S2 = 230 GR	383.89		
S2 = 220 GR	383.69		
S2 = 210 GR	383.51		
S2 = 200 GR	383.32		
S2 = 190 GR	383.12		
S2 = 180 GR	382.93		
S2 = 170 GR	382.74		
S2 = 160 GR	382.~~3~~54		
S2 = 150 GR	382.34		
S2 = 140 GR	382.15		
S2 = 130 GR	381.96		
S2 = 120 GR	381.78		
S2 = 110 GR	381.59		
S2 = 100 GR	381.40		
S2 = 90 GR	381.22		
S2 = 80 GR	381.00		
S2 = 70 GR	380.60		

DATE: 2-10-96	RISER: 1C		
DV = 135	DW = 276.16		
S2/TENSION	ELEVATION	CONDITION	COMMENTS
S2 = 60 GR	83.59		
S2 = ~~50~~ 60 GR			
S2 = 40 GR			INITIAL VALUE
S2 = ~~40~~ 60 GR	83.59		AFTER 10 MINUTES
		DISP @ 412 -420 INCHES	WT W/WASTE
		DISPLACER IN RISER	WT AFTER WASHING
N/A	699.95	FINAL REF ELEVATION	

Copy this sheet as needed.

WESTINGHOUSE STANDARDS LABORATORY PHYSICAL AND ELECTRICAL REPORT

CUSTODIAN/ADDRESS	STANDARDS CODE NUMBER		NEW / MODIFY	REFERENCE NUMBER
DOWELL JL E6-21	679-99-20-002		NEW ✓	397135
			ORGANIZATION CODE: W57C00	WORK ORDER: E39625

INSTRUMENT	SERIAL NUMBER		PROPERTY NUMBER	RECALL STATUS	RECALL CYCLE	TOLERANCE HISTORY
DISPLACER SHOP MADE	SL566		N/A	1 ACTIVE 2 NONRECALL 3 SUSPENDED 4 DELETED 5 PM 6 NONDATA M&TE — 1	360	
	ROOM: N/A	BUILDING: 306E	SERVICE DEPARTMENT: 7		DATE RECEIVED: 960125	TOLERANCE AS RECEIVED: 1 IN 2 OUT 3 NA 4 FAILED — NA

SENDER	COMMENTS	SHIPPING DAY
K)J DOWELL 6-9301	FOR KEH	WE

INSTRUMENT SPECIFICATIONS: ± .1% of Reading

TRAINING HOURS: .
CALIBRATION HOURS: 2.0
REPAIR HOURS: .
OTHER HOURS: .4
MATERIALS:
TOTAL CHARGE = ($120 x SUM OF HOURS) + MATERIALS

STANDARD(S) USED IN CALIBRATION TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY OR NATIONALLY RECOGNIZED STANDARDS — 4:1 RATIO Y ☐ N ☒ Best available

STANDARD	EXPIRATION DATE	STANDARD	EXPIRATION DATE
001-86-02-005	3-12-96		
002-06-03-002	7-18-96		
002-06-01-013	7-18-96		

REMARKS: (WP-477)

DATE CALIBRATED: 1-29-96 DATE DUE: 1-29-97

PROCEDURE NUMBER: WHC-7-WEIGHING-DEVICES REV.0 SHOP MADE

AMBIENT TEMPERATURE =

DRY WT. 284.176 g.

WT. in H_2O 147.32 g

DENSITY 1.9289 g/cm³

APPROVED BY: 1-29-96 D. J. Nelson

CALIBRATED BY: BS

Hanford Operations and Engineering Contractor for the United States Department of Energy — Westinghouse Hanford Company, Subsidiary of Westinghouse Electric Corporation, Box 1970, Richland, WA 99352

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WESTINGHOUSE STANDARDS LABORATORY PHYSICAL AND ELECTRICAL REPORT

CUSTODIAN/ADDRESS: DOWELL JL E6-21	STANDARDS CODE NUMBER: 679-99-20-003		NEW ✓ / MODIFY	REFERENCE NUMBER: 397136	
			ORGANIZATION CODE: W57C00	WORK ORDER: E39625	
INSTRUMENT: DISPLACER SHOP MADE	SERIAL NUMBER: SL567	PROPERTY NUMBER: N/A	RECALL STATUS (1 ACTIVE, 2 NONRECALL, 3 SUSPENDED, 4 DELETED, 5 PM, 6 NONDATA M&TE): 1	RECALL CYCLE: 360	TOLERANCE HISTORY
	ROOM: N/A	BUILDING: 306E	SERVICE DEPARTMENT: 7	DATE RECEIVED: 960125	TOLERANCE AS RECEIVED (1 IN, 2 OUT, 3 NA, 4 FAILED): NA
SENDER: K J DOWELL 6-9301	COMMENTS: FOR KEH			SHIPPING DAY: WE	

INSTRUMENT SPECIFICATIONS: ±.1% of Reading

TRAINING HOURS

CALIBRATION HOURS 2.0

REPAIR HOURS

OTHER HOURS 4*

MATERIALS

TOTAL CHARGE = ($120 x SUM OF HOURS) + MATERIALS

STANDARD(S) USED IN CALIBRATION TRACEABLE TO NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY OR NATIONALLY RECOGNIZED STANDARDS 4:1 RATIO Y ☐ N ☒ Best acceptable

Standard	EXPIRATION DATE
001-81-02-005	3-12-96
002-06-03-002	7-18-96
002-06-01-013	7-18-96

REMARKS (WP-477)

DATE CALIBRATED 1-29-96 DATE DUE 1-29-97

PROCEDURE NUMBER WHC-7-WEIGHING-DEVICES REV.0 SHOP MADE

AMBIENT TEMPERATURE =

DRY WT. 286.689 g

WT. in H_2O 151.14 g

DENSITY 1.8968 g/cm²

APPROVED BY 1-29-96 D J Nelson

CALIBRATED BY [signature] WHC STD LAB 53

Hanford Operations and Engineering Contractor for the United States Department of Energy

Westinghouse Hanford Company Subsidiary of Westinghouse Electric Corporation Box 1970, Richland, WA 99352

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15A

OPERATIONAL TEST PROCEDURE

FOR THE 241-AN-107

ENRAF ADVANCED TECHNOLOGY GAUGES

AUGUST 1995

J. L. Dowell

Westinghouse Hanford Company
P.O. Box 1970
Richland, Washington 99352

CONTENTS

CONTENTS (cont)

OPERATIONAL TEST PROCEDURE FOR THE 241-AN-107 ENRAF ADVANCED TECHNOLOGY GAUGE

1.0 INSTRUCTION SECTION

1.1 PURPOSE/SCOPE

The purpose of this document is to demonstrate that the Enraf Advanced Technology Gauges (ATGs), Communications Interface Unit (CIU), digital panel meters, and LOGVR18 software installed at 241-AN tank farm function as intended. Actual test execution steps begin in Section 1.6. All portions of the test shall be completed before the system is either accepted or rejected. Testing is expected to take one to two days to complete.

The purpose of this procedure is to verify correct operation of the level and density data acquisition system to be used for the Tank 241-AN-107 Caustic Addition program. This procedure provides operational testing of equipment and software prior to measuring and recording the waste density and waste stratification levels in Tank 241-AN-107. Operational testing will verify that the hardware and software function according to intent prior to starting tank mixing tests.

1.2 DESCRIPTION OF THE SYSTEM

The following items will be tested for operation: the two (2) Enraf ATGs, Enraf CIU, digital panel meters, LOGVR18 software and the interconnecting cables.

The system being tested consists of:

- Two Enraf Series 854 ATGs
- One Enraf Series 858 CIU
- Enraf LOGVR18 software running on a standard administrative workstation to communicate with the gauges by single command and "batch" files
- Digital panel meters

1.2.1 854 ATG

The Enraf Series 854 Advanced Technology Gauges (Type UEAN854C11F10/LCDZ-US) measure liquid levels, and with the density option, can measure liquid density. The two ATGs installed at 241-AN-107 include the density option and can measure both density and liquid level. These measurements are recorded on the computer (using LOGVR18 software to run "batch" file) via the CIU.

1.2.2 Communications Interface Unit

The Series 858 CIU provides the communications interface between a workstation and multiple tank instruments. Communications between the workstation and the CIU are via a full duplex EIA RS-232 serial link. Communications between the CIU and tank instruments are over a proprietary, bidirectional, "Bi-Phase Mark" serial bus. The CIU provides the necessary communications signal conversion and retransmission. The CIU is installed on the North wall of 241-AN-271 near the computer running LOGVR18.

1.2.3 Digital Panel Meters

The two digital panel meters display the current elevation of the displacers based on the 4-20mA signal from the gauges. The gauges will be scaled to display the current elevation (above tank bottom) of the displacer. Meter display ranges will be 0 to 650 inches. The panel meters are installed in the rack with the ultrasound gear.

1.2.4 LOGVR18 Software

The Enraf LOGVR18 software package is normally used for gauge testing and troubleshooting by single command. The software's "batch" file capabilities will be used for the 241-AN-107 application to measure and record density and sediment levels.

1.3 CRITERIA

This Operational Test Procedure (OTP) will be successful if all the following criteria are met:

1.3.1 The Workstation/Computer Criteria

1.3.1.1 Boots up to DOS.

1.3.1.2 Communicates to the ATGs via the CIU using the LOGVR18 program.

1.3.1.3 Runs "batch" files CYL_OTP.RQS and IP_OTP.RQS to collect vertical density profiles from both gauges simultaneously.

1.3.1.4 Runs a "batch" file to individually lift a displacer 7 to 10 inches then stop.

1.3.2 ATG Criteria

1.3.2.1 Responds with an error code = 000 or 0000 (indicating no problems) for the XPU and SPU of the ATG.

1.3.2.2 Gauge Transmission Address (TA) is correlated to the riser on which the gauge is installed on.

1.3.2.3 Reports an I1 elevation within 1.5 inches of the accepted waste elevation.

1.3.2.4 Reports a density for the upper 3 feet of unmixed supernatant of 1.39 ± 0.05 sp.g. using the "batch" files CYL_OTP.RQS and IP_OTP.RQS.

1.3.3 Rinse Spool Assembly Spray Nozzle Criteria

1.3.3.1 Flow through each spray nozzle is 1.3 gpm or greater when 80 psi (minimum) is applied.

1.3.4 Digital Panel Meter Criteria

1.3.4.1 Each gauge will display 0 to 650 ±20 inches for an input of 4 to 20 mA.

1.4 REFERENCES

1.4.1 Procedures

- 6-TF-125, *ENRAF SERIES 854 PREVENTIVE MAINTENANCE AND CALIBRATION PROCEDURE*
- TO-020-420, *CLEAN LIT TAPES, PLUMMETS AND DISPLACERS; REPLACE FIC/ROBERTSHAW TAPES AND PLUMMETS*

1.4.2 Drawings

- H-2-824485, Densitometer Mechanical Installation.
- H-2-824486, Densitometer Electrical Installation.

1.4.3 Other

- *Instruction Manual, Series 854 ATG level gauge*, Part No. 4416.220, Version 2.2, Enraf B.V., The Netherlands.
- *Installation Info, Model 854 ATG Servo Powered Tank Gauge*, Part No. 4416.601, Version 1.0, Enraf B.V., The Netherlands.
- *Instruction Manual 854 ATG density software package*, Part No. 564.4416.221-40, Version 1.0, Enraf B.V., The Netherlands.
- *Instruction Manual MPU analog output 4-20mA*, Part No. 4416.222, Version 2.0, Enraf B.V., The Netherlands.

- *Instruction Manual, series 847 Portable Enraf Terminal*, Part No. 4416.210, Version 1.1, Enraf B.V., The Netherlands.
- *Instruction Manual, Series 858 Communications Interface Unit*, Part No. 4416.500, Version 2.1, Enraf B.V., The Netherlands.

1.5 RESPONSIBILITIES

Each organization participating in the execution of this OTP will designate personnel for the responsibilities and duties as defined herein for their respective roles. The names of these designees shall be provided to the Recorder for listing on the Recorder's copy of the Test Execution Sheet prior to the performance of any part of this OTP.

All individuals shall carry out their assigned work in a safe manner to protect themselves, others, and the equipment from undue hazards and to prevent damage to property and environment. Performance of test activities shall always include safety and health aspects as delineated in the operations manuals and as directed by the Project Engineer. Any hazard identified during the performance of the OTP shall be reported to the Test Director.

1.5.1 Project Engineer

1.5.1.1 Designate a Test Director.

1.5.1.2 Coordinate testing with facility management.

1.5.1.3 Act as liaison between the participants in operational testing.

1.5.1.4 Ensure informal testing and inspection is complete.

1.5.1.5 Schedule and conduct a pre-OTP meeting with test participants prior to start of testing.

1.5.1.6 Notify the persons performing and witnessing the test prior to the start of testing.

1.5.1.7 Notify all concerned parties when a change is made in the testing schedule.

1.5.1.8 Approve field changes to the OTP.

1.5.1.9 Sign/date Test Execution Sheet (Appendix D) when OTP is approved and accepted.

1.5.1.10 Take necessary action to clear exceptions to the OTP.

1.5.1.11 Sign/date Test Exception Sheet (Appendix B) when an exception has been resolved.

1.5.1.12 Provide a distribution list for the approved and accepted OTP.

1.5.1.13 Confirm that all equipment required for performing this test, as listed in Section 1.6.2, will be available for the test duration.

1.5.1.14 Provide equipment required for performing this operational test, which has not been designated as being provided by others.

1.5.2 Test Director

1.5.2.1 Witness the tests.

1.5.2.2 Coordinate all operational testing.

1.5.2.3 Confirm that shop testing (if any) and/or inspection (if any) of the test unit(s) or portion of the test unit(s) have been completed.

1.5.2.4 Stop any test which may cause damage to the test unit(s) until the test procedure has been revised.

1.5.2.5 Approve field changes to the OTP.

1.5.2.6 Obtain revisions to the OTP, as necessary, to comply with authorized field changes or to accommodate existing field conditions.

