JUL 03 1984

50-298

Nebraska Public Power District
ATTN: J. M. Pilant, Manager, Technical
Staff-Nuclear Power Group
P.O. Box 499
Columbus, Nebraska 68601

Gentlemen:

SUBJECT: Cooper-Operator Licensing Examination Report Addendum

The May 11, 1984, Operator Licensing Examination Report inadvertently omitted the figures, charts, and tables that were provided to candidates as part of the reactor and senior reactor operator examinations administered in March of this year. Enclosed is one copy of this material which should be added to the examination master copy provided in our May 11 letter. We regret any inconvenience this may have caused you.

In accordance with 10 CFR 2.790(a), a copy of this letter and the enclosure will be placed in the NRC Public Document Room unless you notify this office by telephone within 10 days of the date of this letter and submit written application to withhold information contained herein within 30 days of the date of this letter. Such application must be consistent with the requirements of 10 CFR 2.790(b)(1).

Should you have any questions concerning this letter, please contact us.

Sincerely,

Original Signed By
E. H. Johnson
E. H. Johnson, Chief
Reactor Project Branch 1

Enclosure:
Examination master copy figures, charts, and tables

cc:
Paul V. Thomason, Division Manager
of Nuclear Operations
Cooper Nuclear Station
P.O. Box 98
Brownville, Nebraska 68321

R. Beilke, Training Manager (Same address)

bcc: DMB M003

R. Cooley	RPB1	RPB2
J. Pellet	Section Chief	RIV File
E. Haycraft	R. Denise	J. Collins
R. Eaton, OLB	TPB	RRI

Kansas State Dept. of Health
Nebraska State Dept. of Health

RPB2	RPB2	RPB2	RPB1
JPellet/vs	RCooley	EHJohnson	EHJohnson
7/2/84	7/2/84	7/2/84	7/2/84

