Errata: Emergency Relief System Design Using DIERS Technology – The DIERS Project Manual

June 12, 2006

	Page	Equation	Description
1.	ix	-	Page number for 5. References (Chapter IV) should be 306 and not 305.
2.	xiii	-	Second sentence of the second paragraph should read "… or frozen and viscous or non-viscous fluids."
3.	4	Reference 20	Should read (1993).
4.	5	X_o	is the flowing weight fraction of the vapor or quality of the fluid entering the vent line.
5.	5	X_m	is the stagnation or thermodynamic weight fraction of the vapor or quality of the fluid at the liquid surface which is related to the void fraction at the liquid surface α_m) via the equation
6.	8	-	X_o - is the flowing mass fraction of the vapor entering the vent (flowing quality).
7.	23	X_m	Thermodynamic or stagnation weight fraction of the vapor or quality of the fluid at the liquid surface.
8.	23	X_o	Flowing weight fraction of the vapor or quality of the fluid entering the vent.
9.	27	I-B2	Exponent on numerator should be 1/4 and not 1/2
10.	29	3 (2 places)	Exponent on numerator should be 1/4 and not 1/2.
11.	30	-	Second sentence of paragraph I-C2 should read "Similarly, the vessel thermodynamic quality . . . ".
12.	31	-	Fifth sentence of paragraph I-C2 should read "In addition, the flowing quality entering . . . ".
13.	31	-	Sixth sentence of paragraph I-C2 should read " . . . between the flowing quality entering the vent and the vessel thermodynamic quality".
14.	34	Figure I-C1	Exponent on pressure value should be 10^2 and not 10^{-2}.
15.	35	-	Second sentence of the first paragraph should read "The foamy correlation yields significantly smaller vent sizes than would an assumption of no slip."
16.	45	I-D14	Term (dP_r / dT_r) should be enclosed in parentheses.
17.	47	X_o	Flowing weight fraction of the vapor or quality of the fluid entering the emergency vent.

	Page	Equation	Description
18.	47	X_r	Thermodynamic weight fraction of the vapor or quality of the fluid in the vessel.
19.	49	-	Third line should read “Reference [21]” and not [20].
20.	56	-	Last sentence of paragraph 1 of section 2-1-3 should read “default value of 0.9” and not 0.8.
21.	56	-	Last sentence of paragraph 2 of section 2-1-3 should read “10% downrating” and not 20%.
22.	61	II-12	Left term should be $-1 / (G_c^2 s)$, not $– G_c^2 / s$
23.	61	II-12	Right term should be $X [1 – X (s –1)]$, not $X [1 + X (s – 1)]$
24.	65	II-23	Term (X_O / P) should have an intermediate divisor symbol.
25.	65	II-24	Term (k-1) / k should be an exponent on the variable η (i.e., $\eta^{(k-1) / k)}$.
26.	66	-	$n = [(1 – X) (Cp)_f / (CP)_g + X] / [(1 – X) (Cp)_f / (CP)_g + X / k]$
27.	67	II-27	Remove bar over variable υ_f.
28.	68	First	Remove bar over variable υ_{Vf}.
29.	82	II-52	First term on RHS should be {0.001375} and not {0.0001375}.
30.	83	II-55	First term should be ϕ_f^2, not ϕ_f
31.	88	II-68	Term (A2 / A1) should not be squared.
32.	95	-	Section VIII of the ASME Code [4] specifies the method of determining the rated capacity of a rupture disk. The July 2001 edition retains the nozzle-type calculation for short piping runs (less than thirteen diameters of device-size piping) using a default coefficient of discharge of 0.62. The pipe flow model is defined for all lengths of piping using values of the resistance factor of the device as determined by certification tests. Certified values of the resistance factor are selected for the given service according to the fluids used in the tests (K_{RG} if with air or gas, K_{RL} if with liquid, K_{RGL} if on air or gases, and liquid). The rated relieving capacity is the calculated flow capacity of the system, multiplied by 0.9
33.	95	-	Last line of last paragraph of section 3-6-3 should contain a value of 0.9 and not 0.8.
34.	98	g_C	Units should be (ft lb mass / lb force s^2).

