



Enraf Reference Level Updates for High-Level Nuclear Waste Tanks at Hanford Site

Anthony Fernandez – DOE Fellow, Mr. Ruben Mendoza, P.E. – Mentor
Washington River Protection Solutions, Hanford Site, Richland, WA



ABSTRACT

The United States Department of Energy Hanford Site Tank Farm has implemented a system for monitoring tank waste levels in all single-shell tanks (SST), double-shell tanks (DST) and miscellaneous catch tanks using Enraf Series 854 level gauges. To ensure an accurate computation of the tank waste levels, a precise calculation of the tank reference level must be kept up to date. A system was developed where accurate waste tank reference levels are kept consistent with each Enraf assembly in the Tank Farms to ensure the continuation of accurate waste level monitoring.

ACKNOWLEDGEMENTS

This research was supported by the U.S. Department of Energy through the DOE-FIU Science and Technology Workforce Development Program. Special thanks to:

- Leonel Lagos, Ph.D. (FIU)
- Amer Awwad, M.S., P.E. (FIU)
- Jairo Crespo, E.I. (FIU)
- Ruben Mendoza, P.E. (WRPS)
- Greg Gauck, B.S. (WRPS)



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BACKGROUND

ENRAF NONIUS SERIES 854 LEVEL GAUGE

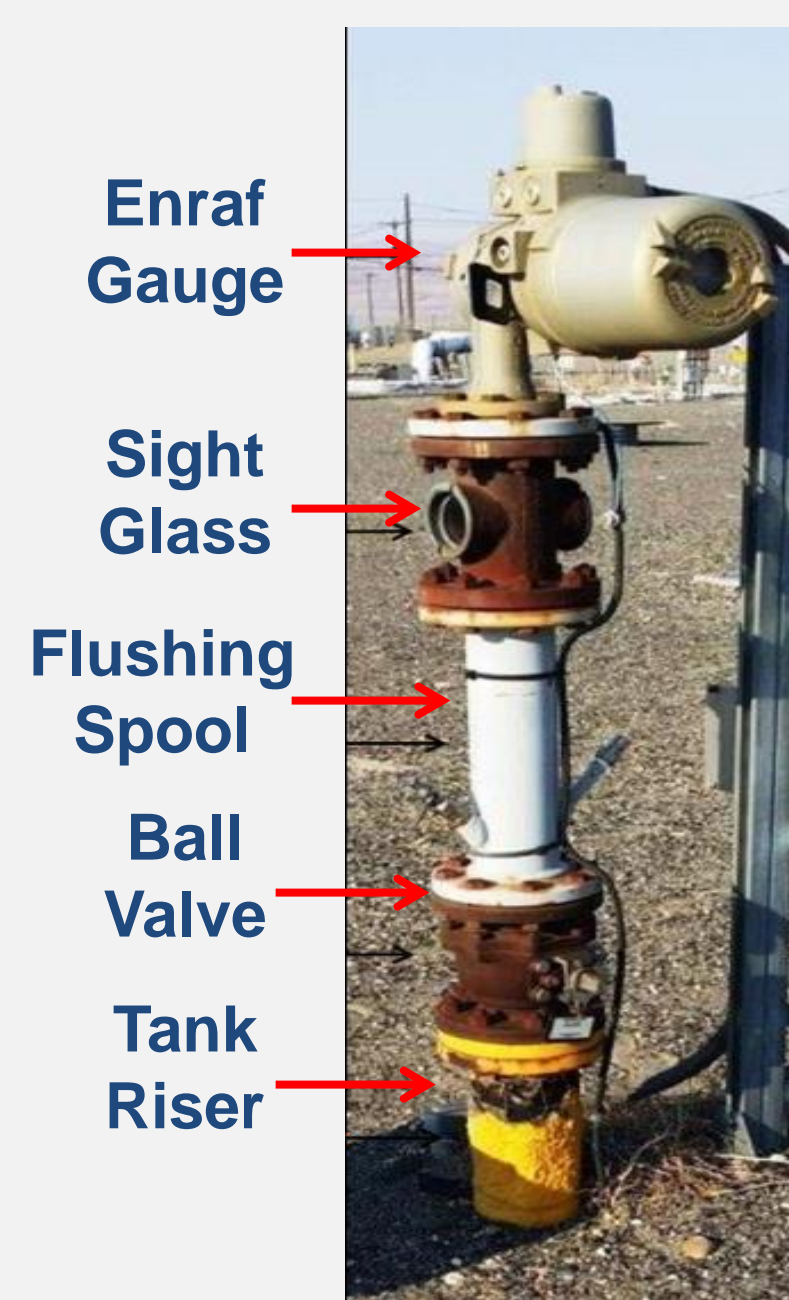


Figure 1: Enraf Assembly

Purpose

- Primary level indicating transmitter (LIT) used to measure tank waste levels (accuracy ±0.01 & safety)