M003

1/1

SIMPLIFIED SCHEMATIC OF MODIFIED
CRD HYDRAULIC SYSTEM

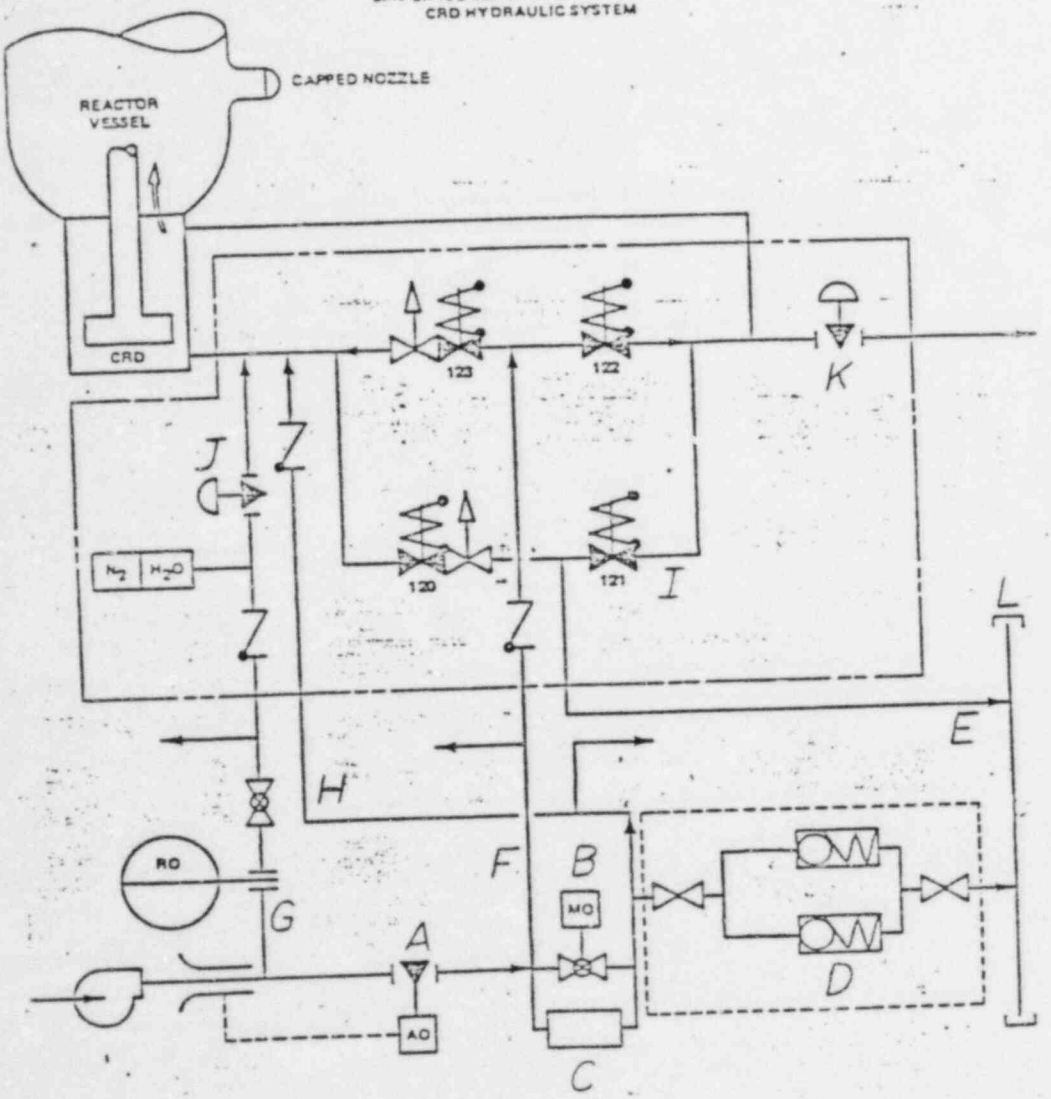

Figure 1B

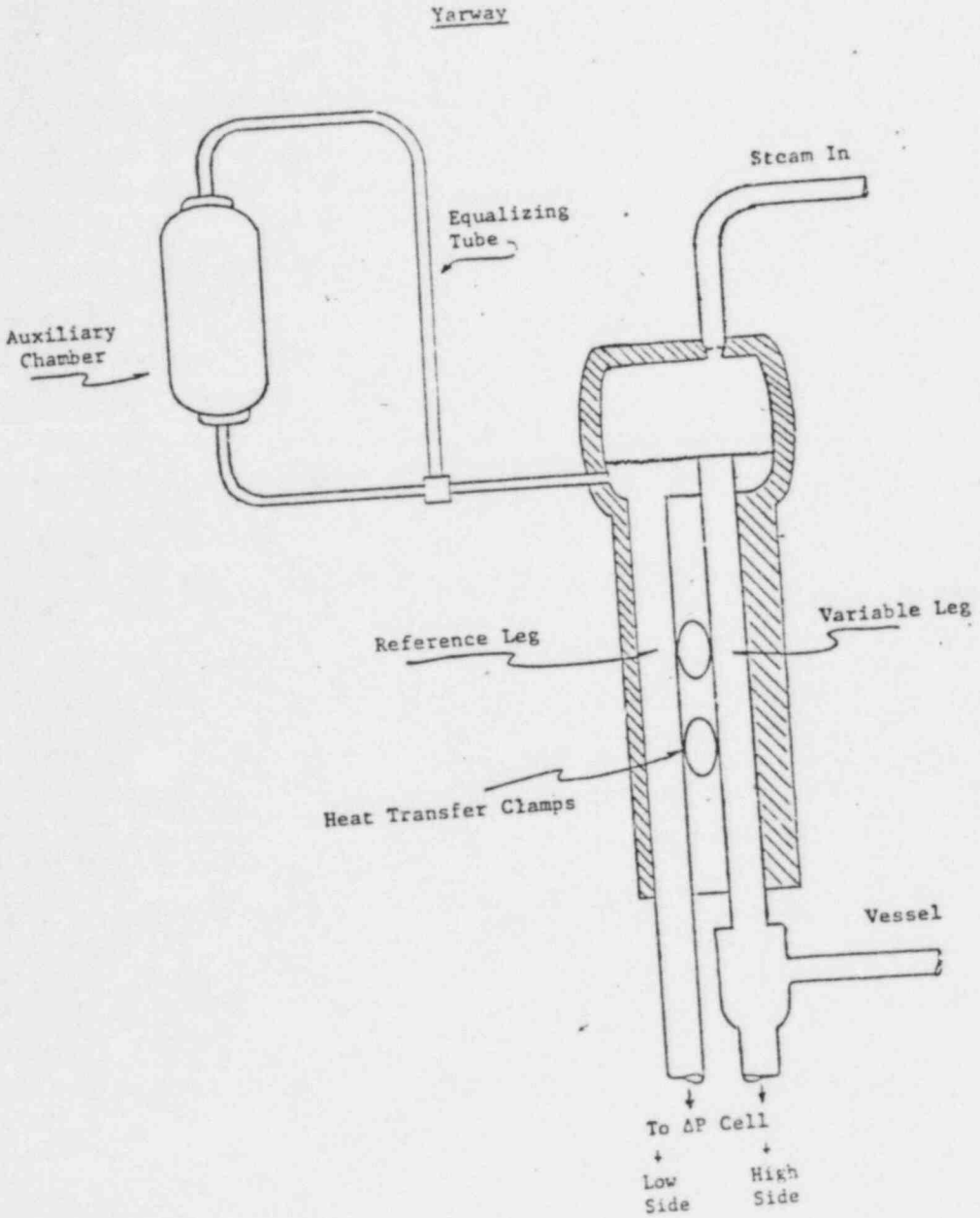
Yarway
Steam In
Equalizing Tube
Auxiliary Chamber
Variable Leg
Reference Leg
Heat Transfer Clamps
Vessel
To ΔP Cell
Low Side
High Side