1.5.2.7 Evaluate recorded data, discrepancies, and exceptions.

1.5.2.8 Obtain from the Project Engineer, any information or changes necessary to clear or resolve exceptions.

1.5.2.9 Sign/date Test Data sheets and Test Execution sheet (Appendix A & D) when execution of the OTP has been completed.

1.5.2.10 Sign/date Test Exception Sheet (Appendix B) when acceptable retest has been performed.

1.5.2.11 Prepare and obtain required signatures on the Operational Test Report prior to reproduction and distribution.

1.5.3 Safety

1.5.3.1 Review and approve this Operational Test Procedure.

1.5.4 Recorder

1.5.4.1 Witness testing and perform all recording using black ink.

1.5.4.2 Record names of all designated personnel on the Test Execution sheet (Appendix D) on the Recorder's copy of OTP prior to testing.

1.5.4.3 Observe tests, record test data and maintain Test Log (Appendix C).

1.5.4.4 Sign/date the Test Execution Sheet, Test Data sheets and Test Exception sheet(s) (Appendices A, B & D) as the Recorder.

1.5.4.5 Initial every test step on the Recorder's copy as it is completed, next to the step number and under the appropriate gauge identifier.

1.5.4.6 Record authorized field changes to the OTP.

1.5.4.7 Record, on a Test Exception Sheet, exceptions and test steps that are either modified or are not performed. Additional Test Exception Sheets can be reproduced as needed (Appendix B).

1.5.4.8 Orally notify the Test Director at the time an objection is made.

1.5.4.9 After OTP is complete assign page numbers to Test Exception Sheets.

1.5.4.10 Submit the completed OTP to the Test Director for approval signatures and distribution.

1.5.5 Quality

1.5.5.1 Witness the tests.

1.5.5.2 Evaluate recorded data, discrepancies, and exceptions.

1.5.5.3 Approve field changes to the OTP.

1.5.5.4 Sign/date Test Execution Sheet (Appendix D) when execution of the OTP is completed and again when it is approved and accepted.

1.5.5.5 Sign/date Test Exception Sheet (Appendix B) when an exception is made and again when it has been resolved.

1.5.5.6 Initial/mark Test Data sheets (Appendix A), assuring data is entered correctly.

1.5.6 Other Personnel

1.5.6.1 Health Physics Technician (HPT).

1.5.6.2 Tank Farm Operator(s).

1.6 TEST CONDITIONS & EQUIPMENT REQUIRED

1.6.1 Test Conditions

No unique or unusual chemical, fire, release of energy, or criticality safety hazards are involved with performing or supporting these tests. Normal facility safety rules and procedures shall be followed during these tests. All electrical and mechanical apparatus shall be operated as designed.

The test items, equipment, and facilities used in this test procedure are not expected to be affected permanently by this procedure. Test equipment that has been damaged shall be repaired or replaced.

1.6.2 Equipment Required

The Project Engineer shall assure all test equipment is available unless otherwise noted. The following list is provided as an aid and is not intended to be an exhaustive list.

- Portable ENRAF Terminal (PET) Model Number 847.
- Blank, formatted 3.5 inch or 5 1/4 inch data diskette(s).
- Hose to connect rinse spool assembly flush connections to AN Farm water supply.
- Pressure gauge that will indicate water pressure over range of 60 to 140 ± 5 psig and connect to the hose.
- Fitting(s), as needed, for pressure gauge, hose, and flow control valve.
- Stop watch or clock/watch with a second hand.

1.7 OPERATIONAL TEST SETUP

> **Step Checkoff and Data Sheet Entries**
>
> Spaces for the Recorders initials are provided to the left of the step numbers. The gauge identifiers 00 and 01 or risers 1C and 15A are at the top of the check mark columns, as needed. Initial each space as the step is completed for the corresponding gauge.
>
> Each RECORD, RECORD VERIFICATION, or VERIFY in a step requires an entry on the data sheets. The data sheets include the step numbers and two separate columns for entries for gauges TA=00 and TA=01, or risers 1C and 15A.

1.7.1 Preliminary Conditions

✓ ✓ 1.7.1.1 The pre-OTP meeting with test participants has been held and the personnel responsible for directing, witnessing and performing the test described in this OTP have read and understand their roles.

DV 10-16-95 1.7.1.2 **VERIFY** a copy of the calibration data sheet(s), filled out when procedure 6-TF-125, "ENRAF Series 854 Preventive Maintenance and Calibration Procedure," was performed, are on hand for each gauge and calibration is still current.

✓ ✓ 1.7.1.3 Assure batteries in the PET are charged.

✓ 1.7.1.4 Assure power to the computer, digital panel meters, and CIU is "OFF".

✓ ✓ 1.7.1.5 Assure the displacer for each gauge is visible through the site glass.

✓ ✓ 1.7.1.6 **VERIFY** by visual inspection the isolation valve for each gauge is in the CLOSED position.

✓ 1.7.1.7 Obtain release from Operations management prior to continuing this test.

1.7.2 Initializing the Workstation

✓ ✓ 1.7.2.1 **RECORD VERIFICATION** that all the steps in Section 1.7.1 are complete and calibration is still current.

✓ 1.7.2.2 Turn the power to the CIU and panel meters ON. If needed, turn the power to the gauges ON.

✓ 1.7.2.3 Turn the power to the computer system ON.

✓ 1.7.2.4 When the menu comes up select the DOS function and press the ENTER key.

✓ 1.7.2.5 Call the TMACs operators by phone (373-2618).

✓ 1.7.2.6 Request the time; set the workstation time to within ± 1 minute of the time the TMACs system uses. Exit DOS and return to the menu. 1:48:15

✓ 1.7.2.7 Request the current level of the waste in 241-AN-107. RECORD this value. 384.4C

✓ 1.7.2.8 When the menu comes up, select LOGGER, and press ENTER. A LOGV18 menu screen will be shown.

> COMMANDS:
>
> The commands typed on the computer are shown in square brackets "[]" (the square brackets are NOT to be typed as part of the command). Included is any additional information the command requires. After typing the text within the square brackets, press the ENTER key. If an error is made during the typing of the command, use the backspace key to delete the error. If the input contains an error in format or protocol, the response will include an exclamation point (!). If the command is accepted, the response includes an ampersand (&).
>
> The small x replaces a number where values will differ. Direction is given as to where to find the specific value. Commands require certain formats for the data being entered. They will not be accepted in any other form.

1.7.3 Check Gauge Error codes

> INFORMATION
>
> This section checks that a gauge does not show an error code pertaining to an internal problem. The commands are entered from the computer using LOGVR18.

Perform this test sequence for gauge TA=00 first then gauge TA=01.

00 / 01

✓ 1.7.3.1 RECORD VERIFICATION all steps in Section 1.7.2 are complete.

Gauge 00 / 01 15A

00 ✓ / 00 1.7.3.2 Enter command [EP] to obtain the XPU error codes. **RECORD** the error codes displayed by LOGVR18 on the data sheet. Correct any error, or enter it as a Test Exception. For definitions of EP error codes, see Section 12 (pages 60-62) of the 854 ATG Instruction Manual. An error code of 000 means there are no XPU problems.

00 ✓ / 00 1.7.3.3 Enter command [ES] to obtain SPU error codes. **RECORD** the error codes displayed by LOGVR18 on the data sheet. Correct any error, or enter it as a Test Exception. For definitions of ES error codes, see Section 12 (pages 63-65) of the 854 ATG Instruction Manual. An error code of 0000 means there are no SPU problems.

✓ 1.7.3.4 Switch the gauge to TA=01 by pressing F2, entering 01 and pressing ENTER. Repeat Steps 1.7.3.2 through 1.7.3.3 for the TA=01 ATG.

1.7.4 Correlate Gauge Address to Riser Location

00 / 01

✓ 1.7.4.1 **RECORD VERIFICATION** all steps in Section 1.7.3 are complete.

EXCEPTION #1 DV 10-16-95

____ 1.7.4.2 Press F2, enter 00, and press ENTER to change the active ATG to TA=00.

/ 1.7.4.3 Select item 2) SEND ITEMS from the LOGV18 menu.

/ 1.7.4.4 For the active gauge, **RECORD** the DW, DV, DC, and RL values.

____ 1.7.4.5 Switch to the gauge at TA=01 by pressing F2, entering 01 and pressing ENTER. Repeat Steps 1.7.4.3 and 1.7.4.4.

✓ 1.7.4.6 Using the information gathered in the previous steps of this section and the DW, DV, and DC values from the 6-TF-125 data sheets, determine and **RECORD** the Transmission Address (TA) of the gauge and the riser it is installed on.

✓ 1.7.4.7 Exit to DOS. Copy from the root directory of the removable disc to C:\LOGGER\RQS the following files: CYL_OTP.RQS and IP_OTP.RQS.

✓ 1.7.4.8 If the gauge with TA=00 is on riser 1C, then copy both files from the sub-directory \00AT1C of the removable disc to C:\LOGGER\RQS. If the gauge with TA=00 is on riser 15A, then copy both files from the sub-directory \00AT15A of the removable disc to C:\LOGGER\RQS.

✓ 1.7.4.9 Exit DOS and return to the menu.

✓ 1.7.4.10 When the menu comes up, select LOGGER, and enter. A LOGV18 menu screen will be shown.

> **NOTE**
>
> Responses from the gauges with DW, DV, and DC values that match those on the 6-TF-125 data sheets show the workstation, CIU, and gauges are communicating successfully using the LOGVR18 program.

1.7.5 Assure the Rinse Spool Assembly Functions

Perform this test sequence for the rinse spool assembly on Riser 1C (101G) first then for the gauge on Riser 15A (131G).

1C/15A

✓ 1.7.5.1 **RECORD VERIFICATION** all steps in Section 1.7.4 are complete.

✓/✓ 1.7.5.2 OPEN isolation valve AND SECURE it, if not already done. (This will allow the water to drain into the tank).

✓/✓ 1.7.5.3 **RECORD** water meter initial value.

✓/✓ 1.7.5.4 Connect the hose, flowmeter (if needed), control valve, and pressure gauge to a rinse spool piece spray nozzle and water source. (Connect valve and pressure gauge at riser end).

✓/✓ 1.7.5.5 Turn the water ON long enough to **RECORD** the pressure and determine the flowrate; then turn the water OFF and disconnect hose from nozzle.

✓/✓ 1.7.5.6 Repeat Steps 1.7.5.4 to 1.7.5.5 for the other two spray nozzles.

✓ 1.7.5.7 Repeat Steps 1.7.5.2 to 1.7.5.6 for the rinse spool assembly on Riser 15A.

✓/✓ 1.7.5.8 **RECORD** water meter final value.

✓ 1.7.5.9 Connect the regular water source equipment, per the Test Directors instructions.

✓/✓ 1.7.5.10 **VERIFY** by visual inspection the displacer is visible through the sight glass.

NA/NA ~~1~~.7.5.11 Close AND SECURE the isolation valve.

JLS 10-17-95

1.8 SETUP GAUGE PARAMETERS

1.8.1 Gauge Reference Elevations

> **INFORMATION**
>
> This section assigns elevation values to the parameters of the gauge. These values tailor the gauge's response for a specific tank location. The relative levels of these parameters are shown in Figure 1 and Figure 2.

1C/15A

____ 1.8.1.1 **RECORD VERIFICATION** all steps in Sections 1.7.1 through 1.7.5 are complete.

____ 1.8.1.2 Set the TA in the SEND ITEMS menu to communicate to the gauge on riser 1C (based on the information in Section 1.7.4).

__/__ 1.8.1.3 Enter command [W2=ENRAF2] to enter protection level 2.

__/__ 1.8.1.4 Enter command [W1=ENRAF1] to enter protection level 1.

__/__ 1.8.1.5 For each parameter in the test data sheet, read the value from the gauge. If the value is different from that shown in the test data sheet, change the value to match that in the test data sheet. **RECORD VERIFICATION** for each item in the test data sheet.

JFD 10-17-95

__/__ 1.8.1.6 Enter command [TI] to display the Tank Identifier for the gauge. Set TI to ~~AN~~107.1C for the gauge on Riser 1C and set TI to ~~AN~~107.15~~A~~ for the gauge on Riser 15A.

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__/__ 1.8.1.7 Enter command [TT] to display the ATG Tank Top valve. For the gauge on Riser 1C, (if needed) set TT=703.00. For the gauge on Riser 15A, (if needed) set TT=699.04.

__/__ 1.8.1.8 Enter command [UR] to display the ATG Upper Reference valve. For the gauge on Riser 1C, (if needed) set UR=703.00. For the gauge on Riser 15A, (if needed) set UR=699.04.

__/__ 1.8.1.9 Enter command [EX] to exit protection levels 1 and 2, store the changed data and initialize the 854 ATG.

____ 1.8.1.10 Change the TA in the SEND ITEMS menu to communicate to the gauge on riser 15A; repeat Steps 1.8.1.3 through 1.8.1.9.

