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Conf-941102 -- 20

WAPD-T-3014

AN EXTENSION OF THE FORMULA OF ONO AND TSURO FOR THE FLUX FROM A CYLINDRICAL SOURCE

by

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Contract No. DE-AC11-93PN38195

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AN EXTENSION OF THE FORMULA OF ONO AND TSURO FOR THE FLUX FROM A CYLINDRICAL SOURCE

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ABSTRACT

A semi-analytic approximate formula for the flux at a point outside the radial and axial extensions of a cylindrical source with an intervening slab shield perpendicular to the source axis has been derived, based on the work of Ono and Tsuro. The required function tables are available, and a detailed analysis of the error as a function of problem geometry has been calculated, so that this formula has a wide area of application. No other approximate calculation method for this case is available in the literature.

AN EXTENSION OF THE FORMULA OF ONO AND TSURO FOR THE FLUX FROM A CYLINDRICAL SOURCE

I. Introduction

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Hand calculation methods involving semi-analytic approximations of exact flux formulas continue to be useful in shielding calculations since they enable shield design personnel to make quick estimates of dose rates, check calculations made by more exact and time-consuming methods, and rapidly determine the scope of problems. They are also a valuable teaching tool.

The most useful approximate flux formula is that for the flux at a lateral detector point from a cylindrical source with an intervening slab shield. An improved formula for this case is given by Ono and Tsuro in Reference (1). Further improvements and extensions of this formula and tables of the required functions are given in References (2), (3) and (4).

The flux at a detector point outside the radial and axial extensions of a cylindrical source with an intervening slab shield perpendicular to the source axis is a case treated only in Reference (4). In this paper, a further extension of this case will be developed.

II. Flux at a Lateral Detector Point from a Cylindrical Source with a Slab Shield Perpendicular to the Source Axis

The semi-analytic formula of Ono and Tsuro is given in the References, along with tables of the required functions. This formula substitutes a section of an annulus for the cylindrical source.

As shown in Figure 1, a section of an annulus is also substituted for a cylindrical source (with radius R and height l) in this case. The sector has height = 2R and thickness l. Equating the Volumes of the annular section and the cylinder gives

$$\pi R^2 t = 2R\phi_0 [(h+t)^2 - h^2]'$$
 (1)

so that to preserve source volume,

$$\Phi_{0} = \frac{\pi}{2} \frac{R}{2h+l} . \qquad (2)$$

Then if $\phi_0 > 60^\circ$ or $\frac{\pi}{3}$ radians, this approximation does not apply. If $\phi_0 \leq \frac{\pi}{3}$,

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Figure 1. Cylindrical Source with a Detector Point Outside the Axial and Radial Extensions of the Source with Section of an Annulus Used as an Approximation $R \leq \frac{1}{2} (2h+l)$, then (7)

$$\Theta = \tan^{-1} \frac{\Theta}{h+t} \tag{4}$$

$$\theta_{s} = \tan^{-1} \frac{\epsilon + 2R}{h}$$
 (5)

and the flux at the point P₁ is approximately given by

$$\Phi_{\mu_1} = \frac{S_v \Phi_0}{2\pi\mu_s} L_o (\Phi_{\mu} b) \{G(\theta_{\mu} b) - G(\theta_{\mu} b + \mu_s \ell) -G(\theta_{\mu} b + \mu_s \ell)\}$$
(6)
-G(\theta_2, b) + G(\theta_2, b + \mu_s \ell)\}

where b is the shield attenuation distance in mean-free-paths, μ_s as the source selfattenuation coefficient, and the functions L_{σ} (ϕ_{σ} , b) and G (θ_{σ} , b) are defined and tabulated in the References.

Error ratios for a wide range of problem parameters are given in Table 1, assuming that the criterion of (3) is observed. The data in this table show that this approximation is useful for cases where $\frac{\mu_s l}{R} \ge 0.65$ and $\mu_s \le 0.1$ or $\frac{\mu_s l}{R} \le 1.5$, $0.1 < \mu_s < 0.5$ and a/R > 1.0.