FIGURE 6

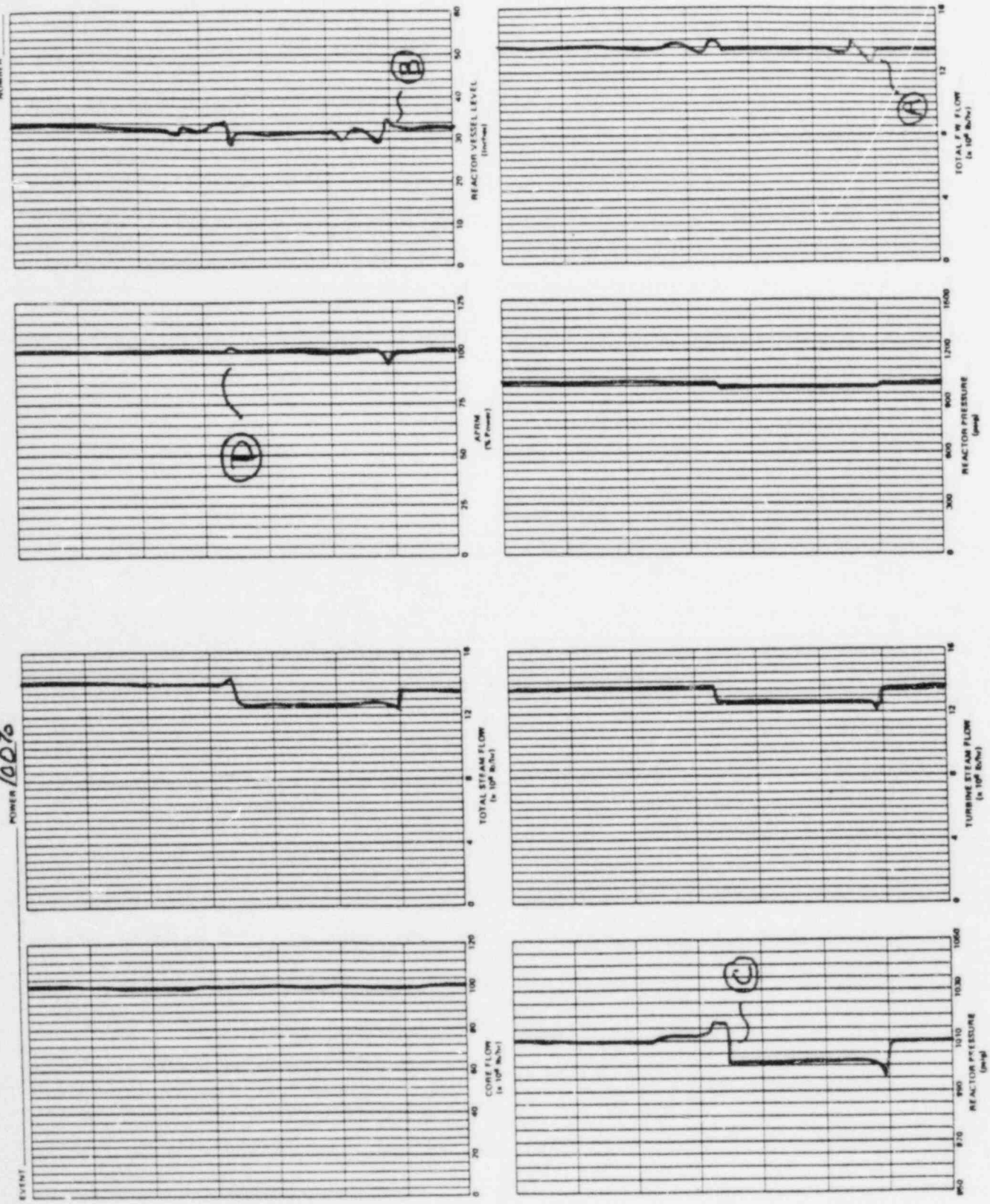
NUMBER
POWER 100%
EVENT
REACTOR VESSEL LEVEL (inches)
TOTAL FW FLOW (x 10⁶ lb/hr)
APRM (% Power)
REACTOR PRESSURE (psig)
TOTAL STEAM FLOW (x 10⁶ lb/hr)
TURBINE STEAM FLOW (x 10⁶ lb/hr)
CORE FLOW (x 10⁶ lb/hr)
REACTOR PRESSURE (psig)
A
B
C
D