Figure 1. Parameter Elevations for Riser 1C

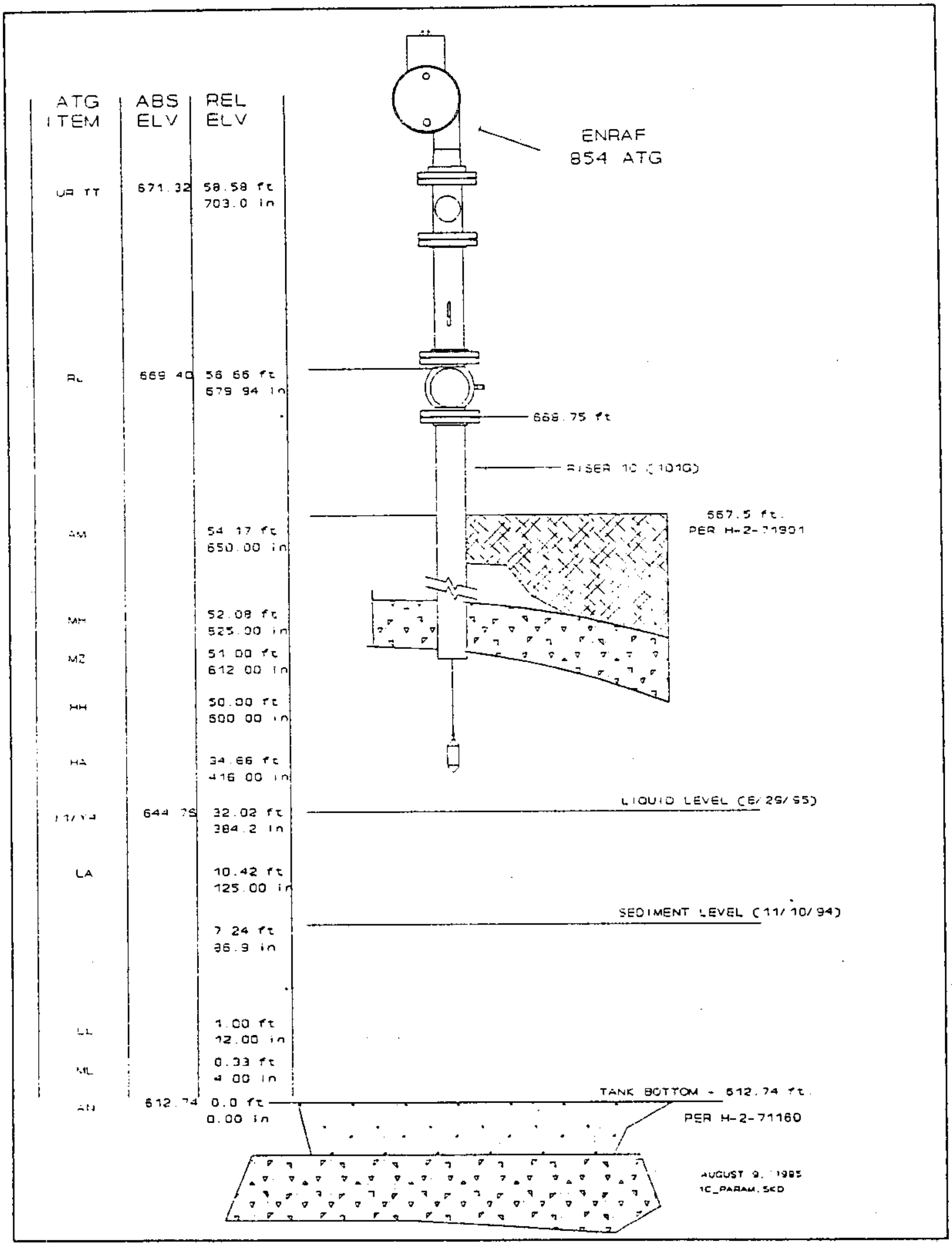
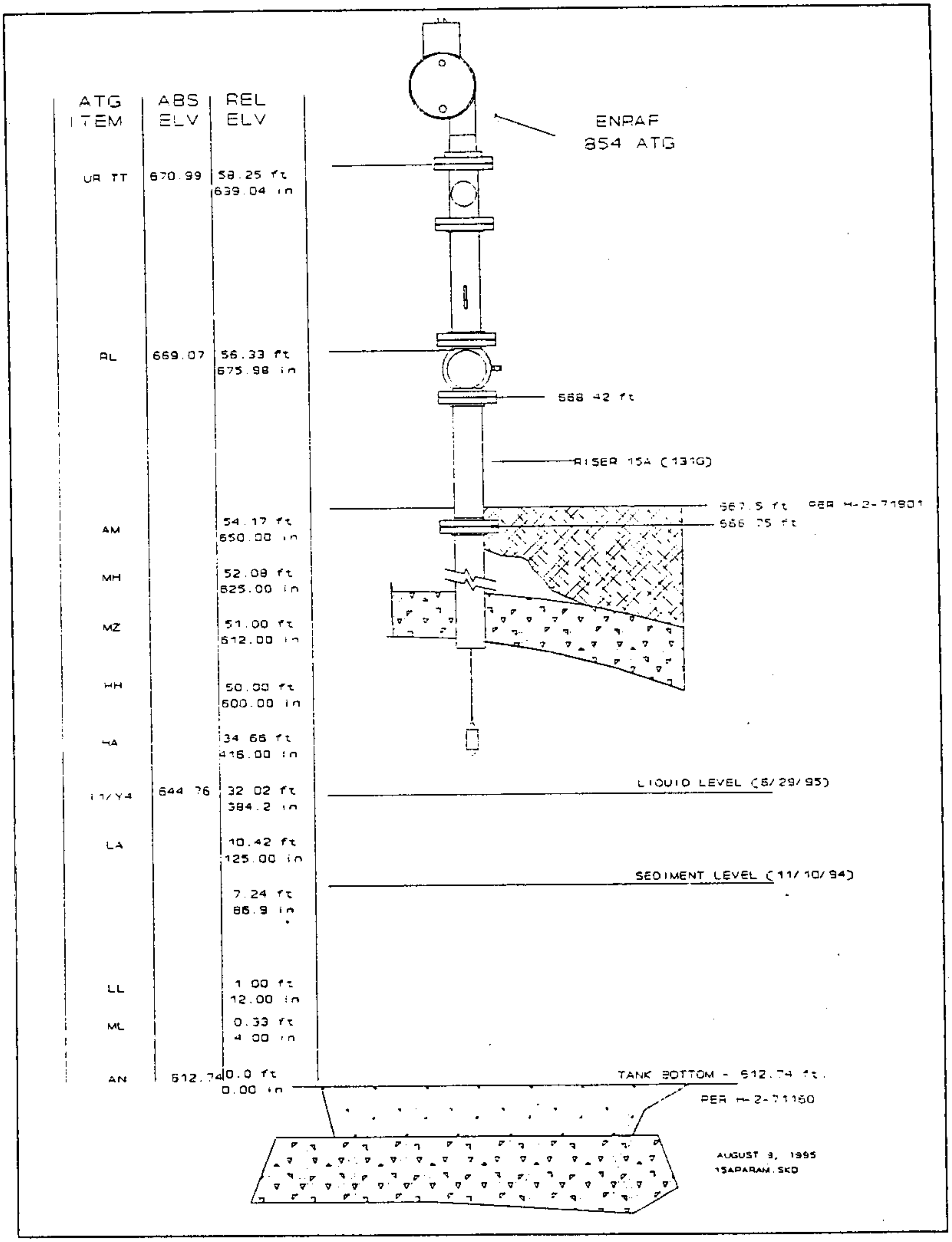


Figure 2. Parameter Elevations for Riser 15A



✓ 1.8.1.11 Change the TA in the SEND ITEMS menu to communicate to the gauge on riser 1C.

> **INFORMATION**
>
> This section assures the current loop signal from the gauge is correctly displayed on the digital panel meter.

1.8.2 Digital Panel Meter

1C/15A

✓ 1.8.2.1 **RECORD VERIFICATION** all steps in Section 1.8.1 are complete.

✓ 1.8.2.2 Set the TA in the SEND ITEMS menu to communicate to the gauge on riser 1C (based on the information in Section 1.7.4).

✓/✓ 1.8.2.3 Enter command [W1=ENRAF1] to enter protection level 1.

✓/✓ 1.8.2.4 Enter command [A6] to force the gauge analog output to 18 mA. Note which meter responded; label the meter, if needed. **RECORD** the reading of the digital panel meter associated with that gauge.

✓/✓ 1.8.2.5 Enter command [A5] to force the gauge analog output to 4 mA. **RECORD** the reading of the digital panel meter associated with that gauge.

✓/✓ 1.8.2.6 Enter command [EX] to exit protection level 1.

✓ 1.8.2.7 Change the TA in the SEND ITEMS menu to communicate to the gauge on riser 15A; repeat Steps 1.8.2.3 through 1.8.2.6.

✓ 1.8.2.8 Change the TA in the SEND ITEMS menu to communicate to the gauge on riser 1C.

1.9 OPERATIONAL TEST

1.9.1 Determine Sediment Level

INFORMATION

The sediment level needs to be determined prior to performing the Density Profile or the Interface Density Profile measurements, otherwise a fault condition can occur during either or both measurements. This section is performed only during the OTP and is not to be part of the regular operational procedures.

Testing on 12-14-95

Test steps done on 2-13-96

Perform this test sequence for the gauge on Riser 1C (101G) first then for the gauge on Riser 15A (131G).

1C / 15A	1C /15A	Step	Action	1C/15A
/ ✓	✓	1.9.1.1	RECORD VERIFICATION all steps in Sections 1.8.1 and 1.8.2 are complete.	TE#7
/ N/A	✓	1.9.1.2	Assure the TA in the SEND ITEMS menu to communicate to the gauge on riser 1C.	✓
/ ✓	NA / NA JBD 10-17-95	1.9.1.3	OPEN isolation valve AND SECURE it, if not already done. (This will allow the displacer to enter the tank).	2-13-96 / ...
/ ✓	✓ / ✓	1.9.1.4	ENTER command [I1]. (This commands the gauge to find the elevation of the waste.)	✓ / ✓
/ ✓	✓ / ✓	1.9.1.5	Wait for the elevation to stabilize. RECORD elevation.	TE#7 / TE#7
/ ✓	✓ / ✓	1.9.1.6	VERIFY adjusted displacer elevation is within ± 1.5 inches of waste elevation recorded in Step 1.7.2.7. [NOTE: About 1.9 cm (0.748 inch) of the displacer will be submerged in the waste.]	TE#7 / TE#7
/	✓ / ✓	1.9.1.7	ENTER Command = [~~I3~~ I2 *] (This commands the gauge to find the sediment level.)	/
TE6B /	✓ / ✓	1.9.1.8	RECORD ~~I3~~ I2 * level. Wait 10 minutes.	/
/	✓ / ✓	1.9.1.9	RECORD ~~I3~~ I2 * level.	/
/	/	1.9.1.10	Wash displacer and wire per Section 1.9.2.	/
N/A /		1.9.1.11	Change the TA in the SEND ITEMS menu to communicate to the gauge on riser 15A; repeat Steps 1.9.1.3 through 1.9.1.10.	✓
/		1.9.1.12	Continue at Section 1.9.3.	✓

* See Exception #6A

TE#7

1.9.2 Washing the Displacer and Wire

NOTE
This section is performed as indicated in the test procedure. This section must be worked in conjunction with TO-020-420.

✓✓ 1.9.2.1 CONNECT PET to gauge per Test Directors instruction, if not already connected.

✓✓ 1.9.2.2 FLUSH per TO-020-420.

✓✓ 1.9.2.3 ENTER Command = [CA]. (This command causes the displacer to rise).

✓✓ 1.9.2.4 Assure the displacer is rising by looking at the gauge display. If not, cease flushing and contact Test Director.

✓✓ 1.9.2.5 When displacer rises to within an elevation of 370 inches (nominal), REQUEST HPT to **VERIFY** and **RECORD** initial maximum whole-body exposure. Using the radiation limits established in RWP, HPT will determine whether displacer and wire will need to be flushed further to reduce exposure rates. If necessary, Operations will re-flush.

✓✓ 1.9.2.6 Flush until displacer is visible in the sight glass window. ENTER Command = [FR] (this command stops the displacers' upward travel). Cease flushing. **RECORD** final value of whole body exposure.

✓✓ 1.9.2.7 IF required, lower displacer, and repeat Steps 1.9.2.2 through 1.9.2.6 until desired dose rate is achieved.

✓✓ 1.9.2.8 Return to the test section that requested this section be performed.

1.9.3 Density Profile Measurement

INFORMATION
Procedures in this section serve to verify and validate the "batch" mode capabilities of obtaining a density profile using the file CYL_OTP.RQS.

✓ 1.9.3.1 **RECORD VERIFICATION** all steps in Section 1.9.1 are complete.

✓ 1.9.3.2 Press the ESC key to return to the main menu of LOGVR18 software. Select 5) File-to-Field Utility.

✓ 1.9.3.3 From the File-to-Field menu, select item 2) .RQS file.

✓ 1.9.3.4 Select the CYL_OTP.RQS file and press ENTER. This should return you to the File-to-Field menu with your selected file. **RECORD VERIFICATION** of the correct file name.

✓ 1.9.3.5 Select 3) .RPL file and press ENTER. Enter the file name as the month, day, underscore and test run number (e.g., MAR7_3 represents March 7, test run 3). **RECORD** the file name.

✓ 1.9.3.6 Select item 7) Send CYL_OTP.RQS file and press ENTER. The file will be tested then sent to the ATG. This will take about 75 minutes. NOTE: if a fault condition occurs due to the displacer hitting the sediment layer, then perform section(s) 1.9.5 or 1.9.6, as appropiate.

✓ 1.9.3.7 Select item 9) Convert .RPL to .LOG and press ENTER.

✓ 1.9.3.8 Select the file created in Step 1.9.3.5 to be converted from the reply file to a log file and press ENTER. **RECORD** the file name.

✓ 1.9.3.9 Type EXIT to return to the File-to-Field menu.

✓ 1.9.3.10 Select C) to return to the main menu of the LOGVR18 software.

✓/✓ 1.9.3.11 Wash each displacer per Section 1.9.2.

✓ TE #10 1.9.3.12 Examine the .LOG file and **VERIFY** the density of the supernatant within the first 3 feet of the waste surface is 1.39 ± 0.05 sp.g. Note: this step may be deferred per the Test Directors instructions.

1.9.4 Interface Density Profile Measurement

INFORMATION

Procedures in this section serve to verify and validate the batch mode capabilities of obtaining density profiles using file IP_OTP.RQS.

✓ 1.9.4.1 **RECORD VERIFICATION** all steps in Section 1.9.3 are complete.

✓ 1.9.4.2 Press the ESC key to return to the main menu of LOGVR18 software. Select 5) File-to-Field Utility.

✓ 1.9.4.3 From the File-to-Field menu, select item 2) .RQS file.

✓ 1.9.4.4 Select the IP_OTP.RQS file and press ENTER. This should return you to the File-to-Field menu with your selected file. **RECORD VERIFICATION** of the correct file name.

✓ 1.9.4.5 Select 3) .RPL file and press ENTER. Enter the filename as the month, day, underscore and test run number (e.g., MAR7_4 represents March 7, test run 4). Make sure the test run number is different than in Step 1.9.3.5. RECORD the file name.