	Page	Equation	Description
35.	100	Reference 5	Should read: American Petroleum Institute. "Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries." API Recommended Practice 520. Part II - Installation, 4th Ed (December 1994).
36.	101	Reference 6	Should read: Anon: "Pressure Relief Device Certifications." The National Board of Boiler and Pressure Vessel Inspectors, Columbus, Ohio (Latest Edition).
37.	103	Reference 53	Keenan, J. H., et al., "Thermodynamic Properties of Water, Including Vapor, Liquid, and Solid Phases", Wiley, New York (1978).
38.	116	Last	Term (0.05 / 74) should have an intermediate divisor symbol (not multiplication symbol).
39.	117	Last	ψ equation should have a term (1.6197 - 0.4543) and not (1.6197 - 0.4472).
40.	118	First	First term on RHS should be (1 - 0.9293) and not (1 - 0.09293).
41.	118	Fourth	Second line should contain the term (0.01774) and not (0.1774).
42.	118	Fourth	Fourth line should contain the term (0.003286 + 0.04687) and not (0.003286 + 0.4687).
43.	119	Third	LHS term should be υ_{gt} and not υ_{fg}.
44.	121	First	Term (0.2997 + 0.2671) / 2 should have a plus sign (not a minus sign).
45.	127	II-E4-1 Inlet Loss	Insert. The following three examples are quite accurate if the entrance pressure drop is rather small with respect to the overall drop across the piping system. A more general method is to calculate the contraction as an ideal nozzle, then account for the loss by adding the K factor (or the corresponding equivalent length) to that of the piping run. For the present example: 1. Interpolating in the HEM integration table of Example II-E2-5 (Page 121) for G=366.7 yields P = 95.48 psia and v^{bar} = 0.2664. Account for the inlet loss K = 0.5 by adding to the overall loss factors in the piping. 2. Alternatively, using the friction factor of 0.00457 of this example (from II-E4-2), equivalent length = KD/4f = (0.5)(2/12)/[(4)(0.00457)] = 4.56 ft. Add this to the length of the piping system and proceed as in II-E4-2. For this example, the pressure after the 4.56 feet of piping is 93.7 psia.
46.	129	-	Second equation should read…liquid = …$(346.6)^2$ (0.01769) …

	Page	Equation	Description
47.	152	-	Second sentence of paragraph 4-5-1 should read "The vent nozzle had a 12.2-mm (0.48-inch) diameter and was 6-mm (0.25 inch) long.
48.	153	-	Third sentence of paragraph 4-6-1 should read "For both tests, the vent nozzle had a 15.9-mm (0.625-inch) diameter and was 8-mm (0.325 inch) long".
49.	163	Figure III-4	Should read "SCALE CHANGE".
50.	202/203	-	Should read "Test-T4A" (3 places).
51.	204/205	-	Should read "Test-T5A" (3 places).
52.	305	2-1-3	Should read "in Figure V-2 except that"
53.	324	-	A_S equation of paragraph 2 should contain the terms 59920 / [(3600) and not (59.920 / [(3.600)).
54.	327	-	Paragraph 5 of section 2-2-5-2 should read "*. . .* entering the pool if noncondensable gases are not generated by the reaction and 15-20 °C below the boiling point of the pool mixture if noncondensable gases are generated by the reaction."
55.	337	V-12 / V-13	Second sentence of paragraph 4-5 should read "Based on heat, mass and momentum balances, these charts were developed by L. L. Simpson [23] from the following equations:

<u>If sonic outlet velocity</u> (V-12A)

$$\frac{P_o}{P_a} > \frac{A_p}{A_n}\left(\frac{k+1}{2}\right)^{k/(k-1)}$$

Then (V-13A)

NEW (CORRECTION)

$$\frac{T}{P_o A_n} = 2\left(\frac{2}{k+1}\right)^{1/(k-1)} - \left(\frac{A_p P_a}{A_n P_o}\right)$$

<u>If subsonic outlet velocity</u> (V-12B)

$$\frac{P_o}{P_a} < \frac{A_p}{A_n}\left(\frac{k+1}{2}\right)^{k/(k-1)}$$

Then (V-13B)

	Page	Equation	Description
NEW		(CORRECTION)	$\frac{T}{P_o A_n} = \frac{2k\left(\frac{A_n}{A_p}\right)\left(\frac{2}{k+1}\right)^{(k+1)/(k-1)}}{\left(\frac{P_a}{P_o}\right) + \sqrt{\left(\frac{P_a}{P_o}\right)^2 + 2(k-1)\left(\frac{2}{k+1}\right)^{(k+1)/(k-1)}\left(\frac{A_n}{A_p}\right)^2}}$
Where	Subscripts	Pressure	o - Stagnation Pressure
			a - Pipe BackpressureGE Atmospheric Pressure
		Area	p - Safety Relief Valve Exit Plane LE Discharge Pipe Area
			n - ASME / API Nozzle Area
NEW	339	-	T = (Thrust Parameter) (P_o A_n)
56.	364	Reference 26	Leung, J. C., "Reaction Forces During Two-Phase Discharges", J. Fluids Eng., 114(12), 689-692 (December 1992).
57.	364	Reference 27	Should read (1992).
58.	364	Reference 28	Nazario, F. N. and Leung, J. C., "Sizing Pressure Relief Valves in Flashing and Two-Phase Service: An Alternative Procedure", J. Loss Prev. Process Ind., 5(5), 264-269 (December 1992).
59.	366	-	Accelerating Rate Calorimeter™ (Arthur D. Little, Inc.).
60.	399	Table VI-A1	Delete Paragraphs VI-A5-4 and VI-A5-8 under Safety Valve.
61.	399	-	Delete Paragraphs VI-A5-3, VI-A5-5, VI-A5-6, VI-A5-7 and VI-A5-8 under Rupture Disk (Horizontal).
62.	399	-	Delete Paragraph VI-A5-7 under Rupture Disk (Vertical).
63.	399	-	VI-A5-1 Flashing (Choked) Nozzle / Pipe Flow – etc.
64.	400	-	VI-A5-2 Flashing (Choked) Nozzle / Pipe Flow – etc.
65.	404	-	VI-A5-3 Flashing (Unchoked) Nozzle Flow
66.	405	-	VI-A5-4 Flashing (Unchoked) / Nonflashing (Unchoked) Pipe Flow
67.	405	-	The Note under equation VI-A5-11 should read: "Note: Factor = Discharge Coefficient".
68.	405	-	Delete the words "zero length line (nozzle with a L > 0.1 m) or the equivalent L / D of".
69.	406	VI-A5-5	LHS term should be G_T and not G_1.