For other cases a possible calculation technique is to use superposition. Calculate the flux from a source of height l + l' and from that portion of the source defined by l' and subtract the latter from the former. That is, for the cases which fall outside the above criteria, define a problem with source of height l + l' and define the additional angles

$$\theta_4 = \tan^{-1} \frac{a}{h+\ell+\ell'} \tag{7}$$

$$\theta_{g} = \tan^{-1} \frac{a + 2R}{h + \ell}$$
(8)

Then for this case,

$$\Phi_{\mu_{1}}^{\prime} = \frac{S_{\nu}\phi_{0}}{2\pi\mu_{e}} L_{\phi}(\phi_{0}, b) \begin{cases} G(\theta_{3}, b) - G(\theta_{3}, b + \mu_{e}(l+l')) \\ -G(\theta_{5}, b) + G(\theta_{5}, b + \mu_{e}l') \\ +G(\theta_{4}, b + \mu_{e}(l+l')) - G(\theta_{4}, b + \mu_{e}l') \end{cases}$$
(9)

This formula is new, and extends the work reported in Reference (4).

(3)

Table 1

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free A Cylinerical Source at Datector Points Outside the Badial and Anial Extensions of the Source with an Intervening Slab Shield Perpendicular to the Source Anis

		R+ 18.88	N/8 + 18	a/R= 20	1.9+8+ 1 +0
		. 25	b • 1 44	D+ 2.30	8. 5
H*/L+	1.18	1.50 2.50	1.10 1 80 2.8	1 10 1 50 2 1	10 1 10 1 Se 2 Se
0 25 15 83	- 31	1.11 1.10	1 40 1 15 1.00	1 56 1 24 1 .1	17 1 84 1 34 1 88 14 1 15 87 99
21 25 78,12	48			32 00	3 3 4 -15
		R= 10.00	M/8+ 18	a/R= 39	B/8+8+ 1.00
				·····	·····
H'/L+	1 10	1.50 2.50	1.10 1 50 2 50		
2 50	1.01	1 24 1 14	1 99 1 34 1 13	2 10 1 54 1	4 2 48 1 78 1 17
12.50 11.16					
a · 43			Nust 18		
				•••••••	
M1 // a		. 25	D• 1 88	D* 2,50	b= 5 ++
L/8	1.10	1.30 2.30	- 1 10 1.30 2.30 	/ 3.30 3 30 2 .3	it 1.10 1 50 2 50
3 (3 9 25		- 12 1 10	1 27 - 1 1 - 1	1 17 1.01	7 1 35 1.23 1 86
15.03	27	00 10		i i i i	8 .49 .89 .89 .
		R= 10,00		a/R= 2.50	Nus•R+ 1.00
		25	D + 1.00	0= 2.59	D+ 5 ,00
H'/L+ L/8	1 10	1.50 2.50	1.39 1.50 2.50	1 10 1 50 2.5	I 1.10 1 80 2 50
1 25	2.18	9. 62 1.37 1.13 1.14	2.80 2 12 1.44 1 79 1 24 1 14	3 56 3 61 1 6 3 31 1 67 1 1	5 5 6 7 4 7 7 7 1 8 5 1 1 1 1 1 1 1 1 1 1
4 . 25	47				
		19.80	Aus+ 58	a/R+ 28	144+R+ 5.00
		25	D* 1.40	by 2 %s	
H'/L+ -	1.10 1	. 50 2.50	1.10 1 \$0 2.50	1.10 1.80 2.80	1.10 1 50 2.50
15 87 F	<u></u>	-1:	<u>, 35 , 63 65</u>	1 20 1 10 25	. 25 . 20 _ 22
31 25 78.13	34 23	59 80 58 78	40 58 89		
			Muse \$0	s/R+	Nusette S. DO
		 7 6		····	····
H'/L+	1 10 1	. 30 2.50	1.10 1 50 2.50	1 10 1 50 2.50	1.10 1 50 2.56
2.50	1 34 1	13 15	1 92 1 18 99	1 50 1 22 1.00	1 82 1 46 1 48
12 50	41	62 52 57 54	.49 82 82 (27 87 82 6		1 3
		10.00	Must	a/R= 1.99	Nuselle 5 66
	-				*********
H'/L+ -		. 23 			
L/B 1 25 1	45 1	. 12 . 16	1 87 1 38 1.81	1.81 1.52 1.67	1.56 1.72 1.18
3 13 (*** 6.25	<u>.</u>				
15.67	29	.39 .81 	. 32 . 58 . 81	. 37 . 66 . 61	
	2			5.3V •••••	
••	D •	. 28	b • 1.00	b • 2.50	D= 5.00
	1.10 1 .43 4	. JU 2.30	1.19 1.99 2.90 1.76 1.45 1.44	1.10 1.50 2.50	1.10 1.50 2.50
	J.				
A 28	31	49 11	44 49 41		in the second