✓ 1.9.4.6 Select item 7) Send IP_OTP.RQS file and press ENTER. The file will be tested then sent to the ATG. This step will take about 30 minutes. NOTE: if a fault condition occurs due to the displacer hitting the sediment layer, then perform section(s) 1.9.5 or 1.9.6, as appropiate.

~~TG~~ JJD

✓ 1.9.4.7 Select item 9) Convert .RPL to .LOG and press ENTER.

✓ 1.9.4.8 Select the file created in Step 1.9.4.5 to be converted from the reply file to a log file and press ENTER. RECORD the file name.

✓ 1.9.4.9 Type EXIT to return to the File-to-Field menu.

✓ 1.9.4.10 Select C) to return to the main menu of the LOGVR18 software.

✓ 1.9.4.11 Select item 9) END PROGRAM to exit.

MOVE per TE #8

✓ / ✓ 1.9.4.12 Perform Section 1.9.2 to clean the displacer and wire.

✓ TE#10 1.9.4.13 Examine the .LOG file and **VERIFY** the density of the supernatant within the first 3 feet of the waste surface is 1.39 ± 0.05 sp.g. Note: this step may be deferred per the Test Directors instructions.

1.9.5 Recover from Fault Conditions: Gauge on Riser 1C

INFORMATION
Procedures in this section serve to verify and validate the capabilities of file LIFT1C.RQS.

Perform these steps if a fault condition (due to the displacer landing on the sediment during a density profile measurement) occurs with the gauge on Riser 1C (101G). This file will command the gauge to lift the displacer about 8 inches, then stop.

✓ ~~N/A~~ 1.9.5.1 If this section has not been performed for the gauge on Riser 1C, assure the displacer is visible in the sight glass.

JJD

Lower the displacer 24 inches (nominal), perform this section, skipping the last step.

✓ 1.9.5.2 **RECORD** current elevation of displacer.

✓ 1.9.5.3 Press the ESC key to return to the main menu of LOGVR18 software. Select 5) File-to-Field Utility.

✓ 1.9.5.4 From the File-to-Field menu, select item 2) .RQS file.

✓ 1.9.5.5 Select the LIFT1C.RQS file and press ENTER. This should return you to the File-to-Field menu with your selected file. **RECORD VERIFICATION** of the correct file name.

✓ 1.9.5.6 Select item 7) Send LIFT1C file and press ENTER. The file will be tested then sent to the ATG. This will take about 15 seconds.

TE #8/9 JJD ✓ 1.9.5.7 **RECORD** current elevation of displacer.

✓ 1.9.5.8 **VERIFY** the displacer was lifted between 7 to 10 inches.

✓ 1.9.5.9 Return to the test section that requested this section be performed.

1.9.6 Recover from Fault Conditions: Gauge on Riser 15A

INFORMATION
Procedures in this section serve to verify and validate the capabilities of file LIFT15A.RQS.

Perform this test sequence if a fault condition occurs with the gauge on Riser 15A (131G).

N/A JJD 1.9.6.1 If this section has not been performed for the gauge on Riser 15A, assure the displacer is visible in the sight glass. Lower the displacer 24 inches (nominal), perform this section, skipping the last step.

✓ 1.9.6.2 **RECORD** current elevation of displacer.

✓ 1.9.6.3 Press the ESC key to return to the main menu of LOGVR18 software. Select 5) File-to-Field Utility.

✓ 1.9.6.4 From the File-to-Field menu, select item 2) .RQS file.

✓ 1.9.6.5 Select the LIFT15A.RQS file and press ENTER. This should return you to the File-to-Field menu with your selected file. **RECORD VERIFICATION** of the correct file name.

✓ 1.9.6.6 Select item 7) Send LIFT15A.RQS file and press ENTER. The file will be tested then sent to the ATG. This will take about 20 seconds. This file will command the gauge to lift the displacer about 8 inches then stop.

TE#89 JJP 1.9.6.7 **RECORD** current elevation of displacer.

✓ 1.9.6.8 **VERIFY** the displacer was lifted between 7 to 10 inches.

✓ 1.9.6.9 Return to the test section that requested this section be performed.

1.10 OPERATIONAL TEST CLOSURE

✓ 1.10.1 **RECORD VERIFICATION** that Sections 1.7, 1.8, and 1.9 inclusive have been completed.

✓ 1.10.2 Include a copy CYL_OTP.RQS, IP_OTP.RQS, LIFT1C.RQS, LIFT15A.RQS and the .LOG files as part of the Test Data. To obtain a copy, Select B) DOS Shell and change to the appropriate sub-directory. Copy the files to the removable disk and transfer it to another computer to print.

_______ 1.10.3 The person(s), by their signature below state the installed ENRAF ATGs, CIU, digital panel meters and LOGVR18 software [running "batch" files CYL_OTP.RQS, IP_OTP.RQS, LIFT1C.RQS, and LIFT15A.RQS] is functional and ready for operational use.

Test Director Date	J J Dowell 2.20.96 Project Engineer Date
Tank Farm Operations Date	

Original Signed by J. Borrowman JJDowell

1.11 TEST DATA SHEETS

The Test Data Sheets are used to document any procedure step requiring verification or recording of a value. All entries are made in black ink. A description of the data sheet format follows. Upon successful completion of testing activities, the master copy of the test execution data sheets shall be signed by the Test Witnesses. Witness signatures at the bottom of the data sheets indicate that the witness agrees to the accuracy of the data recorded and comparisons made.

1. Date of Test--Record the date the test is performed.

2. Gauge Transmission Address--The transmission address of the gauge is prerecorded as TA=00 and TA=01.

3. Equipment Serial Number(s)--Record the serial numbers of any device used during the tests.

4. Test Performed By--Print the name of the person performing the test.

5. Procedure Step Number--This column contains the test steps requiring verification.

6. Item--This column contains the item or parameter being verified or recorded.

7. Expected Result--This column indicates the acceptable value of the item being recorded.

8. Value--Record the quantitative or qualitative measure (i.e., a line voltage may have a value of 120V, whereas a pump may have a value of ON or OFF) of the item being verified in this column.

9. Accept/Reject--Indicate whether the value obtained is acceptable in comparison with the Expected Value.

10. Comment--If the value is rejected, give a justification for denial.

11. QA--This column indicates that QA concurred with the items recorded or verified. Test Data Sheets are in Appendix A.

1.12 TEST LOG SHEET

Test Log Sheets are used to document test start and stop times and to document any other notes concerning the execution of the Operational Test Procedure. A Test Log Sheet is included in Appendix C.

2.0 CHANGE CONTROL AND EXCEPTIONS TO OPERATIONAL TEST SECTION

2.1 OPERATIONAL TEST PROCEDURE CHANGE CONTROL

Operational testing is to be conducted in accordance with the steps and requirements specified in this procedure. Any required field changes must be per Sections 1.5.1, 1.5.2, and 1.5.5. Field changes shall also be recorded as a test exception.

2.2 TEST EXECUTION

The operational test procedures detailed in Sections 1.7, 1.8, and 1.9 shall be performed in sequential steps starting with Section 1.7.1, except for flushing operations and recovery from faults, as specified within the procedure. As required by Section 1.5.4, the Recorder will initial every test step in the space provided on the Recorder's copy of the OTP as each step is completed. Any step that requires a value recording or verification must also be recorded on the Test Data Sheet.

2.2.1 Without Exception

2.2.1.1 Check applicable space on the Test Execution Sheet (Appendix D) to show that the OTP has been performed and no exceptions have been recorded.

2.2.1.2 Sign and date the Test Execution Sheet in the spaces provided.

2.2.1.3 Distribute requisite copies of OTP.

2.2.2 With Exception(s) Resolved

2.2.2.1 Check applicable space on the Test Execution Sheet to show that the OTP has been performed with exceptions recorded and resolved.

2.2.2.2 Sign and date the Test Execution Sheet in the spaces provided.

2.2.2.3 Distribute requisite copies of OTP.

2.2.3 With Exception(s) Outstanding

2.2.3.1 Check applicable space on the Test Execution Sheet to show that the OTP has been performed with exceptions recorded, part or all of which are presently outstanding, unresolved.

2.2.3.2 Sign and date the Test Execution Sheet in the spaces provided.

2.2.3.3 Distribute requisite copies of OTP.

3.0 RECORDING AND RESOLVING EXCEPTIONS

3.1 GENERAL

Exceptions to the OTP are sequentially numbered and recorded on individual Exception Sheets. This enables case-by-case resolution, recording, approval, and distribution of each exception.

3.2 RECORDING

3.2.1 Number each exception sequentially as it occurs in the comments column on the Test Data Sheet, if applicable, and record it on a Test Exception Sheet. If the exception occurs without a reference to the data sheet, record the exception on a Test Exception Sheet.

3.2.2 Enter name and organization of objecting party for each exception.

3.2.3 Enter planned action to resolve each exception when determined.

3.3 RETEST/RESOLUTION

3.3.1 Record the action taken to resolve each exception on the Test Exception Sheet. Action taken might not be the same as planned action.

3.3.2 When action taken results in an acceptable retest, sign and date Acceptable Retest section of the Test Exception Sheet.

3.3.3 When action taken does not involve an acceptable retest, mark the N/A block. Resolve exception per Section 3.4 below.

3.4 APPROVAL AND OPERATIONAL

3.4.1 The Project Engineer provides final approval of exception by checking one of the following on the Test Exception Sheet:

- Retest Approved and Accepted: Applicable when Retest Execution and Operational section is completed.
- Exception Accepted-As-Is: Requires detailed explanation.

- Other: Requires detailed explanation.

3.4.2 The Project Engineer signs and dates the Test Exception Sheet and obtains other internal approval, if required.

3.5 DISTRIBUTION

Distribute requisite copies of completed Test Exception Sheets to the OTP participants.

APPENDIX A - TEST DATA SHEETS

Test Data Sheets

Date of test: 10-16-95

Test Performed By: Dowell / Van Dyke

Procedure Step Number	Item	Expected Result	Gauge Transmission Address: IA=00 (~~15A~~ W 10-16-95) Value	(A/R)	Comment	QA	Gauge Transmission Address: IA=01 Value	(A/R)	Comment	QA
1.7.1.2	6-TF-125 data sheet on hand	Yes	YES	A		W	YES	A		W
1.7.1.6	Isolation Valve	Closed	CLOSED ~~YES~~ W 10-16-95			W	CLOSED			W
1.7.2.1	Section 1.7.1 Complete?	Yes	YES			W	YES			W
1.7.2.7	Waste Level	Record Value	384.40			W	384.40			W
1.7.3.1	Section 1.7.2 Complete?	Yes	YES			W	YES			W
1.7.3.2	EP Error	000	000			W	000			W
1.7.3.3	ES Error	0000	0000			W	0000			W
1.7.4.1	Section 1.7.3 Complete?	Yes	YES	A		W	YES	A		W
1.7.4.4	DW	Record Value	N/A		Exp. 1	W	N/A		Exp 1	W
	DV	Record Value				W				W
	DC	Record Value				W				W
	RL	Record Value	N/A		Exp. 1	W	N/A		Exp 1	W
1.7.4.6	Riser Location	Record Value	1C	A		W	15A	A		W

Test Data Sheets

Date of test: 10-16-95, 10-17-95

Test Performed By: Dowell/VanDyke

Procedure Step Number	Item	Expected Result	Gauge on Riser 1C Value	(A/R)	Comment	QA	Gauge on Riser 15A Value	(A/R)	Comment	QA
1.7.5.1	Section 1.7.4 Complete?	Yes	YES	A	WITH EXP. 1	W	YES	A	WITH EXP 1	W
1.7.5.3	Water Meter Reading	Record Value	507932 ~~507767~~ W	A		W	507449 ~~507792~~ W	A		W
1.7.5.5	Nozzle #1 pressure	80 psi or more	170 PSI ~~167 PSI~~ W	A		W	170 PSI	A		W
	Nozzle #1 flow	1.3 gpm or more			TE#5				TE#5	
1.7.5.6	Nozzle #2 pressure	80 psi or more		NA				10-17-95 NA		
	Nozzle #2 flow	1.3 gpm or more		TEST	10-17-95 EXP. #4					
	Nozzle #3 pressure	80 psi or more								
	Nozzle #3 flow	1.3 gpm or more								
1.7.5.8	Water Meter Reading	Record Value	507946	A		W	507932	A		W
1.7.5.10	Displacer Visible?	Yes	YES			W	YES			W
1.8.1.1	Sections 1.7.1 through 1.7.5 •	Yes	YES			W	YES			W
1.8.1.5	AM/FM	00000.00	00000.00		TE 2	W	00000.00		TE 2	W
	AM/BN	00650.00	00650.00			W	00650.00			W
	DA	+.16000000E+02	+.16000000E+02			W	+.16000000E+02			W
	DE	I	I			W	I			W
	DF	B	B			W	B			W
	DG	Y	Y			W	Y			W
	DO	85	5		TE 3	W	5		TE 3	W

Test Data Sheets

Date of test: 10-1~~6~~7-95			Gauge on Riser 1C				Gauge on Riser 15A			
Test Performed By: Dowell/Van Dyke										
Procedure Step Number	Item	Expected Result	Value	(A/R)	Comment	QA	Value	(A/R)	Comment	QA
1.8.1.5 (Continued)	ER	~~FR13~~ FRI3	FRI3	A	TE B4	W	FRI3	A	TE4	W
	GT	B	B			W	B			W
	HC	123BCDFILTPU	123BCDFIL TPU			W	123BCDFIL TPU			W
	HF	+00000000E+00	+00000000E +00			W	+00000000E +00			W
	HL	+00000.00	+00000.00			W	+00000.00			W
	LD	I	I			W	I			W
	T1	+.20000000E+01	+.20000000E +01			W	+.2000000 +01			W
	T2	+.20000000E+01	+.20000000E +01			W	+.2000000 +01			W
	T3	+.20000000E+01	+.20000000E +01			W	+.2000000 +01			W
	TC	E	E			W	E			W
	TS	2400	2400			W	2400			W
	WT	EDE	EDE			W	EDE			W
	HH	+00600.00	+00600.00			W	+00600.00			W
	HA	+00416.00	+00416.00			W	+00416.00			W
	LA	+00125.00	+00125.00			W	+00125.00			W
	LL	+00012.00	+00012.00			W	+00012.00			W
	MH	+00625.00	+00625.00			W	+00625.00			W
	ML	+00004.00	+00004.00			W	+00004.00			W
	MZ	+00612.00	+00612.00			W	+00612.00			W
	S3	+.12500000E+03	+.12500000 +03			W	+.12500000E +03			W
	L2	+00000.00	+00000.00			W	+00000.00			W
	L3	+00000.00	+00000.00	A		W	+00000.00	A		W