FIGURE 7

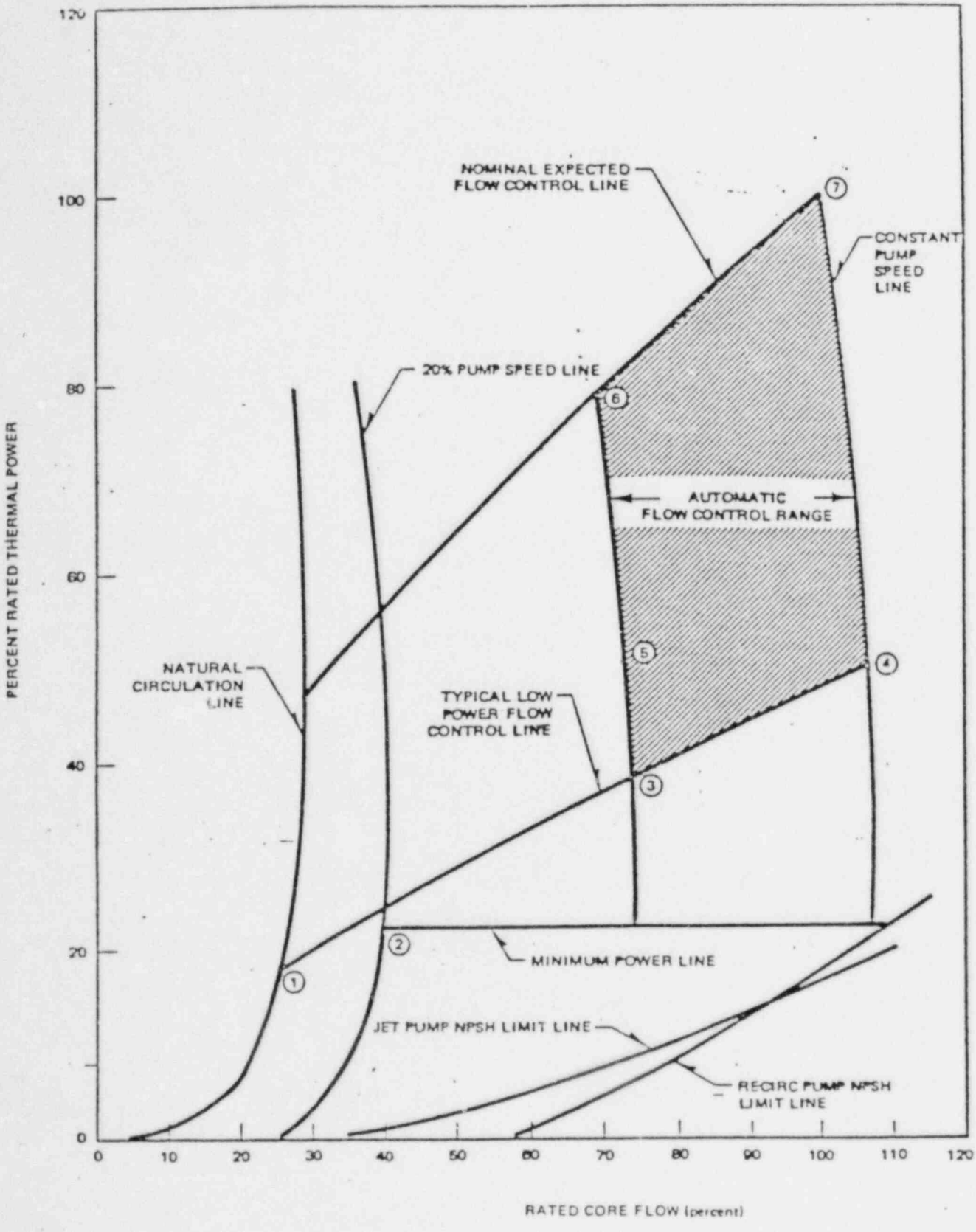

Figure 11 NORMAL OPERATING MAP

Properties of Saturated Steam and Saturated Water

Pressure Lbs. per Sq. In.		Temperature	Heat of the Liquid	Latent Heat of Evaporation	Total Heat of Steam	Specific Volume ∇	
Absolute P'	Gage P	t			h_g	Water	Steam
		Degrees F.	Btu/lb.	Btu/lb.	Btu/lb.	Cu. ft. per lb.	Cu. ft. per lb.
230.0	215.3	400.97	376.1	825.0	1201.1	0.01865	1.84317
235.0	220.3	402.72	378.0	823.3	1201.3	0.01868	1.80802
240.0	225.3	404.44	379.9	821.6	1201.5	0.01870	1.77418
245.0	230.3	406.13	381.7	820.0	1201.7	0.01873	1.74157
250.0	235.3	407.80	383.6	818.3	1201.9	0.01875	1.71013
255.0	240.3	409.45	385.4	816.7	1202.1	0.01878	1.67978
260.0	245.3	411.07	387.1	815.1	1202.3	0.01880	1.65049
265.0	250.3	412.67	388.9	813.6	1202.4	0.01882	1.62218
270.0	255.3	414.25	390.6	812.0	1202.6	0.01885	1.59482
275.0	260.3	415.81	392.3	810.4	1202.7	0.01887	1.56835
280.0	265.3	417.35	394.0	808.9	1202.9	0.01889	1.54274
285.0	270.3	418.87	395.7	807.4	1203.1	0.01891	1.51795
290.0	275.3	420.37	397.4	805.9	1203.3	0.01894	1.49394
295.0	280.3	421.86	399.0	804.4	1203.4	0.01896	1.47067
300.0	285.3	423.33	400.5	802.9	1203.4	0.01899	1.44801
310.0	295.3	426.23	403.7	800.0	1203.7	0.01904	1.40405
320.0	305.3	429.06	406.8	797.0	1203.8	0.01908	1.36405
330.0	315.3	431.84	409.8	794.2	1204.0	0.01913	1.32772
340.0	325.3	434.56	412.8	791.3	1204.1	0.01917	1.29410
350.0	335.3	437.23	415.7	788.5	1204.2	0.01921	1.26284
360.0	345.3	439.85	418.6	785.8	1204.4	0.01925	1.23377
370.0	355.3	442.43	421.4	783.1	1204.5	0.01930	1.20668
380.0	365.3	444.96	424.2	780.4	1204.6	0.01934	1.18095
390.0	375.3	447.45	426.9	777.8	1204.7	0.01938	1.15673
400.0	385.3	449.90	429.6	775.2	1204.7	0.01942	1.13373
410.0	395.3	452.31	432.2	772.6	1204.8	0.01946	1.11189
420.0	405.3	454.68	434.8	770.0	1204.8	0.01950	1.09115
430.0	415.3	457.02	437.4	767.5	1204.9	0.01954	1.07144
440.0	425.3	459.32	439.9	765.0	1204.9	0.01959	1.05269
450.0	435.3	461.58	442.4	762.5	1204.9	0.01963	1.03485
460.0	445.3	463.81	444.8	760.0	1204.8	0.01967	1.01786
470.0	455.3	466.01	447.2	757.6	1204.8	0.01971	1.00167
480.0	465.3	468.18	449.5	755.1	1204.7	0.01975	0.98622