	Page	Equation	Description
70.	406	-	Delete the words “Nozzle” and “Factor = Discharge Coefficient”.
71.	407	-	VI-A5-5 Flashing (Unchoked) Nozzle Flow
72.	407	-	Delete the words “or the equivalent L / D of a horizontal, constant-diameter line (rupture disk)”.
73.	408	VI-A5-22	LHS term should be G_T and not G_1.
74.	408	VI-A5-23	Delete the words “Horizontal Line”, equation VI-A5-23 and the ω and Constant values under equation VI-A5-23.
75. Flow	408	-	VI-A5-6 Nonflashing (Choked or Unchoked) Nozzle / Pipe
76.	408	VI-A5-5	Use flowing specific volume (υ_{21}) rather than the stagnation (vessel) specific volume (υ_{20}).
77.	408	VI-A5-25	Use flowing void fraction (α_1) rather than the stagnation void fraction (α_o).
78.	409	Figure VI-A13	Change X-axis label to α_1 (FLOWING VOID FRACTION) rather than α_o (VOID FRACTION).
79.	409	VI-A5-26	Use flowing void fraction (α_1) rather than the stagnation void fraction (α_o).
80.	409	VI-A5-11	LHS term should be G_T and not G*.
81.	408	VI-A5-11	Use flowing specific volume (υ_{21}) rather than the stagnation (vessel) specific volume (υ_{20}).
82.	410	Figure VI-A14	Parameter on Figure and below should be α_1 (Flowing Void Fraction) rather than α_o (Vessel Void Fraction).
83.	410	-	Delete the Note on the page.
84.	410	-	VI-A5-7 Nonflashing (Unchoked) Nozzle Flow – etc.
85.	411	VI-A5-27 / VI-A5-28	Should be (m / V), not (V / m)
86.	411	-	Delete the Note on the page under equation VI-A5-28.
87.	411	-	VI-A5-8 Mixed Flashing and Nonflashing Nozzle / Pipe Flow
88.	411	-	Delete the words “or unchoked” in the Note in paragraph VI-A5-8.
89.	413		Fourth equation should read $\nu_{20} = V / m_0 = (120 / 80)$ …
90.	414	VI-A5-11	Should be 144, not 114
91.	414/415	-	Delete equation VI-A5-16 and the two-line calculation of G*.

	Page	Equation	Description
92.	414		Delete the words "at N = 1.5 and $\omega_0 = 0$, Factor = 0.62 (Figure VI-A9) (incompressible flow)".
93.	416		Delete equation VI-A5-11 and the two-line calculation of G_T.
94.	416	-	Delete the entire Alternate Calculation of G_T.
95.	417	-	Delete Sample Problem 8.
96.	421	Figure VI-16	Caption should read "BASIS: ≤ 15 FEET RELIEF LINE LENGTH" (not ≥ 15).
97.	421	Figure VI-16	Should be labeled FIA Chart [46] and not FAI Chart.
98.	421	-	The reference in the note at the bottom of the page should be reference [46] and not [43].
99.	427	Reference 45	Should reflect pages 27-32.
100.	437	VI-A7-11	Exponent on numerator should be 1/4 and not 1/2.
101.	446	m - mass	Conversion should be 1000 gm = 2.2046 lb_m
102.	446	q	Should be W / kg
103.	456	SPHTJ	Units should read "(J / kg K)".
104.	456	ENTRPJ	Units should read "(J / kg K)".
105.	457	Liquid Heat Capacity	Units should read "J / kg K".
106.	457	Gas Heat Capacity	Units should read "J / kg K".
107.	457	Liquid Viscosity	Units should read "kg / m s".
108.	457	Gas Viscosity	Units should read "kg / m s".
NEW	458	2-3.	Gas Pressure = f (Y_i) and not f (X_i)
109.	463	G	Units should read "kg / m^2 s".
110.	464	First	Should be $\Sigma = (1-\alpha)^2 / (1-\alpha^3)$ and not $\Sigma = (1-\alpha^2) / (1-\alpha^3)$.
111.	465	-	Term (F / M_A) in equation in paragraph 2-9 should have a capital A as the subscript.
112.	487	-	Equations should read

Fauske $S = \sqrt{\frac{v_g}{v_f}}$

Page	Equation	Description	
487		Moody-Zivi	$S = \left(\frac{v_g}{v_f} \right)^{1/3}$