Test Data Sheets

Date of test: 10-17-95, 12-14-95, 2-13-96			Gauge on Riser 1C				Gauge on Riser 15A			
Test Performed By: Dowell, et al										
Procedure Step Number	Item	Expected Result	Value	(A/R)	Comment	QA	Value	(A/R)	Comment	QA
1.8.2.1	Section 1.8.1 Complete?	Yes	YES	A		W	YES	A		W
1.8.2.4	Digital Meter reading	569 ± 20	565	A		W	566	A		W
1.8.2.5	Digital Meter reading	0 ± 20	000	A		W	001	A		W
1.9.1.1	Sections 1.8.1 and 1.8.2 Complete?	Yes	YES	A	Retest 12/11/95 Already done	W	YES	A	Retest 12/11/95 Already done	W
1.9.1.5	Waste Height	Record Value	+00384.22	A		W	+00384.15	A	+00384.06	W
1.9.1.6	Adjusted Difference 1.5 Inches or Less?	Yes	YES	A		W	YES	A	Y	W
1.9.1.8	1½ Level	Record Value	+00382.61	A	TE 6A, 6B	MN	+00382.40	A	+00382.4	MN
1.9.1.9	1½ Level	Record Value	+00382.61	A	TE 6A, 6B	MN	+00382.41	A		MN
1.9.1.10 (via 1.9.2.5 and 1.9.2.6)	Initial WB dose	Record Value	No increase seen	A		PAW	No increase seen	A		PAW
	Final WB dose	Record Value	No increase seen			PAW	No increase seen			PAW
1.9.3.1	Section 1.9.1 Complete	Yes	YES			PAW	YES			PAW
1.9.3.4	.RQS file	CYL_OTP	CYL_OTP			PAW	CYL_OTP			PAW
1.9.3.5	.RPL file	Record filename	FEB13_1			PAW	FEB13_1			PAW
1.9.3.8	.LOG file	Value in 1.9.3.5	FEB13_1			PAW	FEB13_1			PAW
1.9.3.11 (via 1.9.2.5 and 1.9.2.6)	Initial WB dose	Record Value	No ~~increase~~ increase			PAW	No increase			PAW
	Final WB dose	Record Value	No increase	A		PAW	No increase			PAW
1.9.3.12	Density of Waste	1.39 ± 0.05	1.515	A	TE10	PAW	1.372			PAW
1.9.4.1	Section 1.9.3 Complete	Yes	Yes	A		PAW	Yes	A		PAW

TE #7

Test Data Sheets

Date of test: 2-13-96

Test Performed By: Dowell / Borrowman

Procedure Step Number	Item	Expected Result	Gauge on Riser 1C Value	Gauge on Riser 1C (A/R)	Gauge on Riser 1C Comment	Gauge on Riser 1C QA	Gauge on Riser 15A Value	Gauge on Riser 15A (A/R)	Gauge on Riser 15A Comment	Gauge on Riser 15A QA
1.9.4.4	.RQS file	IP_OTP	IP_OTP	A		PAW	IP_OTP	A		PAW
1.9.4.5	.RPL file	Record filename	FEB13-2			PAW	FEB13-2			PAW
1.9.4.8	.LOG file	Value in 1.9.4.5	FEB13-2			PAW	FEB13-2			PAW
1.9.4.12 (via 1.9.2.5 and 1.9.2.6)	Initial WB dose	Record Value	NO increase			PAW	NO INCREASE			PAW
	Final WB dose	Record Value	NO increase			PAW	NO INCREASE	A		PAW
1.9.4.13	Density of Waste	1.39 ± 0.05	—		TE11	PAW	—		TE11	PAW
1.9.5.2	Displacer Elevation	Record Value	97.37			PAW				
1.9.5.5	Record Filename	LIFT1C	LIFT1C			PAW				
1.9.5.7	Displacer Elevation	Record Value	105.54			PAW			N/A	
1.9.5.8	Displacer Movement	7 to 10 Inches	8.17	A		PAW				
1.9.6.2	Displacer Elevation	Record Value					83.64	A		PAW
1.9.6.5	Record Filename	LIFT15A		N/A			LIFT15A*			PAW
1.9.6.7	Displacer Elevation	Record Value					92.10			PAW
1.9.6.8	Displacer Movement	7 to 10 Inches					8.46			PAW
1.10.1	Sections 1.7, 1.8, 1.9 Completed	Yes	YES	A			YES	A		PAW