Method

- Level measuring system based on detection of variations in the weight of a displacer that becomes suspended in the tank waste (15g)
- Servo motor adjusts position of displacer according to reference level (RL)
- Waste level displayed on digital readout

REFERENCE LEVEL

What is it?

- The distance from the absolute tank bottom to the top of the isolation ball valve (Figure 2)
- Each Hanford waste tank has its own, specific RL

Purpose

- Serves as calibration level for accurate Enraf waste level readings
- Calculation depends on ball inset dimension and immersion depth

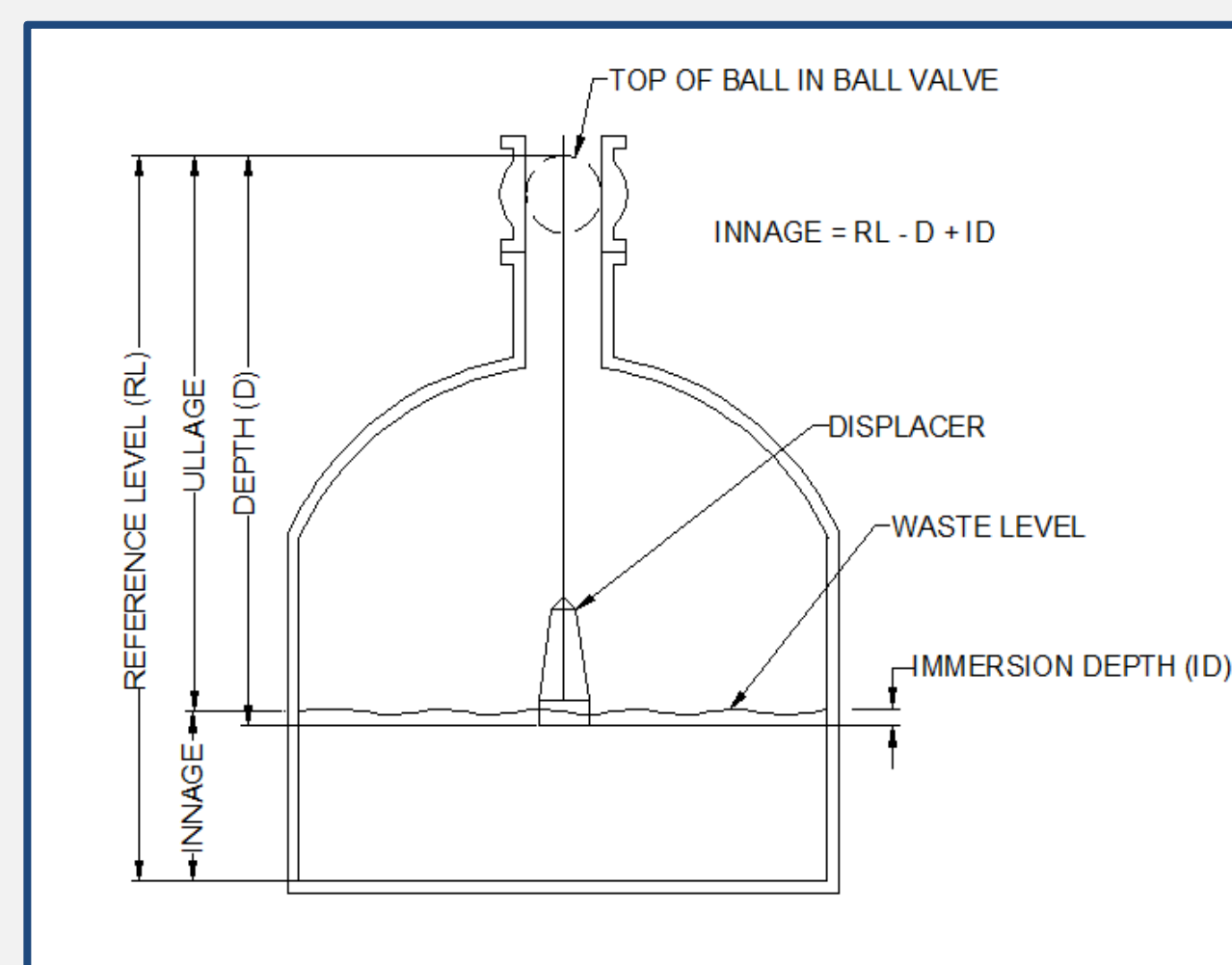


Figure 2: Reference Level Schematic

BALL INSET DIMENSION

What is it?