490.0	475.3	470.32	451.8	752.7	1204.6	0.01979	0.97147
500.0	485.3	472.43	454.2	750.4	1204.5	0.01982	0.95737
510.0	495.3	474.51	456.4	748.0	1204.4	0.01986	0.94388
520.0	505.3	476.57	458.7	745.7	1204.4	0.01990	0.93096
530.0	515.3	478.60	460.9	743.4	1204.3	0.01994	0.91858
540.0	525.3	480.61	463.1	741.0	1204.2	0.01998	0.90670
550.0	535.3	482.59	465.3	738.8	1204.1	0.02002	0.89529
560.0	545.3	484.55	467.5	736.5	1204.0	0.02006	0.88432
570.0	555.3	486.49	469.6	734.2	1203.8	0.02009	0.87377
580.0	565.3	488.40	471.7	732.0	1203.7	0.02013	0.86362
590.0	575.3	490.30	473.8	729.8	1203.6	0.02017	0.85384
600.0	585.3	492.18	475.8	727.5	1203.4	0.02021	0.84442
610.0	595.3	494.04	477.9	725.3	1203.2	0.02025	0.83533
620.0	605.3	495.87	479.9	723.1	1203.0	0.02028	0.82655
630.0	615.3	497.69	481.9	720.9	1202.8	0.02032	0.81807
640.0	625.3	499.49	483.9	718.8	1202.7	0.02036	0.80987
650.0	635.3	501.27	485.8	716.6	1202.5	0.02039	0.80194
660.0	645.3	503.04	487.8	714.5	1202.3	0.02043	0.79426
670.0	655.3	504.79	489.7	712.4	1202.1	0.02047	0.78682
680.0	665.3	506.52	491.6	710.2	1201.8	0.02050	0.77960
690.0	675.3	508.24	493.5	708.1	1201.6	0.02054	0.77260
700.0	685.3	509.94	495.4	706.0	1201.4	0.02058	0.76581
710.0	695.3	511.63	497.2	703.9	1201.2	0.02061	0.75922
720.0	705.3	513.30	499.1	701.9	1200.9	0.02065	0.75282
730.0	715.3	514.96	500.9	699.8	1200.7	0.02068	0.74661
740.0	725.3	516.61	502.7	697.7	1200.4	0.02072	0.74057
750.0	735.3	518.24	504.5	695.7	1200.2	0.02076	0.73470
760.0	745.3	519.86	506.3	693.6	1199.9	0.02080	0.72899
770.0	755.3	521.47	508.1	691.6	1199.7	0.02083	0.72343
780.0	765.3	523.06	509.8	689.6	1199.4	0.02087	0.71802
790.0	775.3	524.64	511.6	687.6	1199.1	0.02090	0.71275
800.0	785.3	526.21	513.3	685.5	1198.8	0.02094	0.70762
810.0	795.3	527.77	515.0	683.5	1198.5	0.02097	0.70262
820.0	805.3	529.31	516.7	681.5	1198.2	0.02101	0.69775
830.0	815.3	530.84	518.4	679.6	1197.9	0.02105	0.69300
840.0	825.3	532.36	520.1	677.6	1197.7	0.02109	0.68837
850.0	835.3	533.87	521.8	675.6	1197.4	0.02112	0.68385
860.0	845.3	535.37	523.4	673.6	1197.0	0.02116	0.67944
870.0	855.3	536.86	525.1	671.7	1196.8	0.02119	0.67513
880.0	865.3	538.34	526.7	669.7	1196.4	0.02123	0.67092
890.0	875.3	539.81	528.3	667.8	1196.1	0.02126	0.66681