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Table 1 (Continued)

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	R+ 25.00	18/8+ 18	s/R• 21	M/8+8+ 2 \$8
	76	be 1 88	B+ 2 50	D+ 5.44
L/B	1.30 2.30			
		┌┶╡┋╼┷┿┱┑╴╏		
31 26 37	63		27 . 57	
	8. 38.44	Muna 18		Marila 9 84
			••••••	
	. 25	b = 1.00	D+ 2.51	b+ \$ 10
H'/L= 1.10	1.50 2.50	1.10 1.80 2.80	1.10 1.80 2.1	80 1.30 1.50 2.50
L/a 2 50 1 44	1.10 1.02	1.06 1 23 1.03	1.79 1.41 1.	5 1.52 1.59 1.11
0 25				
31 25 27	80 81	. 28 . 80 . 81	. 31 . 89	1 20 00 01
	R+ 15.00	M/8* . 18	8/R+ 1.00	Mus+8+ 2.50
	•••••	~ u • <i>e • • •</i> • • • •	•••••	* * * * * * * * * * * * * * * *
	. 29	b • 1.88	D+ 2.9	b• \$ ••
H'/L# 1.18	1.50 2.50	1.10 1.30 2.50	1.10 1.80 2.9	60 1.10 1 .90 2.9 0
1.25 _1.61	1.21 1.07	1.92 1.42 1.91	2.20 1.72 1.	14 2 35 2.05 1.28
6 25 . 52			1 1 1	
15.02 .31	. 62 . 82	. 33 . 42 . 62	.30 .02 .	JZ 40 .02 .02
	A= 25.00	Mas* .10	s/R+ 2.90	Musete 2.58
B 1	. 25	b = 1.30	D+ 2.50	b • 5 ••
M//1 a 4 44		· · · · · · · · · · · · · · · · · · ·		
L/a	1.30 4.30			
1 25 1.10		1.41 1	1.74 1.19	17 3 17 2 77 9 80 16 2 11 1 46 1 60
2.50 72				<u><u>8</u> <u>8</u> <u>8</u> <u>8</u> <u>8</u></u>
	R+ 25.00	Mus*	a/R• .20	Nus+R+ 12.30
D	R+ 25.00	Rus+	a/R• .20	Rus-8+12.20
) H'/L+ 1.10	R+ 25.00	Muse 50	a/R• .20 b• 2.50	Nus+R+12.50 D+ 5 00 A0 1.10 1.50 2 50
5 M'/L+ 1.18 L/8 8.25 1.18	R+ 25.00 	Mus	a/A+ .20 b+ 2.50 1.10 1.50 2.1 1.22 1.14	Bus 4: 12 . 50 Bus 5: 00 Bus 1. 10 1. 50 2. 50 Bus 1. 10 1. 50 2. 50 Bus 1. 10 1. 50 2. 50
B H'/L+ 1.18 L/a 0 25 <u>1 18</u> 15.02 - 30	R+ 25.00 25 1.50 2.50 	Mus 50 br 1.00 1.10 1.50 2.50 <u>7 20 1 01 00</u> 21 85 8	<i>b</i> /R• 20 <u>b</u> • 2.50 1.10 1.50 2.1 1.32 1.14 <u>1.32</u> 88	Bus - B - 12 . 50 Bo - 5 - 00 Bo - 1. 10 - 1. 50 - 2. 50 Bo - 1. 10 - 1. 50 - 2. 50 Bo - 1. 10 - 1. 27 10 Bo - 1. 10 12 10
N'/L+ 1.10 L/8 0 25 <u>1 10</u> 15.02 <u>50</u> 31 25 50 37 12 22	R • 25.00 - 25 1.80 2.50 - 05 - 10 - 07 - 0	Rus:	<i>b</i> 2.50 <i>b</i> 2.50 <i>b</i> 2.50 <i>b</i> 1.10 <i>b</i> 2.50 <i>b</i> 2	Busicht 12.50 Br. 5.00
H'/L+ 1.10 L/8 0 25 1 10 15.02 .50 370.13 .22	R= 25.00 25 1.50 2.50 	Rus: 80 be 1.00 1.10 1.50 2.50 1.20 01 00 20 57 70 20 54 77 Rus: 50	<i>a</i> /R · 20 b · 2.50 1.10 1.50 2.1 1.32 1.14 - 48 57 - 25 54 <i>a</i> /R · 50	But s 4: 12.50 B* 5.00 B* 5.00 B* 1.00 1.50 2.50