J E Borrowman 2-21-96
Test Director Date

J Dowell 2-13-96
Recorder Date

Failed MVW M.C. Winfield 2/28/96
Quality Date

FAILED E.M. Wagner R.L. Weginger 2-28-96

* A added per telecon with J. Dowell PAW 3-5-96

```
'This is the batch file for the Operational Test at AN-107.
'The file runs 3 density profile scans, each scan about 140 inches overall
'Written by V.R. Enderlin on March 9, 1995,
'last revised August 8, 1995 by JL Dowell for the OTP
'Program Name CYL_OTP.RQS
'****************
'Get date and time.
!DATE
'State which gauge is active for this test
>000BZTA
'Unlock just in case
>000BZUN
'Send to Interface 1
>000BZI1
'Get some info while waiting to get to I1
'State number of samples per level
>000BZDO
'Current reference level (I1)
>000BZRL
'Force on transducer at I1 (to determine density assumption of fluid)
>000BZS1
'State which gauge is active for this test
>001BZTA
'Unlock just in case
>001BZUN
'Send to Interface 1
>001BZI1
'Get some info while waiting to get to I1
'State number of samples per level
>001BZDO
'Current reference level (I1)
>001BZRL
'Force on transducer at I1 (to determine density assumption of fluid)
>001BZS1

'***************Upper profile*****************
'TA=00
'Set upper and lower bounds for profile scan
>000BZW1=ENRAF1
>000BZDB=+00008.00
>000BZDZ=+00236.00
>000BZEX

'TA=01
'Set upper and lower bounds for profile scan
>001BZW1=ENRAF1
>001BZDB=+00008.00
>001BZDZ=+00236.00
>001BZEX

'Wait for communications to come back
!PAUSE 30
```

```
=00
ear the default FREEZE
)BZUN
nd to I1
)BZI1

=01
ear the default FREEZE
IBZUN
nd to I1
IBZI1
ke sure they get there
JSE 240
=00
t innage level for start of profile scan
)BZY4
art scan for TA=00
)BZTP

=01
t innage level for start of profile scan
IBZY4
art scan for TA=01
IBZTP

it for 25 minutes to complete scans and displacers to return to I1
JSE 1500

ate which gauge is active for this test
OBZTA
t levels at which densities were taken
OBZD0
OBZD1
OBZD2
OBZD3
OBZD4
OBZD5
OBZD6
OBZD7
OBZD8
OBZD9
t densities
OBZR0
OBZR1
OBZR2
OBZR3
OBZR4
OBZR5
OBZR6
OBZR7
OBZR8
OBZR9
t average density over entire scan range
OBZSC
TE
```

```
'State which gauge is active for this test
>001BZTA
'Get levels at which densities were taken
>001BZD0
>001BZD1
>001BZD2
>001BZD3
>001BZD4
>001BZD5
>001BZD6
>001BZD7
>001BZD8
>001BZD9
'Get densities
>001BZR0
>001BZR1
>001BZR2
>001BZR3
>001BZR4
>001BZR5
>001BZR6
>001BZR7
>001BZR8
>001BZR9
'Get average density over entire scan range
>001BZSC
!DATE

'**************Middle profile***************
'TA=00
'Set upper and lower bounds for profile scan
>000BZW1=ENRAF1
>000BZDB=+00138.50
>000BZDZ=+00152.00
>000BZEX

'TA=01
'Set upper and lower bounds for profile scan
>001BZW1=ENRAF1
>001BZDB=+00138.50
>001BZDZ=+00152.00
>001BZEX

'Wait for communications to come back
!PAUSE 30

'TA=00
'Clear the default FREEZE
>000BZUN
'Send to I1
>000BZI1
```

```
'TA=01
'Clear the default FREEZE
>001BZUN
'Send to I1
>001BZI1

'Make sure they get there
!PAUSE 240

'TA=00
'Get innage level for start of profile scan
>000BZY4
'Start scan for TA=00
>000BZTP

'TA=01
'Get innage level for start of profile scan
>001BZY4
'Start scan for TA=01
>001BZTP

'Wait for 25 minutes to complete scans and displacers to return to I1
!PAUSE 1500

'State which gauge is active for this test
>000BZTA
'Get levels at which densities were taken
>000BZD0
>000BZD1
>000BZD2
>000BZD3
>000BZD4
>000BZD5
>000BZD6
>000BZD7
>000BZD8
>000BZD9
'Get densities
>000BZR0
>000BZR1
>000BZR2
>000BZR3
>000BZR4
>000BZR5
>000BZR6
>000BZR7
>000BZR8
>000BZR9
'Get average density over entire scan range
>000BZSC
!DATE
```

```
'State which gauge is active for this test
>001BZTA
'Get levels at which densities were taken
>001BZD0
>001BZD1
>001BZD2
>001BZD3
>001BZD4
>001BZD5
>001BZD6
>001BZD7
>001BZD8
>001BZD9
'Get densities
>001BZR0
>001BZR1
>001BZR2
>001BZR3
>001BZR4
>001BZR5
>001BZR6
>001BZR7
>001BZR8
>001BZR9
'Get average density over entire scan range
>001BZSC
!DATE

'*************Bottom profile*****************
'TA=00
'Set upper and lower bounds for profile scan
>000BZW1=ENRAF1
>000BZDB=+00234.50
>000BZDZ=+00012.00
>000BZEX

'TA=01
'Set upper and lower bounds for profile scan
>001BZW1=ENRAF1
>001BZDB=+00234.50
>001BZDZ=+00012.00
>001BZEX

'Wait for communications to come back
!PAUSE 30

'TA=00
'Clear the default FREEZE
>000BZUN
'Send to I1
>000BZI1
```

```
'TA=01
'Clear the default FREEZE
>001BZUN
'Send to I1
>001BZI1

'Make sure they get there
!PAUSE 240

'TA=00
'Get innage level for start of profile scan
>000BZY4
'Start scan for TA=00
>000BZTP
'Keep the displacer at the lower level when done with scan
>000BZI3

'TA=01
'Get innage level for start of profile scan
>001BZY4
'Start scan for TA=01
>001BZTP
'Keep the displacer at the lower level when done with scan
>001BZI3

'Wait for 25 minutes to complete scans and displacers to get to I3
!PAUSE 1500

'State which gauge is active for this test
>000BZTA
'Get levels at which densities were taken
>000BZD0
>000BZD1
>000BZD2
>000BZD3
>000BZD4
>000BZD5
>000BZD6
>000BZD7
>000BZD8
>000BZD9
'Get densities
>000BZR0
>000BZR1
>000BZR2
>000BZR3
>000BZR4
>000BZR5
>000BZR6
>000BZR7
>000BZR8
>000BZR9
'Get average density over entire scan range
>000BZSC
!DATE
```

```
'State which gauge is active for this test
>001BZTA
'Get levels at which densities were taken
>001BZD0
>001BZD1
>001BZD2
>001BZD3
>001BZD4
>001BZD5
>001BZD6
>001BZD7
>001BZD8
>001BZD9
'Get densities
>001BZR0
>001BZR1
>001BZR2
>001BZR3
>001BZR4
>001BZR5
>001BZR6
>001BZR7
>001BZR8
>001BZR9
'Get average density over entire scan range
>001BZSC

'Get the finish time
!DATE
```

```
'This is the batch file for the Operational Test at AN-107.
'The file runs 3 profile scans, each about 140 inches in height
'Written by V.R. Enderlin on March 9, 1995,
'last revised August 8, 1995 by JL Dowell for the OTP
'Program Name IP_OTP.RQS
'*****************
'Get date and time.
!DATE

'State which gauge is active for this section
>000BZTA
'Unlock just in case
>000BZUN
'Send to Interface 1
>000BZI1
'Get some info while waiting to get to I1
'State number of samples per level
>000BZDO
'Current reference level (I1)
>000BZRL
'Force on transducer at I1 (to determine density assumption of fluid)
>000BZS1

'State which gauge is active for this section
>001BZTA
'Unlock just in case
>001BZUN
'Send to Interface 1
>001BZI1
'Get some info while waiting to get to I1
'State number of samples per level
>001BZDO
'Current reference level (I1)
>001BZRL
'Force on transducer at I1 (to determine density assumption of fluid)
>001BZS1

'TA=00
'Set upper and lower bounds for profile scan
>000BZDK=+00378.50
>000BZDN=+00236.00
'Clear the default FREEZE
>000BZUN
'Send to I1 instead of default I3
>000BZI1

'TA=01
'Set upper and lower bounds for profile scan
>001BZDK=+00378.50
>001BZDN=+00236.00
'Send to I1 instead of default I3
>001BZI1

'Make sure they get there
!PAUSE 240
```

```
'Start scan for TA=00
>000BZIP

'Start scan for TA=01
>001BZIP

'Wait for 10 minutes to complete scans and displacers to return to I1
!PAUSE 600

'Get current transmission address
>000BZTA
'Get levels at which densities were taken
>000BZD0
>000BZD1
>000BZD2
>000BZD3
>000BZD4
>000BZD5
>000BZD6
>000BZD7
>000BZD8
>000BZD9
'Get densities
>000BZR0
>000BZR1
>000BZR2
>000BZR3
>000BZR4
>000BZR5
>000BZR6
>000BZR7
>000BZR8
>000BZR9
'Get average density over entire scan range
>000BZSC
!DATE

'Get current transmission address
>001BZTA
'Get levels at which densities were taken
>001BZD0
>001BZD1
>001BZD2
>001BZD3
>001BZD4
>001BZD5
>001BZD6
>001BZD7
>001BZD8
>001BZD9
```

```
'Get densities
>001BZR0
>001BZR1
>001BZR2
>001BZR3
>001BZR4
>001BZR5
>001BZR6
>001BZR7
>001BZR8
>001BZR9
'Get average density over entire scan range
>001BZSC
!DATE


'**************Middle profile********************
'TA=00
'Set upper and lower bounds for profile scan
>000BZDK=+00292.00
>000BZDN=+00152.00
'Clear the default FREEZE
>000BZUN
'Send to I1 instead of default I3
>000BZI1

'TA=01
'Set upper and lower bounds for profile scan
>001BZDK=+00292.00
>001BZDN=+00152.00
'Clear the default FREEZE
>001BZUN
'Send to I1 instead of default I3
>001BZI1

'Make sure they get there
!PAUSE 240

'Start scan for TA=00
>000BZIP

'Start scan for TA=01
>001BZIP

'Wait for 10 minutes to complete scans and displacers to return to I1
!PAUSE 600
```

```
'Get current transmission address
>000BZTA
'Get levels at which densities were taken
>000BZD0
>000BZD1
>000BZD2
>000BZD3
>000BZD4
>000BZD5
>000BZD6
>000BZD7
>000BZD8
>000BZD9
'Get densities
>000BZR0
>000BZR1
>000BZR2
>000BZR3
>000BZR4
>000BZR5
>000BZR6
>000BZR7
>000BZR8
>000BZR9
'Get average density over entire scan range
>000BZSC
!DATE

'Get current transmission address
>001BZTA
'Get levels at which densities were taken
>001BZD0
>001BZD1
>001BZD2
>001BZD3
>001BZD4
>001BZD5
>001BZD6
>001BZD7
>001BZD8
>001BZD9
'Get densities
>001BZR0
>001BZR1
>001BZR2
>001BZR3
>001BZR4
>001BZR5
>001BZR6
>001BZR7
>001BZR8
>001BZR9
'Get average density over entire scan range
>001BZSC
!DATE
```

```
'*****************Bottom Profile***************
'TA=00
'Set upper and lower bounds for profile scan
>000BZDK=+00152.00
>000BZDN=+00012.00
'Clear the default FREEZE
>000BZUN
'Send to I1 instead of default I3
>000BZI1

'TA=01
'Set upper and lower bounds for profile scan
>001BZDK=+00152.00
>001BZDN=+00012.00
'Clear the default FREEZE
>001BZUN
'Send to I1 instead of default I3
>001BZI1

'Make sure they get there
!PAUSE 240

'Start scan for TA=00
>000BZIP
'Keep displacer at lower level when done with scan
>000BZI3

'Start scan for TA=01
>001BZIP
'Keep displacer at lower level when done with scan
>001BZI3

'Wait for 10 minutes to complete scans and displacers to get to I3
!PAUSE 600

'Get current transmission address
>000BZTA
'Get levels at which densities were taken
>000BZD0
>000BZD1
>000BZD2
>000BZD3
>000BZD4
>000BZD5
>000BZD6
>000BZD7
>000BZD8
>000BZD9
```

```
'Get densities
>000BZR0
>000BZR1
>000BZR2
>000BZR3
>000BZR4
>000BZR5
>000BZR6
>000BZR7
>000BZR8
>000BZR9
'Get average density over entire scan range
>000BZSC
!DATE

'Get current transmission address
>001BZTA
'Get levels at which densities were taken
>001BZD0
>001BZD1
>001BZD2
>001BZD3
>001BZD4
>001BZD5
>001BZD6
>001BZD7
>001BZD8
>001BZD9
'Get densities
>001BZR0
>001BZR1
>001BZR2
>001BZR3
>001BZR4
>001BZR5
>001BZR6
>001BZR7
>001BZR8
>001BZR9
'Get average density over entire scan range
>001BZSC

'Get the finish time
!DATE
```

```
'This lifts the displacer at Riser 1C
'Written by JL Dowell August 8, 1995
'Modified Feb 13, 1996
'File name LIFT1C.RQS
'Exit just to make sure
>000BZEX
!PAUSE 15
'Setup for Mode 1 & Mode 2
>000BZW1=ENRAF1
!PAUSE 10
>000BZW2=ENRAF2
!PAUSE 10
'Put in Maintainence mode
>000BZSM
!PAUSE 15
'Go Up command
>000BZGU
!PAUSE 15
'Stop Displacer motion
>000BZFR
!PAUSE 15
>000BZSO
!PAUSE 15
>000BZEX
!PAUSE 15
```

```
'This lifts the displacer at Riser 15A
'Written by JL Dowell August 8, 1995
'Modified Feb 13, 1996
'File name LIFT15A.RQS
'Exit just to make sure
>001BZEX
!PAUSE 15
'Setup for Mode 1 & Mode 2
>001BZW1=ENRAF1
!PAUSE 10
>001BZW2=ENRAF2
!PAUSE 10
'Put in Maintainence mode
>001BZSM
!PAUSE 15
'Go Up command
>001BZGU
!PAUSE 15
'Stop Displacer motion
>001BZFR
!PAUSE 10
>001BZSO
!PAUSE 15
>001BZEX
!PAUSE 15
```

```
' LOGv18 RPL_LOG converter v1.00  / 02-13-1996 21:50:52
'THIS IS THE BATCH FILE FOR THE OPERATIONAL TEST AT AN-107.
'THE FILE RUNS 3 DENSITY PROFILE SCANS, EACH SCAN ABOUT 140 INCHES OVERALL
'WRITTEN BY V.R. ENDERLIN ON MARCH 9, 1995,
'LAST REVISED FEB 13, 1996 BY JL DOWELL FOR THE OTP
'PROGRAM NAME CYL_OTP.RQS
'*****************
'GET DATE AND TIME.
' !DATE 02-13-1996 19:48:23
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=00
'UNLOCK JUST IN CASE
UN=&
'SEND TO INTERFACE 1
I1=&
'GET SOME INFO WHILE WAITING TO GET TO I1
'STATE NUMBER OF SAMPLES PER LEVEL
DO=5
'CURRENT REFERENCE LEVEL (I1)
RL=+00679.94
'FORCE ON TRANSDUCER AT I1 (TO DETERMINE DENSITY ASSUMPTION OF FLUID)
S1=+.26115888E+03
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=01
'UNLOCK JUST IN CASE
UN=&
'SEND TO INTERFACE 1
I1=&
'GET SOME INFO WHILE WAITING TO GET TO I1
'STATE NUMBER OF SAMPLES PER LEVEL
DO=5
'CURRENT REFERENCE LEVEL (I1)
RL=+00675.98
'FORCE ON TRANSDUCER AT I1 (TO DETERMINE DENSITY ASSUMPTION OF FLUID)
S1=+.26436123E+03
'***************UPPER PROFILE******************
'TA=00
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
W1=&
DB=+00008.00&
DZ=+00236.00&
'TA=01
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
W1=&
DB=+00008.00&
DZ=+00236.00&
'WAIT FOR COMMUNICATIONS TO COME BACK
' !PAUSE  30 02-13-1996 19:49:16
'TA=00
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1
I1=&
'TA=01
'CLEAR THE DEFAULT FREEZE
```

```
UN=&
'SEND TO I1
I1=&
'MAKE SURE THEY GET THERE
' !PAUSE  240 02-13-1996 19:53:19
'TA=00
'GET INNAGE LEVEL FOR START OF PROFILE SCAN
Y4=@@@-+00384.50
'START SCAN FOR TA=00
TP=&
'TA=01
'GET INNAGE LEVEL FOR START OF PROFILE SCAN
Y4=@@@-+00384.25
'START SCAN FOR TA=01
TP=&
'WAIT FOR 25 MINUTES TO COMPLETE SCANS AND DISPLACERS TO RETURN TO I1
' !PAUSE  1500 02-13-1996 20:18:23
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=00
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00235.99
D1=@@+00251.61
D2=@@+00267.22
D3=@@+00282.83
D4=@@+00298.44
D5=@@+00314.05
D6=@@+00329.67
D7=@@+00345.28
D8=@@+00360.89
D9=@@+00376.50
'GET DENSITIES
R0=@+01537.54
R1=@+01534.39
R2=@+01537.58
R3=@+01538.82
R4=@+01543.12
R5=@+01544.22
R6=@+01546.00
R7=@+01543.03
R8=@+01545.90
R9=@+01457.44
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=@+01532.80
' !DATE 02-13-1996 20:18:49
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=01
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00235.99
D1=@@+00251.58
D2=@@+00267.16
D3=@@+00282.75
D4=@@+00298.33
D5=@@+00313.91
D6=@@+00329.50
D7=@@+00345.08
```

```
D8=@@+00360.66
D9=@@+00376.25
'GET DENSITIES
R0=@+01389.31
R1=@+01393.45
R2=@+01395.74
R3=@+01395.25
R4=@+01395.10
R5=@+01399.13
R6=@+01400.44
R7=@+01401.30
R8=@+01401.93
R9=@+01314.09
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=@+01388.57
' !DATE 02-13-1996 20:19:16
'**************MIDDLE PROFILE***************
'TA=00
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
W1=&
DB=+00138.50&
DZ=+00152.00&
'TA=01
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
W1=&
DB=+00138.50&
DZ=+00152.00&
'WAIT FOR COMMUNICATIONS TO COME BACK
' !PAUSE  30 02-13-1996 20:19:55