900.0	885.3	541.27	529.9	665.8	1195.7	0.02130	0.66279
910.0	895.3	542.72	531.5	663.9	1195.4	0.02133	0.65886
920.0	905.3	544.16	533.1	661.9	1195.1	0.02137	0.65502
930.0	915.3	545.59	534.7	660.0	1194.7	0.02141	0.65126
940.0	925.3	547.01	536.3	658.0	1194.4	0.02145	0.64758
950.0	935.3	548.42	537.8	656.2	1194.0	0.02148	0.64398
960.0	945.3	549.82	539.3	654.2	1193.7	0.02152	0.64045
970.0	955.3	551.22	540.9	652.3	1193.3	0.02156	0.63700
980.0	965.3	552.60	542.4	650.4	1192.9	0.02159	0.63362
990.0	975.3	553.98	543.9	648.5	1192.5	0.02163	0.63031
1000.0	985.3	555.35	545.4	646.6	1192.0	0.02167	0.62707
1050.0	1035.3	562.03	552.8	637.3	1190.1	0.02186	0.61150
1100.0	1085.3	568.59	560.0	628.3	1188.3	0.02205	0.59677
1150.0	1135.3	575.04	567.1	619.4	1186.5	0.02224	0.58282
1200.0	1185.3	581.39	574.1	610.7	1184.8	0.02243	0.56959
1250.0	1235.3	587.64	581.0	602.1	1183.1	0.02262	0.55703
1300.0	1285.3	593.80	587.8	593.6	1181.4	0.02281	0.54509
1350.0	1335.3	599.88	594.5	585.3	1179.8	0.02300	0.53373
1400.0	1385.3	605.88	601.1	577.1	1178.2	0.02319	0.52291
1450.0	1435.3	611.80	607.6	569.0	1176.6	0.02338	0.51259
1500.0	1485.3	617.64	614.1	561.0	1175.1	0.02357	0.50274
1600.0	1585.3	629.04	626.8	545.3	1172.1	0.02395	0.48417
1700.0	1685.3	640.01	639.2	530.0	1169.2	0.02434	0.46688
1800.0	1785.3	650.59	651.3	515.1	1166.4	0.02473	0.45071
1900.0	1885.3	660.80	663.1	500.5	1163.6	0.02513	0.43557
2000.0	1985.3	670.67	674.7	486.2	1160.9	0.02554	0.42135
2100.0	2085.3	680.21	686.1	472.2	1158.3	0.02595	0.40797
2200.0	2185.3	689.45	697.3	458.4	1155.7	0.02637	0.39535
2300.0	2285.3	698.39	708.4	444.9	1153.2	0.02680	0.38342
2400.0	2385.3	707.05	719.4	431.6	1150.7	0.02724	0.37211
2500.0	2485.3	715.45	730.3	418.5	1148.3	0.02769	0.36137
2600.0	2585.3	723.61	741.1	405.6	1146.0	0.02815	0.35115
2700.0	2685.3	731.53	751.8	392.9	1143.7	0.02863	0.34140
2800.0	2785.3	739.23	762.5	380.4	1141.4	0.02912	0.33209
2900.0	2885.3	746.72	773.1	368.1	1139.2	0.02963	0.32318
3000.0	2985.3	754.00	783.7	355.9	1137.0	0.03015	0.31464
3100.0	3085.3	761.08	794.3	343.9	1134.8	0.03069	0.30645
3200.0	3185.3	767.98	804.8	332.0	1132.7	0.03125	0.29858
3208.2	3193.5	768.54	805.6	331.1	1132.5	0.03130	0.29795