H'/L+ 1.10 L/a € 25 1 18 15.02 .30 31.25 .30 78.13 .22	R• 25.00 25 1.50 2.50 	Nus: 80 b- 1.00 1.10 1.50 2.50 7 20 1.01 80 20 57 70 23 54 77 Nus: 50	a/h• 20 b• 2.50 1.10 1.50 2.1 1.32 1.14 1.32 5.7 25 54 a/R= 50	But set 12.50 B* 5.00
b H'/L* 1.10 L/a 0 25 1 10 15.0230 31.2533 70.13 . 22 D	R- 25.00 - 25 1.50 2.50 - 1.50 2.50 - 1.67 - 50 .78 - 54 .77 R- 25.00 25	Rus: 50 be 1.00 1.10 1.50 2.50 1.20 1.01 55 20 57 71 23 54 77 Rus: 50 be 1.00	a/A• 20 b• 2.50 t.10 1.50 2.1 1.32 1.14 1.32 57 25 84 a/A• 50 b• 2.50	But s 4: 12.50 B* 5.00
B H'/L+ 1.10 L/8 25 1.10 13.02	R- 25.00 - 25 1.80 2.50 - 1.80 2.50 - 1.90 .70 - 50 .70 - 54 .77 R- 25.00 25 1.80 2.80	Num S0 be 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 57 20 57 23 54 50 50 be 1.00 1.00 1.00	a/A• .20 b• 2.50 1.10 1.30 2.1 1.22 1.14 .14 .57 .25 .54 a/A= .50 b• 2.50 1.10 1.50 2.	But set 12.80 Br B 00 Br B 00 B 00
B H //L 1.10 L/a 15.02 54 15.02 50 31.25 33 78.13 22 M //L 1.10 L/a 2.50 1.20	R- 25.00 - 25 1.80 2.50 - 01 - 07 - 05 - 06 - 07 - 05 - 07 - 00 - 07 - 07	Rus: 50 b: 1.00 1.10 1.50 2.50 1.20 1.01 90 20 57 70 23 54 23 54 b: 1.00 1.10 1.50 2.50 1.10 1.50 2.50 1.44 1.32 02	<i>b</i> 2.50 <i>b</i> 2	Bus-R+12.80 B+ 5 00 B+ 5 00 </td
B H'/L+ 1.10 L/B 5 1 10 13.02 50 31.25 30 70.13 22 M'/L+ 1.10 L/B 2.50 1 30 12.50 1 30 12.50 40 12.50 40	R- 25.00 - 25 1.80 2.50 - 01 .07 - 05 .00 - 05 .00 - 05 - 0	Mus. 50 b. 1.00 1.10 1.50 2.50 71 05 0.00 71 05 0.00 71 05 0.00 71 05 0.00 1.00 1.00 2.50 1.10 1.50 2.50 1.44 1.15 0.00 1.44 0.00 1.	<i>b</i> − 2 50 <i>b</i> −	Busick 12.50 Bit 5.00 Bit 1.50 20 1.20 1.10 1.50 20 1.20 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.10 1.50 1.46 1.30 1.46 1.00 1.46 1.00
B H'/L+ 1.10 L/B 15.02 15.02 10.13 12.50 H'/L+ 1.10 L/B 2.50 12.50 40 31.25 24	R- 25.00 - 25 1.80 2.50 - 67 - 65 - 67 - 67 - 87 - 87 - 87 - 25.00 - 25.00	Mus 1.00 1.10 1.50 2.50 1.10 1.50 2.50 1.20 5.7 70 23 5.4 70 Mus 50 2.50 1.10 1.50 2.50 1.10 1.50 2.50 1.44 1.12 62 40 00 00 20 50 70	b 20 b 2.50 1.10 1.50 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.32 1.4 1.4 1.5 1.10 1.80 1.10 1.80 1.10 1.30 1.10 1.30 1.10 1.30 1.10 1.30 1.10 1.30	But s • R • 12 . 50 Bo 5 00 Bo 1.50 2.50 Bo 1.50 2.50 Bo 1.50 2.50 Bo 1.50 2.50 Bo 1.64 27 99 Bo 1.64 1.50 2.50 Bo 1.64 1.50 2.50 Bo 1.10 1.50 2.50 Bo 1.10 1.50 2.50 Bo 1.10 1.50 2.50 Bo 1.44 1.30 2.50 Bo 1.10 1.50 2.50 Bo 1.44 1.30 2.50 Bo 1.46 1.30 2.50 Bo 1.44 1.50 2.50 Bo 1.46 1.30 2.50 Bo 1.46 1.30 1.50 Bo 1.50 2.50 1.50