'TA=00
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1
I1=&
'TA=01
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1
I1=&
'MAKE SURE THEY GET THERE
' !PAUSE  240 02-13-1996 20:23:59
'TA=00
'GET INNAGE LEVEL FOR START OF PROFILE SCAN
Y4=@A@-+00384.50
'START SCAN FOR TA=00
TP=&
'TA=01
'GET INNAGE LEVEL FOR START OF PROFILE SCAN
Y4=@@@-+00384.24
'START SCAN FOR TA=01
TP=&
'WAIT FOR 25 MINUTES TO COMPLETE SCANS AND DISPLACERS TO RETURN TO I1
' !PAUSE  1500 02-13-1996 20:49:03
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=00
```

```
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00151.99
D1=@@+00162.44
D2=@@+00172.88
D3=@@+00183.33
D4=@@+00193.78
D5=@@+00204.22
D6=@@+00214.67
D7=@@+00225.11
D8=@@+00235.56
D9=@@+00246.00
'GET DENSITIES
R0=@+01529.78
R1=@+01531.34
R2=@+01529.51
R3=@+01530.19
R4=@+01528.79
R5=@+01534.41
R6=@+01535.30
R7=@+01537.06
R8=@+01534.63
R9=@+01533.80
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=@+01532.48
' !DATE 02-13-1996 20:49:29
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=01
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00151.99
D1=@@+00162.41
D2=@@+00172.83
D3=@@+00183.24
D4=@@+00193.66
D5=@@+00204.08
D6=@@+00214.49
D7=@@+00224.91
D8=@@+00235.33
D9=@@+00245.74
'GET DENSITIES
R0=@+01386.35
R1=@+01386.14
R2=@+01389.08
R3=@+01386.90
R4=@+01389.85
R5=@+01390.25
R6=@+01390.15
R7=@+01390.08
R8=@+01390.10
R9=@+01393.92
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=@+01389.28
' !DATE 02-13-1996 20:49:55
'*************BOTTOM PROFILE*****************
'TA=00
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
```

```
W1=&
DB=+00234.50&
DZ=+00012.00&
'TA=01
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
W1=&
DB=+00234.50&
DZ=+00012.00&
'WAIT FOR COMMUNICATIONS TO COME BACK
' !PAUSE  30 02-13-1996 20:50:35
'TA=00
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1
I1=&
'TA=01
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1
I1=&
'MAKE SURE THEY GET THERE
' !PAUSE  240 02-13-1996 20:54:39
'TA=00
'GET INNAGE LEVEL FOR START OF PROFILE SCAN
Y4=@@@-+00384.49
'START SCAN FOR TA=00
TP=&
'KEEP THE DISPLACER AT THE LOWER LEVEL WHEN DONE WITH SCAN
I2=&
'TA=01
'GET INNAGE LEVEL FOR START OF PROFILE SCAN
Y4=@@@-+00384.21
'START SCAN FOR TA=01
TP=&
'KEEP THE DISPLACER AT THE LOWER LEVEL WHEN DONE WITH SCAN
I2=&
'WAIT FOR 25 MINUTES TO COMPLETE SCANS AND DISPLACERS TO GET TO I3
' !PAUSE  1500 02-13-1996 21:19:45
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=00
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00011.99
D1=@@+00027.33
D2=@@+00042.66
D3=@@+00058.00
D4=@@+00073.33
D5=@@+00088.66
D6=@@+00104.00
D7=@@+00119.33
D8=@@+00134.67
D9=@@+00150.00
'GET DENSITIES
R0=B-99999999
R1=B-99999999
R2=B-99999999
```

```
R3=B-99999999
R4=B-99999999
R5=@+01566.13
R6=@+01525.54
R7=@+01524.80
R8=@+01527.90
R9=@+01530.16
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=B-99999999
' !DATE 02-13-1996 21:20:11
'STATE WHICH GAUGE IS ACTIVE FOR THIS TEST
TA=01
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00011.99
D1=@@+00027.30
D2=@@+00042.60
D3=@@+00057.90
D4=@@+00073.20
D5=@@+00088.51
D6=@@+00103.81
D7=@@+00119.11
D8=@@+00134.41
D9=@@+00149.72
'GET DENSITIES
R0=B-99999999
R1=B-99999999
R2=B-99999999
R3=B-99999999
R4=B-99999999
R5=@+01380.95
R6=@+01381.70
R7=@+01382.78
R8=@+01383.71
R9=@+01384.23
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=B-99999999
'GET THE FINISH TIME
' !DATE 02-13-1996 21:20:38
' # END CYL_OTP.RQS 02-13-1996 21:20:38
' # APPEND 02-13-1996 21:24:25
'THIS LIFTS THE DISPLACER AT RISER 1C
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT1C.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:24:41
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 21:24:51
W2=&
' !PAUSE  10 02-13-1996 21:25:01
'PUT IN MAINTAINENCE MODE
SM=&
'GO UP COMMAND
' !PAUSE  8 02-13-1996 21:25:14
```

```
'STOP DISPLACER MOTION
FR=&
' !PAUSE  15 02-13-1996 21:25:35
' !PAUSE  15 02-13-1996 21:25:50
' # END LIFT1C.RQS 02-13-1996 21:25:50
' # APPEND 02-13-1996 21:27:00
'THIS LIFTS THE DISPLACER AT RISER 1C
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT1C.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:27:16
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 21:27:26
W2=&
' !PAUSE  10 02-13-1996 21:27:36
'PUT IN MAINTAINENCE MODE
SM=&
'GO UP COMMAND
' !PAUSE  8 02-13-1996 21:27:49
'STOP DISPLACER MOTION
FR=&
' !PAUSE  15 02-13-1996 21:28:10
' !PAUSE  15 02-13-1996 21:28:25
' # END LIFT1C.RQS 02-13-1996 21:28:25
' # APPEND 02-13-1996 21:30:47
'THIS LIFTS THE DISPLACER AT RISER 1C
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT1C.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:31:02
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 21:31:12
W2=&
' !PAUSE  10 02-13-1996 21:31:22
'PUT IN MAINTAINENCE MODE
SM=&
'GO UP COMMAND
' !PAUSE  8 02-13-1996 21:31:36
'STOP DISPLACER MOTION
FR=&
' !PAUSE  15 02-13-1996 21:31:56
' !PAUSE  15 02-13-1996 21:32:11
' # END LIFT1C.RQS 02-13-1996 21:32:11
' # APPEND 02-13-1996 21:33:33
'THIS LIFTS THE DISPLACER AT RISER 1C
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT1C.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:33:48
'SETUP FOR MODE 1 & MODE 2
```

```
W1=&
' !PAUSE  10 02-13-1996 21:33:59
W2=&
' !PAUSE  10 02-13-1996 21:34:09
'PUT IN MAINTAINENCE MODE
SM=&
' !PAUSE  15 02-13-1996 21:34:24
'GO UP COMMAND
GU=&
' !PAUSE  8 02-13-1996 21:34:32
'STOP DISPLACER MOTION
FR=&
' !PAUSE  15 02-13-1996 21:34:52
' !PAUSE  15 02-13-1996 21:35:08
' # END LIFT1C.RQS 02-13-1996 21:35:08
' # APPEND 02-13-1996 21:38:06
'THIS LIFTS THE DISPLACER AT RISER 15A
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT15A.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:38:22
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 21:38:32
W2=&
' !PAUSE  10 02-13-1996 21:38:42
'PUT IN MAINTAINENCE MODE
SM=&
' !PAUSE  15 02-13-1996 21:38:57
'GO UP COMMAND
GU=&
' !PAUSE  8 02-13-1996 21:39:05
'STOP DISPLACER MOTION
FR=&
' !PAUSE  10 02-13-1996 21:39:15
SO=&
' !PAUSE  15 02-13-1996 21:39:31
' !PAUSE  15 02-13-1996 21:39:46
' # END LIFT15A.RQS 02-13-1996 21:39:46
' # APPEND 02-13-1996 21:43:56
'THIS LIFTS THE DISPLACER AT RISER 1C
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT1C.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:44:11
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 21:44:21
W2=&
' !PAUSE  10 02-13-1996 21:44:31
'PUT IN MAINTAINENCE MODE
SM=&
' !PAUSE  15 02-13-1996 21:44:47
```

```
'GO UP COMMAND
GU=&
' !PAUSE  15 02-13-1996 21:45:02
'STOP DISPLACER MOTION
FR=&
' !PAUSE  15 02-13-1996 21:45:17
' !PAUSE  15 02-13-1996 21:45:36
' !PAUSE  15 02-13-1996 21:45:51
' # END LIFT1C.RQS 02-13-1996 21:45:51
' # APPEND 02-13-1996 21:47:30
'THIS LIFTS THE DISPLACER AT RISER 15A
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT15A.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 21:47:45
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 21:47:55
W2=&
' !PAUSE  10 02-13-1996 21:48:05
'PUT IN MAINTAINENCE MODE
SM=&
' !PAUSE  15 02-13-1996 21:48:20
'GO UP COMMAND
GU=&
' !PAUSE  15 02-13-1996 21:48:36
'STOP DISPLACER MOTION
FR=&
' !PAUSE  10 02-13-1996 21:48:46
SO=&
' !PAUSE  15 02-13-1996 21:49:01
' !PAUSE  15 02-13-1996 21:49:16
' # END LIFT15A.RQS 02-13-1996 21:49:16
```

```
' LOGv18 RPL_LOG converter v1.00  / 02-13-1996 23:27:59
'THIS IS THE BATCH FILE FOR THE OPERATIONAL TEST AT AN-107.
'THE FILE RUNS 3 PROFILE SCANS, EACH ABOUT 140 INCHES IN HEIGHT
'WRITTEN BY V.R. ENDERLIN ON MARCH 9, 1995,
'LAST REVISED FEB 13, 1996 BY JL DOWELL FOR THE OTP
'PROGRAM NAME IP_OTP.RQS
'*****************
'GET DATE AND TIME.
' !DATE 02-13-1996 22:21:46
'STATE WHICH GAUGE IS ACTIVE FOR THIS SECTION
TA=00
'UNLOCK JUST IN CASE
UN=&
'SEND TO INTERFACE 1
I1=&
'GET SOME INFO WHILE WAITING TO GET TO I1
'STATE NUMBER OF SAMPLES PER LEVEL
DO=5
'CURRENT REFERENCE LEVEL (I1)
RL=+00679.94
'FORCE ON TRANSDUCER AT I1 (TO DETERMINE DENSITY ASSUMPTION OF FLUID)
S1=+.26115888E+03
'STATE WHICH GAUGE IS ACTIVE FOR THIS SECTION
TA=01
'UNLOCK JUST IN CASE
UN=&
'SEND TO INTERFACE 1
I1=&
'GET SOME INFO WHILE WAITING TO GET TO I1
'STATE NUMBER OF SAMPLES PER LEVEL
DO=5
'CURRENT REFERENCE LEVEL (I1)
RL=+00675.98
'FORCE ON TRANSDUCER AT I1 (TO DETERMINE DENSITY ASSUMPTION OF FLUID)
S1=+.26436123E+03
'TA=00
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
DK=+00378.50&
DN=+00236.00&
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1 INSTEAD OF DEFAULT I3
I1=&
'TA=01
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
DK=+00378.50&
DN=+00236.00&
'SEND TO I1 INSTEAD OF DEFAULT I3
I1=&
'MAKE SURE THEY GET THERE
' !PAUSE  240 02-13-1996 22:26:08
'START SCAN FOR TA=00
IP=&
'START SCAN FOR TA=01
IP=&
```

```
'WAIT FOR 10 MINUTES TO COMPLETE SCANS AND DISPLACERS TO RETURN TO I1
' !PAUSE  600 02-13-1996 22:36:09
'GET CURRENT TRANSMISSION ADDRESS
TA=00
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=B@-99999999
D1=B@-99999999
D2=B@-99999999
D3=B@-99999999
D4=B@-99999999
D5=B@-99999999
D6=B@-99999999
D7=B@-99999999
D8=B@-99999999
D9=B@-99999999
'GET DENSITIES
R0=L-99999999
R1=L-99999999
R2=L-99999999
R3=L-99999999
R4=L-99999999
R5=L-99999999
R6=L-99999999
R7=L-99999999
R8=L-99999999
R9=L-99999999
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=L-99999999
' !DATE 02-13-1996 22:36:35
'GET CURRENT TRANSMISSION ADDRESS
TA=01
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=B@-99999999
D1=B@-99999999
D2=B@-99999999
D3=B@-99999999
D4=B@-99999999
D5=B@-99999999
D6=B@-99999999
D7=B@-99999999
D8=B@-99999999
D9=B@-99999999
'GET DENSITIES
R0=L-99999999
R1=L-99999999
R2=L-99999999
R3=L-99999999
R4=L-99999999
R5=L-99999999
R6=L-99999999
R7=L-99999999
R8=L-99999999
R9=L-99999999
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=L-99999999
```

```
' !DATE 02-13-1996 22:37:02
'*************MIDDLE PROFILE*******************
'TA=00
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
DK=+00292.00&
DN=+00152.00&
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1 INSTEAD OF DEFAULT I3
I1=&
'TA=01
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
DK=+00292.00&
DN=+00152.00&
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1 INSTEAD OF DEFAULT I3
I1=&
'MAKE SURE THEY GET THERE
' !PAUSE  240 02-13-1996 22:41:11
'START SCAN FOR TA=00
IP=&
'START SCAN FOR TA=01
IP=&
'WAIT FOR 10 MINUTES TO COMPLETE SCANS AND DISPLACERS TO RETURN TO I1
' !PAUSE  600 02-13-1996 22:51:13
'GET CURRENT TRANSMISSION ADDRESS
TA=00
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00151.99
D1=@@+00167.55
D2=@@+00183.11
D3=@@+00198.66
D4=@@+00214.22
D5=@@+00229.77
D6=@@+00245.33
D7=@@+00260.88
D8=@@+00276.44
D9=@@+00291.99
'GET DENSITIES
R0=D+01532.26
R1=D+01530.68
R2=D+01527.70
R3=D+01533.57
R4=D+01534.95
R5=D+01541.60
R6=D+01537.91
R7=D+01539.38
R8=D+01537.60
R9=D+01543.25
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=D+01535.89
' !DATE 02-13-1996 22:51:38
'GET CURRENT TRANSMISSION ADDRESS
TA=01
```

```
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00151.99
D1=@@+00167.55
D2=@@+00183.11
D3=@@+00198.66
D4=@@+00214.22
D5=@@+00229.77
D6=@@+00245.33
D7=@@+00260.88
D8=@@+00276.44
D9=@@+00291.99
'GET DENSITIES
R0=D+01387.41
R1=D+01383.96
R2=D+01387.23
R3=D+01390.54
R4=D+01396.03
R5=D+01388.45
R6=D+01392.70
R7=D+01393.57
R8=D+01397.27
R9=D+01398.07
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=D+01391.52
' !DATE 02-13-1996 22:52:05
'*****************BOTTOM PROFILE***************
'TA=00
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
DK=+00152.00&
DN=+00012.00&
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1 INSTEAD OF DEFAULT I3
I1=&
'TA=01
'SET UPPER AND LOWER BOUNDS FOR PROFILE SCAN
DK=+00152.00&
DN=+00012.00&
'CLEAR THE DEFAULT FREEZE
UN=&
'SEND TO I1 INSTEAD OF DEFAULT I3
I1=&
'MAKE SURE THEY GET THERE
' !PAUSE  240 02-13-1996 22:56:15
'START SCAN FOR TA=00
IP=&
'KEEP DISPLACER AT LOWER LEVEL WHEN DONE WITH SCAN
I2=&
'START SCAN FOR TA=01
IP=&
'KEEP DISPLACER AT LOWER LEVEL WHEN DONE WITH SCAN
I2=&
'WAIT FOR 10 MINUTES TO COMPLETE SCANS AND DISPLACERS TO GET TO I3
' !PAUSE  600 02-13-1996 23:06:18
'GET CURRENT TRANSMISSION ADDRESS
```

```
TA=00
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00011.99
D1=@@+00027.55
D2=@@+00043.11
D3=@@+00058.66
D4=@@+00074.22
D5=@@+00089.77
D6=@@+00105.33
D7=@@+00120.88
D8=@@+00136.44
D9=@@+00151.99
'GET DENSITIES
R0=F-99999999
R1=F-99999999
R2=F-99999999
R3=F-99999999
R4=F-99999999
R5=D+01517.22
R6=D+01520.64
R7=D+01526.27
R8=D+01531.82
R9=D+01532.05
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=F-99999999
' !DATE 02-13-1996 23:06:44
'GET CURRENT TRANSMISSION ADDRESS
TA=01
'GET LEVELS AT WHICH DENSITIES WERE TAKEN
D0=@@+00011.99
D1=@@+00027.55
D2=@@+00043.11
D3=@@+00058.66
D4=@@+00074.22
D5=@@+00089.77
D6=@@+00105.33
D7=@@+00120.88
D8=@@+00136.44
D9=@@+00151.99
'GET DENSITIES
R0=F-99999999
R1=F-99999999
R2=F-99999999
R3=F-99999999
R4=F-99999999
R5=D+01377.52
R6=D+01381.59
R7=D+01385.67
R8=D+01383.30
R9=D+01387.06
'GET AVERAGE DENSITY OVER ENTIRE SCAN RANGE
SC=F-99999999
'GET THE FINISH TIME
' !DATE 02-13-1996 23:07:11
' # END IP_OTP.RQS 02-13-1996 23:07:11
```

```
' # APPEND 02-13-1996 23:07:36
'THIS LIFTS THE DISPLACER AT RISER 1C
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT1C.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 23:07:51
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 23:08:01
W2=&
' !PAUSE  10 02-13-1996 23:08:12
'PUT IN MAINTAINENCE MODE
SM=&
' !PAUSE  15 02-13-1996 23:08:27
'GO UP COMMAND
GU=&
' !PAUSE  15 02-13-1996 23:08:42
'STOP DISPLACER MOTION
FR=&
' !PAUSE  15 02-13-1996 23:08:57
' !PAUSE  15 02-13-1996 23:09:16
' !PAUSE  15 02-13-1996 23:09:31
' # END LIFT1C.RQS 02-13-1996 23:09:32
' # APPEND 02-13-1996 23:10:41
'THIS LIFTS THE DISPLACER AT RISER 15A
'WRITTEN BY JL DOWELL AUGUST 8, 1995
'MODIFIED FEB 13, 1996
'FILE NAME LIFT15A.RQS
'EXIT JUST TO MAKE SURE
' !PAUSE  15 02-13-1996 23:10:56
'SETUP FOR MODE 1 & MODE 2
W1=&
' !PAUSE  10 02-13-1996 23:11:07
W2=&
' !PAUSE  10 02-13-1996 23:11:17
'PUT IN MAINTAINENCE MODE
SM=&
' !PAUSE  15 02-13-1996 23:11:32
'GO UP COMMAND
GU=&
' !PAUSE  15 02-13-1996 23:11:47
'STOP DISPLACER MOTION
FR=&
' !PAUSE  10 02-13-1996 23:11:57
SO=&
' !PAUSE  15 02-13-1996 23:12:12
' !PAUSE  15 02-13-1996 23:12:28
' # END LIFT15A.RQS 02-13-1996 23:12:28
```