Material	Half-Life	Energy MEV per disintegration	Table I Col I Air μc/ml	Table I Col II Water μc/ml	Table II Col I Air μc/ml	Table II Col II Water μc/ml
A-41	1.83 h	1.3	2×10^{-6}		4×10^{-8}	
Co-60	5.3 y	2.5	3×10^{-7}	1×10^{-3}	1×10^{-8}	5×10^{-5}
I-131	8.1 d	0.36	9×10^{-9}	6×10^{-5}	1×10^{-10}	3×10^{-7}
Kr-85	10.8 y	0.04	1×10^{-5}		3×10^{-7}	
Ni-65	2.5 h	0.59	9×10^{-7}	4×10^{-3}	3×10^{-8}	1×10^{-4}
Pu-239	2.4×10^{4} y	0.008	2×10^{-12}	1×10^{-4}	6×10^{-14}	5×10^{-6}
Sr-90	28 y		1×10^{-9}	1×10^{-5}	3×10^{-11}	3×10^{-6}
Xe-135	9.2 h	0.25	4×10^{-6}		1×10^{-7}	
Any single radionuclide with $T_{\frac{1}{2}} > 2$ hr which does not decay by α or spontaneous fission			3×10^{-9}	9×10^{-5}	1×10^{-10}	3×10^{-6}

Neutron Energy (MEV)	Neutrons per cm^2 equivalent to 1 rem	Average flux to deliver 100 mrem in 40 hours
Thermal	970×10^{6}	670
0.02	400×10^{6}	280
0.5	43×10^{6}	30
10	24×10^{6}	17

LINEAR ABSORPTION COEFFICIENTS (cm^{-1})

Energy (MEV)	Water	Concrete	Iron	Lead
0.5	0.090	0.21	0.63	1.7
1.0	0.067	0.15	0.44	0.77
1.5	0.057	0.13	0.40	0.57
2.0	0.048	0.11	0.33	0.51
2.5	0.042	0.097	0.31	0.47
3.0	0.038	0.088	0.30	0.47

FORMULAS AND CONVERSIONS

$$r/hr = \frac{6CE}{d^2} \qquad I_x = I_o e^{-\mu x} \qquad I_x = \frac{I_o}{d^2} \qquad N = N_o e^{-\lambda t}$$

$$T_{\frac{1}{2}} = \frac{0.693}{\lambda} \qquad p = \frac{\Sigma \phi V}{3\times10^{10}} \qquad \varrho = \frac{1}{Tk} + \Sigma \frac{\beta_i}{1+\lambda T} \qquad T = \frac{\beta - \varrho}{\lambda \varrho} \qquad T = \frac{\ell}{\varrho - \varrho}$$

$$T = \frac{\ell^*}{\varrho} + \frac{\beta - \varrho}{\lambda \varrho}$$

1 gal = 3.78 liters
1 in = 2.54 cm
1 yr = 3.15×10^{7} sec.
1 kg = 2.21 lbs
1 gm/cm^3 = 62.4 lbs/ft^3
1 ft^3 = 7.48 gal

$N_A = 6.03\times10^{23}$
$\pi = 3.14$
$e = 2.72$

$t^* = 10^{-5}$ seconds

$A = A_o e^{-\lambda t}$

$E = mc^2$

$A = \lambda N$

$\Delta E = 931 \Delta M$

$I = I_o e^{-\mu x}$

$I = I_o e^{-\Sigma x}$

$OH^- \; H^+ = 10^{-14}$

$S.C.R. = \frac{S}{1-K_{eff}}$

$t_{eff} = \frac{(t_{\frac{1}{2}})(t_b)}{t_{\frac{1}{2}} + t_b}$

$E = IR$

$P = IE$

$P = \frac{E^2}{R}$

$\bar{\tau} = 12.7$ sec.