B H'/L+ 1.10 L/B 0 25 1 10 15.02 50 70.13 22 B H'/L+ 1.10 L/B 2 50 1 20 0 25 1 00 12.50 40 21.25 24	R- 25.00 - 25 1.50 2.50 - 15 - 107 -	Nume S0 be 1.00 1.10 1.50 2.50 1.10 1.50 2.50 1.10 1.50 2.50 1.10 1.50 2.50 1.10 1.50 2.50 1.10 1.50 2.50 be 1.60 1.50 1.10 1.50 2.50 1.10 1.50 2.50 1.44 1.12 02 1.44 1.12 02 1.44 50 71 1.50 50 71 1.44 1.12 02 1.44 1.12 02 1.44 1.12 02 1.44 1.12 02 1.44 1.13 50 1.44 1.50 71 1.45 50 71	a/R+ 1.00 a/R+ 1.00 a/R+ 1.00 a/R+ 1.00 a/R+ 1.00 a/R+ 1.00 b+ 2.50 a/R+ 1.00 a/R+ 1.00 b+ 2.50 b+ 2	Burge Re 12.50 25 B* 5.00 B0 1.10 1.50 2.50 B0 1.10 1.50 2.50 B0 1.10 1.50 2.50 B1 1.20 27 .01 70 B2 .50 .71 70 B2 .50 .71 1.20 .54 .77 Bursteller 12.50
B H'/L+ 1.10 L/B 0 25 1 10 15.02 .50 31.25 .50 31.25 .20 H'/L+ 1.10 L/B 0 25 1 20 .13 .22 B	R- 25.00 25 1.80 2.50 1.80 2.50 1.90 .70 .54 .77 R- 25.00 25 1.80 2.30 25 1.80 2.30 25 R- 25.00 35	Rus: 50 b. 1.00 1.00 1.50 2.50 1.00 1.50 2.50 1.00 57 71 23 54 77 Rus: 50 b. 1.00 1.00 2.50 1.00 2.50 1.00 2.50 1.44 1.32 02 1.67 71 63 0.50 71 1.60 71 63 0.50 71 1.00 71 1.00 71 63 1.00 71 1.00 71 63 1.00 71 1.00 71 63 1.00 71 1.00 71 63 1.00 71 1.00 71	a/R+ 20 b+ 2.50 1.10 1.30 2.1 1.22 1.14 a/R+ 50 b+ 2.50 1.10 1.50 2.1 1.00 1.25 1.00 1.25 1.00 1.25 a/R+ 1.00 b+ 2.50	Bug+R+12_S0 B+ S 00
b H'/L+ 1.10 L/A 0 25 1 10 19.02 .50 31.25 .50 31.25 .20 H'/L+ 1.10 L/A 0 25 . 40 0 25 . 20 H'/L+ 1.10 D H'/L+ 1.10	R- 25.00 .25 1.80 2.50 91	Num Num Num b- 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00 1.00	<i>a</i> /R · 20 b · 2.50 1.10 1.50 2.1 1.22 1.14 <i>a</i> /R · 57 25 54 <i>a</i> /R · 50 1.10 1.50 2. 1.10 1.50 2. 1.10 1.50 2. 1.00 1.21 	Bug+R+12.50 B+ 50 B+ <th< th=""></th<>
B H'/L* 1.10 U 25 1 10 15.02 50 31.25 33 78.13 22 M'/L* 1.10 U/a 2.50 1 20 0.25 40 0.25 40 0.25 40 0.25 24 M'/L* 1.10 U/a 0.10 40 0.10 10 0.10 10 0	R- 25.00 25 1.80 2.50 	Num Num Num br 1.00 1.00 1.00 1.00 1.00 20 57 20 57 23 54 71 85 23 54 71 85 23 54 71 80 1.00 1.00 1.00 1.00	<i>b</i> 2.50 <i>b</i> 2.50 1.10 1.50 2.1 <i>b</i> 2.50 <i>b</i> 2.50 <i>c</i> 3.50 <i>c</i> 3.50	Burge Re 12.80 B* 5.00