- Distance from the top of the isolation ball valve to the top of the ball in the valve

Depends on the Isolation Ball Valve Installed

- Symmetrical? If not, ball valve “up” or “down”?

Table 1: Ball Inset Dimension Values

Ball Valve Type	Ball Inset Dimension
Flow-Tek Ball Valve	1.47 inches
Worcester “824” Ball Valve	1.21 inches
Worcester “818” Ball Valve in “up”	1.09 inches
Worcester “818” Ball Valve in “down”	1.31 inches

METHOD

REFERENCE LEVEL CALCULATION

Determined by measuring the distance (in inches) of the following, and adding them together:

- The difference between the tank bottom and the riser elevation
- The length of the 4” diameter ball valve (the ball valve flange-to-flange distance of 9 inches)
- The immersion depth (if applicable to the tank)
- Any associated gasket thickness and/or other miscellaneous parts

To this sum, the ball valve inset dimension is subtracted

TANK NO.	RISER NO.	SIZE	TYPE	REF. LEVEL	ALT. PWB SEL.
241-A-101	8	4"	1	657.92	-040
241-A-102	006	4"	1	657.92	-140
241-A-103	6	4"	1	656.86	-060
241-A-104	0	4"	1	653.80	-030
241-A-105	005	4"	1	644.36	-140
241-A-106	0	4"	1	654.18	-050
241-A-107	004 (2A)	4"	1	677.27	-360**
241-A-108	004	4"	1	677.84	-350
241-A-109	004 (2A)	4"	1	677.60	-360**
241-A-110	004 (2A)	4"	1	677.53	-360**
241-A-111	004 (2A)	4"	1	677.53	-360**
241-A-112	004	4"	1	677.43	-350
241-A-113	004	4"	1	676.45	-350
241-A-114	004 (2)	4"	1	676.45	-350
241-A-115	004 (2)	4"	1	676.09	-350
241-A-116	004 (2)	4"	1	676.45	-350
241-A-117	004 (2)	4"	1	676.45	-350
241-A-118	004 (2)	4"	1	676.45	-350
241-A-119	004 (2)	4"	1	676.45	-350
241-A-120	004 (2)	4"	1	676.45	-350
241-A-121	004 (2)	4"	1	676.45	-350
241-A-122	004 (2)	4"	1	676.45	-350
241-A-123	004 (2)	4"	1	676.45	-350
241-A-124	004 (2)	4"	1	676.45	-350
241-A-125	004 (2)	4"	1	676.45	-350
241-A-126	004 (2)	4"	1	676.45	-350
241-A-127	004 (2)	4"	1	676.45	-350
241-A-128	004 (2)	4"	1	676.45	-350
241-A-129	004 (2)	4"	1	676.45	-350
241-A-130	004 (2)	4"	1	676.45	-350
241-A-131	004 (2)	4"	1	676.45	-350
241-A-132	004 (2)	4"	1	676.45	-350
241-A-133	004 (2)	4"	1	676.45	-350
241-A-134	004 (2)	4"	1	676.45	-350
241-A-135	004 (2)	4"	1	676.45	-350
241-A-136	004 (2)	4"	1	676.45	-350
241-A-137	004 (2)	4"	1	676.45	-350
241-A-138	004 (2)	4"	1	676.45	-350
241-A-139	004 (2)	4"	1	676.45	-350
241-A-140	004 (2)	4"	1	676.45	-350

Figure 3: Enraf Reference Level Summary Example

DOCUMENT CONTROL METHOD

The following flow chart details the updated document control method for accurate Enraf RL's across multiple documents:

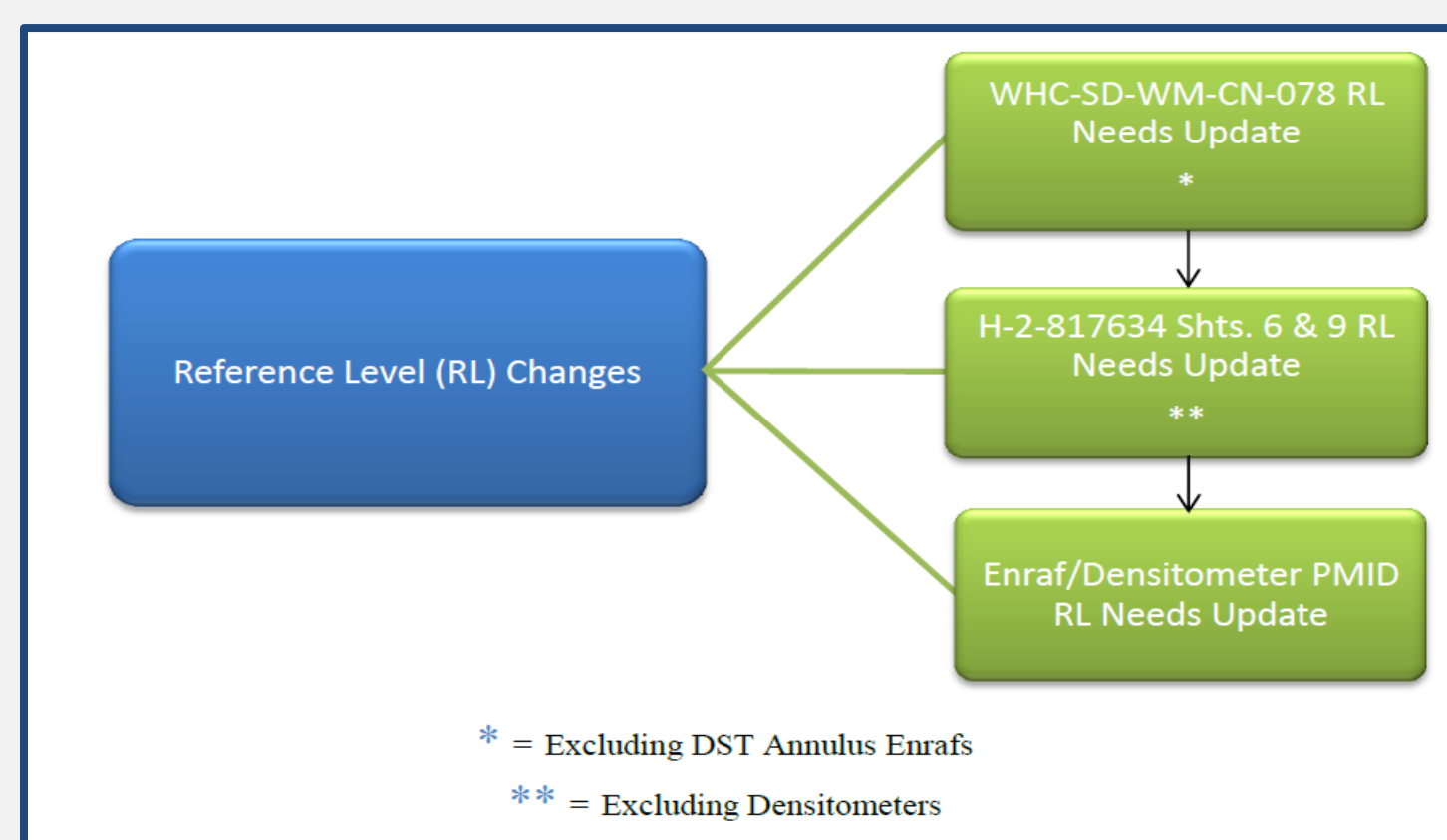


Figure 4: Document Control Methodology

IMMERSION DEPTH

What is it?

- When measuring semi-solid surfaces, the displacer may settle into the surface of the waste
- The distance that the displacer settles is known as the Immersion Depth
- This distance must be taken into account

Displacer Immersion Depth, in cm, in any given liquid:

$$H = \frac{4F_B}{\pi D^2 S_p G}$$

*IMMERSION DEPTH CALCULATION
GOVERNING EQUATION FROM SECTION 5.2.1.4
H = (4F_B) / (π * D² * ρ)
F_B = BOUYANT FORCE = SET POINT
ρ = DENSITY OF LIQUID = SPECIFIC GRAVITY
D = DISPLACER DIAMETER
H = IMMERSION DEPTH (CM)
(In.)