APPENDIX B - TEST EXCEPTION SHEET
(Copy as needed)

TEST EXCEPTION # 1

Test Title: WHC-SD-WM-OTP-187, REV 0					Gauge Transmission Address: 00,01
EXCEPTIONS				CORRECTION APPROVAL	
				Initials/Date	
Procedure Step Number	Date	Description		Project Engineer	Quality
1.7.4.4	10-16-95	Used Alternate method to corelate gauge address w/ riser location. Power at gauge was turned OFF - LOGVRTS gave message of which gauge was not responding.		JFD 10-16-95	EW 10-16-95

Project Engineer 10/16
OBJECTING PARTY Date

E N WEGENER
E. M. Wegener 10-16-95
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

E. M. Wegener 10-16-95
Quality Date

10-16-95
Test Director Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other____

Explanation________________________________

EXCEPTION RESOLVED: yes

J. Y. Lowell
Project Engineer Date

E. M. Wegener 10-16-95
Quality Date

TEST EXCEPTION # 2

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00,01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.8.15	10-17-95	Corrected typo for AN & AM (were reversed on data sheet)	JJD 10-17-95	EW 10-17-95

Project Engineer 10-17-95
OBJECTING PARTY Date

E. M. Wegener 10-17-95
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

E. M. Wegener 10-17-95
Quality Date

10-17-95
Test Director Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other_____

Explanation________________________________

EXCEPTION RESOLVED: yes

J J Dowell 10-17-95
Project Engineer Date

E. M. Wegener 10-17-95
Quality Date

TEST EXCEPTION # 3

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00,01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.8.15	10.17.95	Type for DO value: should be 5. Corrected data sheet.	JJD 10.17.95	EW 10-17-95

Project Eng JJ Dowell 10.17.95
OBJECTING PARTY Date

E.M. Wegner 10-17-95
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

E.M. Wegner 10-17-95
Quality Date

10-17-95
Test Director Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other_____

Explanation____________________

EXCEPTION RESOLVED: yes

JJ Dowell 10-17-95
Project Engineer Date

E.M. Wegner 10-17-95
Quality Date

TEST EXCEPTION # 4

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00, 01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.8.15	10.17.95	Corrected typo for ER parameter: should be FRI3. Corrected data sheet	ALD 10.17.95	EW

A L Dowell 10.17.95
OBJECTING PARTY Date

E. M. Wegener 10-17-95
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

E. M. Wegener 10-17-95
Quality Date

10-17-95
Test Director Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other_____

Explanation______________________________

EXCEPTION RESOLVED: yes

A L Dowell 10.17.95
Project Engineer Date

E. M. Wegener 10-17-95
Quality Date

TEST EXCEPTION # 5

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: N/A	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.7.5.5 & 1.7.5.6	10-17-95	Only 1 connection point on rinse Assy. Revise min gpm to 3.9 gpm. (3+1.3 gpm). Flow exceeded 3.9 gpm, both risers.	JLD 10.17.95	EW 10-17-95

J L Dowell 10.17.95
OBJECTING PARTY Date

E.M. Wegener 10-17-95
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

E.M. Wegener 10-17-95
Quality Date

10-17-95
Test Director Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other_____

Explanation

EXCEPTION RESOLVED: Yes

J L Dowell 10.17.95
Project Engineer Date

E.M. Wegener 10-17-95
Quality Date

TEST EXCEPTION # 6A

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00, 01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.1.7, 1.9.1.8 & 1.9.1.9	12/14/95	Change I3 to I2 as 6T-12S sets S2 = 40 & this change makes this OTP compatible w/ 6T-12S JJD Note: Current level (per CASS) is 384.50 inches	JJD 12-14-95	M.C. Wingfield 12/14/95

Project Eng 12-14-95
OBJECTING PARTY Date

M.C. Wingfield 12/14/95
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

M.C. Wingfield
Quality Date

J E Bowman 12-14-95
Test Director Date

Retest Approved and Accepted ___ Exception Accepted As-Is ✓ Other___

Explanation See above

EXCEPTION RESOLVED: yes

J J Dowell 12-14-95
Project Engineer Date

M.C. Wingfield 12/14/95
Quality Date

TEST EXCEPTION # 6B

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00,01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.1.8	12-14-95	Displacer did no go more than 4 inches into waste (again). Action: Troubleshoot/repair/investigate & restart test @ step 1.9.1.1.	JLD 12-14-95	M.C. Wingfield 2/28/96
	2-10-96	Displacer that weighs 284g will pass 4" layer - approx 10-20 grams support provided. Restart test per above asap.	JLD 2-10-96	N/A
	2-13-96	Restart test - displacers = 285 (±2g) weight. OTP successfully completed.	JLD 2-13-96	PAW 2-26-96

Project Engineer 12-14-95 [signature] 12-14-96
OBJECTING PARTY Date RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES 2-13-96 ✓ NO ___ N/A ___

Paul A. Werner 2-26-96 ← delayed entry witnessed 2-13-96 J.E. Bozeman 2-21-96
Quality Date Test Director Date

Retest Approved and Accepted 2-13-96 ✓ Exception Accepted As-Is _____ Other_____

Explanation This occured during testing on 10-17-95; went to heavier displacers. Suspect subsurface "crust" or gauge problem. See also TE #7

EXCEPTION RESOLVED: Yes - 2/13/96

[signature] 2-13-96
Project Engineer Date

[signature] M.C. Wingfield 2-28-96
Quality Date

TEST EXCEPTION # 7

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00,01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.1.1 thru 1.9.1.10	2-13-96	Skip steps 1.9.1.1, 1.9.1.7 thru 1.9.1.10 - All steps [illegible] are complete; I2 level found on 2-10-96. Do not repeat I2 level to avoid [illegible] displacers. Record data for this section below	[illegible] 2-13-96	PAW 2-13-96
1.9.1.5 1.9.1.6 1.9.1.8 1.9.1.9		~~384.50~~ / 384.24 [illegible] Yes / Yes Adj HE diff Less than 1.5"? 79.1 ~~384.50~~ / 80.2 ~~384.24~~ Record Value LC / TSA Note: Current level is 384.8 per TF-CK-EF-AN entry dated 2-13-96	[illegible] 2-13-96	PAW 2-26-96

Project Engineer 2-13-96
OBJECTING PARTY Date

[signature] 2-13-96
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ✓ NO ___ N/A ___

Paul R. Werner 2-26-96
Quality Date

J E Borneman 2-21-96
Test Director Date

Retest Approved and Accepted ✓ Exception Accepted As-Is _____ Other_____

Explanation Retest began @ 1.9.1 after repair/troubleshooting/informal testing on 2-10-96 indicated displacer would descend past/below "380". During this retest the displacer did go below 380'.

EXCEPTION RESOLVED: yes

[signature] 2-13-96
Project Engineer Date

[signature] 2/28/96
Quality J. VERDERBER Date

TEST EXCEPTION # 8

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: N/A	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.4.11	2.13.96	Move step 1.9.4.11 to be last step of section 1.9.4	JLD 2.13.96	PRW 2-26-96

Project Engineer — OBJECTING PARTY — 2.13.96 Date

J L Dowell — RECORDER — 2.13.96 Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

Paul R. Werner — Quality — 2-26-96 Date

J E Bowman — Test Director — 2-21-96 Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other_____

Explanation Performing step 1.9.4.11 (in current sequence) exits the program prematurely.

EXCEPTION RESOLVED: yes

J L Dowell — Project Engineer — 2.13.96 Date

J. Verderber — Quality J. VERDERBER — 2/28/96 Date

TEST EXCEPTION # 9

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00,01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.5.7	2.13.96	Modify LIFT1C.RQS as follows: 1- Added a !PAUSE after the 000BZSM, 000BZFR & 000BZEX commands. 2- Added the following two commands before 000BZEX (last line) command: 000BZSO !PAUSE 15 3- Changed !PAUSE time after 000BZGU command from 8 to 15.	JLD 2.13.96	PAW 2.26.96
1.9.6.7	2.13.96	Modify LIFT1S.RQS per above.	JLD 2.13.96	PAW 2.26.96
1.9.5.7, 1.9.6.7	2.13.96	Record successful ~~"before" &~~ JLD elevation & verification information on Test Data Sheet.	JLD 2.13.96	PAW 2.26.96

Project Engineer 2.13.96
OBJECTING PARTY Date

J L Dowell 2.13.96
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ✓ NO ___ N/A ___

Paul A. Dennis 2-26-96
Quality Date

J E Borrowman 2-21-96
Test Director Date

Retest Approved and Accepted ✓ Exception Accepted As-Is _____ Other_____

Explanation 1- Pause needed or gauge will ignore the commands following. 2- Leave "SM" mode ~~on~~ so "SM" protected commands are not enabled. 3- Increase time so displacer is lifted per specs.

EXCEPTION RESOLVED: yes

J L Dowell 2.13.96
Project Engineer Date

John Verderber 2/28/96
Quality J. VERDERBER Date

TEST EXCEPTION # 10

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.3.12	2/20/96	Step deferred to later date (2-20-96). Examination of data shows density readings from gauge 00 (Riser 1C) are higher than expected by about 9% or 0.125 sp. g.	JLD 2.20.96	PAW

Project Engineer 2.20.96
OBJECTING PARTY Date

J L Dowell 2-20-96
RECORDER Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

Paul H. Werner 3-7-96
Quality Date

J. E. Bowman 2-21-96
Test Director Date

Retest Approved and Accepted ___ Exception Accepted As-Is ✓ Other___

Explanation Comparisom to data from other gauge shows good corelation; intent of this data is to establish a baseline for comparisom.

EXCEPTION RESOLVED: YES

J L Dowell 2.20.96
Project Engineer Date

John J Verderber 2/28/96
Quality J VERDERBER Date

TEST EXCEPTION # 11

Test Title: WHC-SD-WM-OTP-187, REV 0			Gauge Transmission Address: 00,01	
EXCEPTIONS			CORRECTION APPROVAL	
			Initials/Date	
Procedure Step Number	Date	Description	Project Engineer	Quality
1.9.4.13	2-20-96	No data gathered (by either gauge) for top third of tank. (Step defferred to 2-20-96).	2-20-96 JFD	PAW

Project Engineer — 2-20-96
OBJECTING PARTY — Date

[signature] — 2-20-96
RECORDER — Date

ACCEPTABLE RETEST PERFORMED: YES ___ NO ___ N/A ✓

[signature] — 3-7-96
Quality — Date

[signature] — 2-21-96
Test Director — Date

Retest Approved and Accepted _____ Exception Accepted As-Is ✓ Other_____

Explanation This ~~file~~ data was taken to compare to the data ~~from~~ taken by CYL-OTP, RGS; the 20 data points (per gauge) will be sufficent for a comparison.

EXCEPTION RESOLVED: yes

[signature] — 2-20-96
Project Engineer — Date

[signature] J. VERDERBER — 2/28/96
Quality — Date

APPENDIX C - TEST LOG SHEET
(Copy as needed)

TEST LOG: WHC-SD-WM-OTP-187, REV 0

DATE/TIME	COMMENTS
10/16/95 1:00	Begin Test
10/16/95 3:00	Halt test at step 1.7.5.5
10/17/95 9:00	Fixed connector at rinse spool piece; continued test at step 1.7.5.5
10/17/95 11:00	Halt test at 1.9.1.9 - Sediment level seems abnormal
12/14/95	Halt test at 1.9.1.8 - Sediment level Seems abnormal. M.C. Wingfield Q.C.
2-13-96 7:30 pm	Restart OTP @ 1.9.1.2 per TE #6B as testing & troubleshooting on 2-10-96 indicate displacers will submerge below 380".
2-13-96 11:30 pm	End OTP - all field work is complete.

APPENDIX D - TEST EXECUTION SHEET

TEST EXECUTION SHEET

Date: 10-16-95

Document Number: WHC-SD-WM-OTP-187, REV 0

Test Unit Number: 1C/15A

TEST PERSONNEL

Project Engineer: JL DOWELL

Test Director: J E Boramon 12-14-95

Recorder: ERNIE N. WEGENER
12/14/95 M.C. Wingfield
2-13-96 JL Dowell

Quality: E.N. WEGENER
12/14/95 M.C. Wingfield
Paul A. Werner 2-13-96

TEST EXECUTION

Test Director 2-21-96 Date

Recorder 2-13-96 Date

Quality J. VERDERBER 3/5/96 Date

TEST APPROVAL AND ACCEPTANCE

___ Without Exception

✓ With Exception/Resolved

___ With Exception/Outstanding

Project Engineer 2-20-96 Date

Quality J. VERDERBER 3/5/96 Date

DISTRIBUTION SHEET

To	From	Page 1 of 1
Distribution	Control Systems Engineering	Date Sept 25, 1996
Project Title/Work Order		EDT No. 141087
WHC-SD-WM-OTR-187, Rev. 0, Operational Test Report for the 241-AN-107 ENRAF Advanced Technology Gauges		ECN No. N/A

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
K. G. Carothers	R1-56	X			
J. L. Dowell	E6-21	X			
G. N. Hanson	S5-05				X
M. D. Harding	S5-03	X			
M. N. Islam	R3-08				X
R. S. Nicholson	S5-05	X			
J. J. Verderber	S1-57	X			
S. U. Zaman	R3-08	X			
Central Files	A3-88	X			
TFIC	R1-20	X			