B H'/L 1.10 L/2 1.10 13.02	R- 25.00 - 25 - 25 - 30 2.50 - 5 - 16 - 30 70 - 54 77 R- 25.00 - 25 - 30 - 30 - 30 - 30 -	Num Num br 1.00 1.00 1.00 1.00 1.00 20 57 20 57 20 57 20 57 20 57 20 50 20 57 10 1.50 20 50 1.00 1.00 1.00 1.00 1.00 1.50	<i>b</i> 2.50 <i>b</i> 2.50	Burge Re 12 . 50 Be 5 00 Be 5 00 Be 1.50 2 50 Be 1.50 2 50 Be 1.50 2 50 Be 1.61 .50 2 50 Be 1.62 .50 .77 Be 5.00 Be 5.00 Be 1.00 1.50 Be 1.00
B H'/L+ 1. 18 U/D+ 1. 19 U/D+ 1. 19 15.02 50 31.25 50 31.25 20 H'/L+ 1. 19 L/D 25 1.20 0.25 1.20 12.50 40 31.25 24 B H'/L+ 1. 19 L/D 125 24 B H'/L+ 1. 19 L/D 25 1.20 B H'/L+ 1. 19 B H'/L+ 1. 19 L/D 25 24 B H'/L+ 1. 19 L/D 26 L/D	R • 25.00 . 25 1.80 2.50 . 01	Murg B0 b+ 1.00 1.10 1.50 2.50 1.10 1.50 2.50 1.20 57 71 20 57 71 20 57 71 20 57 71 20 57 71 20 57 71 20 57 71 20 57 71 20 50 71 1.10 1.50 2.50 1.44 1.7 52 50 50 71 50 50 71 50 50 71 50 50 71 50 50 71 50 50 71 50 50 71 50 50 71 50 50 71 50 50 71 50 50 50 50 50 50 50 50 50 50 50 50 51 50 50 53 50 50	<i>b</i> / <i>k</i> 20 <i>b</i> 2.50 <i>1</i> .10 1.50 2.1 <i>1</i> .32 1.14 <i>1</i> .32 5. <i>1</i> .32 5. <i>1</i> .32 5. <i>1</i> .32 5. <i>1</i> .32 5. <i>1</i> .10 1.50 2. <i>1</i> .10 1.50 2. <i>1</i> .10 1.50 2. <i>1</i> .40 1.27 <i>1</i> .40 1.27 <i>1</i> .40 1.27 <i>1</i> .40 1.27 <i>1</i> .40 1.27 <i>1</i> .40 1.60 2. <i>1</i> .10 <i>1</i> .60 <i>1</i> .	Bugs R + 12 . 50 Bo 5 00 Bo 1 10 1 .50 2 50 Bo 1 10 1 .50 2 50 Bo 1 10 1 .50 2 .50 Bo 1 .10 1 .50 2 .50 Bo 1 .00 1 .50 2 .50 Bo 1 .00 1 .50 2 .50 Bo 1 .60 1 .50 100
B H'/L+ 1.19 0 25 1 10 15.02 .50 31.13 .22 H'/L+ 1.19 L/B .13 2.50 .40 31.25 .24 H'/L+ 1.19 L/B .12 .24 H'/L+ 1.19 L/B .12 .24 B H'/L+ 1.19 .24 B H'/L+ 1.19 .24 .24 .24 .24 .24 .24 .24 .25 .24 .25 .24 .25 .25 .25 .24 .25 .25 .25 .24 .25 .24 .25 .25 .24 .25 .24 .25 .24 .25 .24 .24 .24 .24 .24 .24 .24 .24	R- 25.00 - 25 1.80 2.50 - 01 - 07 - 05 - 00 - 07 - 07 - 07 -	Mura - So 	<i>b</i> /R+ 20 <i>b</i> + 2.50 1.10 1.80 2.1 <i>b</i> + 3.50 <i>b</i> + 3	Burge Re 12 . 50 Bo 5 00 Bo 1 10 1 . 50 2 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 40 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 10 1 . 50 2 . 50 Bo 1 . 30 2 . 50 Bo 1 . 30 2 . 50 Bo 1 . 50 2 . 50 Bo 1 . 50 2 . 50 Bo 1 . 50 30 30 Bo 1 . 50 3
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