Figure 5: Immersion Depth Calculation

RESULTS

The WHC-SD-WM-CN-078 document, “Enraf Gauge Reference Level Summaries”, is the primary location for Enraf RLs

- A digital, updated version was developed as the source for updating all Enraf RL documentation

The H-2-817634 engineering design drawings, “INSTM Enraf Nonius ASSY Installation & Riser Schedule,” are the primary location for Enraf assembly drawings.

- Figure 6 and 7 show updates made with new revisions

TANK NO.	RISER NO.	SIZE	TYPE	REF. LEVEL	ALT. PWB SEL.	
241-B-101	8	4"	1	478.34	-140	
241-B-102	1	4"	1	485.20	-020	
241-B-103	1	4"	1	483.92	-140	
241-B-104	8	4"	1	478.50	-140	
241-B-105	14	4"	1	486.25	-140	
241-B-106	1	4"	1	484.82	-140	
241-B-107	8	4"	1	478.22	-140	
241-B-108	8	4"	1	477.38	-140	
241-B-109	3	12"	50	485.87	-140	
241-B-110	5	4"	1	478.74	-140	
241-B-111	1	4"	1	484.34	-140	
241-B-112	4	4"	1	488.66	-140	
241-B-201	8	4"	1	488.66	-140	
241-B-202	5	4"	1	489.38	-140	
241-B-203	8	4"	1	489.62	-140	
241-B-204	8	4"	1	489.62	-140	
241-BX-101	8	4"	1	501.02	-030	
241-BX-102	7	12"	90	524.85	-020	
241-BX-103	8	4"	1	501.26	-030	
241-BX-104	8	4"	1	501.98	-030	
241-BX-105	1	4"	1	508.28	-020	
241-BX-106	8	4"	1	500.28	-010	
241-BX-107	8	4"	1	501.86	-040	
241-BX-108	8	4"	1	501.70	-020	
241-BX-109	8	4"	1	502.70	-030	
241-BX-110	2	4"	2	48	507.32	-030
241-BX-111	2	4"	2	48	507.05	-020
241-BX-112	8	4"	1	502.34	-030	
241-BY-102	5	4"	1	20	588.98	-140
241-BY-103	12A	4"	1	20	604.73	-140
241-BY-104	4	4"	1	20	574.82	-140
241-BY-105	1	4"	1	20	574.82	-140

Figure 6: H-2-817634, Sht. 6, Rev. 37

TANK NO.	RISER NO.	SIZE	TYPE	REF. LEVEL	ALT. PWB SEL.
241-IX-101	4	4"	1	589.78	-030
241-IX-102	9A	4"	1	600.12	-040
241-IX-103	8	4"	1	588.62	-020
241-IX-104	4	4"	1	589.84	-020
241-IX-105	8	4"	1	588.85	-040
241-IX-106	8	4"	1	588.38	-020
241-IX-107	8	4"	1	589.21	-030
241-IX-108	8	4"	1	589.69	-030
241-IX-109	4	4"	1	589.62	-020
241-IX-110	7	12"	50	593.05	-030
241-IX-111	1	4"	1	589.48	-040
241-IX-112	1	4"	1	588.68	-040
241-IX-113	1	4"	1	587.24	-040
241-IX-114	8	4"	1	576.48	-020
241-IX-115	1	4"	1	576.50	-040
241-IX-116	1	4"	1	575.18	-030
241-IX-117	1	4"	1	580.37	-030
241-IX-118	4	4"	1	578.68	-040
241-IX-119	1	4"	1	555.08	-020
241-IX-120	1	4"	1	555.58	-040
241-IX-121	1	4"	1	555.70	-030
241-IX-122	1	4"	1	556.58	-040
241-IX-123	1	4"	1	555.00	-030
241-IX-124	4	4"	1	555.12	-030
241-IX-125	8	4"	1	475.74	-140
241-IX-126	8	4"	1	476.56	-020
241-IX-127	8	4"	1	475.98	-020
241-IX-128	8	4"	1	476.30	-040

Figure 7: H-2-817634, Sht. 9, Rev. 3

CONCLUSION

- Developed a digital version of “Enraf Gauge Reference Level Summaries” document to facilitate future revisions
 - Developed new document control system for accurate Enraf RL documentation (using “Enraf Gauge Reference Level Summaries”), which led to:
 - Updates to over 63% of Enraf RLs
 - Updates to over 47% of Enraf RLs in associated engineering drawings
 - Updates to over 17% of Enraf PMID RLs
- All updates comply with environmental regulations set by the State of Washington and the DOE Office of River Protection