$\Sigma = \sigma N$

$V = \frac{s}{t}$

$ER = I\phi$

$V_F = V_o + at$

$S = V_o T + \frac{1}{2} at^2$

$a = \frac{V_F - V_o}{t}$

$W = Mg$

$F = Ma$

$P = P_o e^{t/\tau}$

$W = \frac{\theta}{t}$

$W = P_a$

$P = \frac{W}{t}$

$\bar{\lambda} = 0.1$ seconds $^{-1}$

$R_t = \frac{R_1 R_2}{R_1 + R_2}$

$C_1(1-K_1) = C_2 (1-K_2)$

$P = P_o 10^{sur\,(t)}$

$M = \frac{1}{1-K} = \frac{C}{C_o}$

$I = I_o 10^{\frac{-x}{TVL}}$

$Q = UA\Delta t$

$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

$P = \frac{2\phi v}{3 \times 10^{10}}$

$\frac{C_o}{C_1} = \frac{1-K_1}{1-K_o}$

$KE = \frac{1}{2} mv^2$

$I_t = I_1 + I_2 + \ldots + I_n$

$\Delta\rho = \frac{K_2 - K_1}{K_2 K_1}$

$A = \frac{\rho}{1-\rho}$

$TVL = \frac{2.3}{\mu}$

MISCELLANEOUS CONVERSIONS

Density H_2O = 62.4 lb/ft^3

Heat of Vaporization H_2O = 970BTU/lb.

Heat of Fusion H_2O = 144 BTU/lb.

Watts = BTU/hr x .293

H. P. = BTU/hr x 3.93 x 10^{-4}

KW. = H. P. x .7457

MW = 3.41 x 10^6 BTU/hr

TVT lead=1.5"

PWR.= $\dot{m}\ \Delta h$

PWR. = $W_F\ \Delta h$

BTU/lb = Cal/gm x 1.8

gms = 453.6 x lb.

ft^3 = gal x .1337

ATM. = Psig x .068

°F = 9/5 °C + 32

HVT lead= .6"

Steam tables also circulated

MISCELLANEOUS EQUATIONS

$$SUR = \frac{26\,\rho}{\ell^* + (\beta - \rho)\,\tau}$$

$$I.d. = I_2 d_2$$

$$I_1 d_1^2 = I_2\, d_2^2$$

$$P = Po\, e^{\,t/\tau}$$

$$\rho = \frac{\ell^*}{\tau} + \frac{\beta_{eff}}{1 + \frac{}{\lambda\tau}}$$

$$R/HR = \frac{.5\ CE}{d^2\,(meter)}$$

$$CR_1 = \frac{S}{1 - K_{eff_1}}$$

$$\rho = \frac{K-1}{K} = \frac{\Delta K}{K}$$

$$T = \frac{\ell^*}{\rho} \quad \frac{+\beta - \rho}{\frac{}{\lambda}\,\rho}$$

$$HVL = \frac{0.693}{\mu}$$

$$D.\ R. = \frac{6CE}{d^2}$$

$$A = \pi r^2$$

$$SUR = \frac{26.06}{\tau}$$

$$PE = mgh$$

$$\tau = \frac{\ell}{\rho - \beta}$$

1 curie = 3.7×10^{10} dps

$$CR_2 = \frac{S}{1 - K_{eff_2}}$$

$$C_1 V_1 + C_2 V_2 + C_{nth} V_{nth} = C_F V_F$$

$$\rho \frac{\bar{\beta}}{1 + \lambda\tau}$$

$$R_t = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

$$SDM = \frac{1-K}{K}$$

$$B = Bo\, e^{\frac{-Ft}{v}}$$

$$R_t = R_1 + R_2 + \ldots + R_n$$

$$\rho = \frac{1}{\tau K_{eff}} + \frac{\beta}{1 + \lambda\tau}$$

$$M = \frac{CR_2}{CR_1}$$

$$M = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

$$\frac{1}{M} = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

$$\frac{1}{M} = \frac{CR_1}{CR_2}$$

$$\frac{CR_1}{CR_2} = \frac{1 - K_{eff_1}}{1 - K_{eff_2}}$$

Westinghouse

$$\Delta\rho = L_N \frac{K_2}{K_1}$$