$$Ec(Corridor) = \left(\sum_{k=1}^{n} E_{c_k} \right) \qquad \text{(Equation D7)}$$

(viii) Alternative casualty expectancy (E_c) analysis. An applicant may employ specified variations to the analysis defined by subparagraphs (d)(1)(i)–(vii). Those variations are identified in subparagraphs (viii)(A) through (F) of this paragraph. Subparagraphs (A) through (D) permit an applicant to make conservative assumptions that would lead to an overestimation of E_c compared with the analysis defined by subparagraphs (d)(1)(i)–(vii). In subparagraphs (E) and (F), an applicant that would otherwise fail the analysis prescribed by subparagraphs (d)(1)(i)–(vii) may avoid (d)(1)(i)–(vii)'s overestimation of the probability of impact in each populated area. An applicant employing a variation shall identify the variation used, show and discuss the specific assumptions made to modify the analysis defined by subparagraphs (d)(1)(i)–(vii), and demonstrate how each assumption leads to overestimation of the corridor E_c compared with the analysis defined by subparagraphs (d)(1)(i)–(vii).

(A) Assume that P_x and P_y have a value of 1.0 for all populated areas.

(B) Combine populated areas into one or more larger populated areas, and use a population density for the combined area or areas equal to the most densely populated area.

(C) For any given populated area, assume P_x has a value of one.

(D) For any given populated area, assume P_y has a value of one.

(E) For a given populated area, divide the populated area into smaller rectangles, determine P_i for each individual rectangle, and sum the individual impact probabilities to determine P_i for the entire populated area.

(F) For a given populated area, use the ratio of the populated area to the area of the P_i rectangle used in the subparagraph (d)(1)(i)–(vii) analysis.

(2) If the estimated expected casualty does not exceed 30×10^{-6}, the FAA will approve the launch point.

(3) If the estimated expected casualty exceeds 30×10^{-6}, then an applicant may modify its proposal and then repeat the impact risk analysis in accordance with this appendix D. If no set of impact dispersion areas exist which satisfy the FAA's risk threshold, the applicant's proposed launch site will fail the launch site location review.

APPENDIX E TO PART 420—TABLES FOR EXPLOSIVE SITE PLAN

TABLE E–1—DIVISION 1.1 DISTANCES TO A PUBLIC AREA OR PUBLIC TRAFFIC ROUTE FOR NEW >450 LBS

NEW (lbs.)	Distance to public area (ft) [1] [2]	Distance to public traffic route distance (ft) [2]
≤0.5	236	142
0.7	263	158
1	291	175
2	346	208
3	378	227
5	419	251
7	445	267
10	474	284
15	506	304
20	529	317
30	561	337
31	563	338
50	601	361
70	628	377
100	658	395
150	815	489
200	927	556
300	1085	651
450	1243	746

[1] To calculate distance d to a public area from NEW:
NEW ≤0.5 lbs: d = 236
0.5 lbs <NEW <100 lbs: d = 291.3 + [79.2 *ln(NEW)]
100 lbs ≤NEW ≤450 lbs: d = -1133.9 + [389 *ln(NEW)]

NEW is in lbs; d is in ft; ln is natural logarithm.
To calculate maximum NEW given distance d (noting that d can never be less than 236 ft):
0 ≤d <236 ft: Not allowed (d cannot be less than 236 ft)
236 ft ≤d <658 ft: NEW = exp [(d/79.2)-3.678]
658 ft ≤d <1250 ft: NEW = exp [(d/389) +2.914]
NEW is in lbs; d is in ft; exp[x] is e^x.
[2] The public traffic route distance is 60 percent of the distance to a public area.

TABLE E–2—DIVISION 1.1 DISTANCE TO PUBLIC AREA AND PUBLIC TRAFFIC ROUTE FOR NEW >450 LBS

NEW (lbs)	Distance to public area (ft) [1]	Distance to public traffic route (ft)
450 lbs<NEW ≤30,000 lbs	1,250	750.
30,000 lbs<NEW ≤100,000 lbs	40*NEW 1/3	0.60*(Distance to Public Area).
100,000 lbs<NEW ≤250,000 lbs	2.42*NEW 0.577	0.60*(Distance to Public Area).
250,000 lbs<NEW	50*NEW 1/3	0.60*(Distance to Public Area).

[1] To calculate NEW from distance d to a public area:
1, 243 ft<d ≤1,857 ft: NEW = $d^3/64{,}000$
1, 857 ft<d ≤3,150 ft: NEW = 0.2162 * $d^{1.7331}$
3,150 ft<d: NEW = $d^3/125{,}000$
NEW is in lbs; d is in ft.

TABLE E–3—DIVISION 1.1 INTRALINE DISTANCES [1 2 3]

NEW (lbs)	Intraline Distance (ft)
50	66
70	74
100	84
150	96
200	105
300	120
500	143
700	160
1,000	180
1,500	206
2,000	227
3,000	260
5,000	308
7,000	344
10,000	388
15,000	444
20,000	489
30,000	559
50,000	663
70,000	742
100,000	835
150,000	956
200,000	1,053
300,000	1,205
500,000 [3]	1,429
700,000	1,598
1,000,000	1,800
1,500,000	2,060
2,000,000	2,268
3,000,000	2,596
5,000,000	3,078

[1] To calculate intraline distance d from NEW:
d = 18*NEW 1/3
NEW is in pounds; d is in feet
[2] To calculate maximum NEW from given intraline distance d:
NEW = $d^3/5{,}832$
NEW is in pounds; d is in feet.
[3] NEW values of more than 500,000 lbs only apply to liquid propellants with TNT equivalents equal to those NEW values. The intraline distances for NEW greater than 500,000 pounds do not apply to division 1.1 explosives.

TABLE E–4—DIVISION 1.3 SEPARATION DISTANCES

NEW (lbs)	Distance to public area or public traffic route (ft) [1]	Intraline distance (ft) [2]
≤1000	75	50
1,500	82	56
2,000	89	61
3,000	101	68
5,000	117	80
7,000	130	88
10,000	145	98
15,000	164	112
20,000	180	122
30,000	204	138
50,000	240	163
70,000	268	181
100,000	300	204
150,000	346	234
200,000	385	260
300,000	454	303
500,000	569	372
700,000	668	428
1,000,000	800	500
1,500,000	936	577
2,000,000	1,008	630

[1] To calculate distance d to a public area or traffic route from NEW:
NEW ≤1,000lbs
d= 75 ft
1,000 lbs<NEW ≤96,000 lbs
$d=\exp[2.47 + 0.2368*(\ln(NEW)) + 0.00384*(\ln(NEW))^2]$
96,000 lbs<NEW ≤1,000,000 lbs
$d = \exp[7.2297 - 0.5984*(\ln(NEW)) + 0.04046*(\ln(NEW))^2]$
NEW >1,000,000 lbs
$d = 8*NEW^{1/3}$
NEW is in pounds; d is in feet; exp[x] is e^x; ln is natural logarithm.
To calculate NEW from distance d to a public area or traffic route (noting that d cannot be less than 75 ft):
0 ≤d <75 ft:
Not allowed (d cannot be less than 75 ft) for NEW ≤1000 lbs
75 ft ≤d≤296 ft
$NEW = \exp[-30.833 + (307.465 + 260.417*(\ln(d)))^{1/2}]$
296 ft<d≤800 ft
$NEW = \exp[7.395 + (-124.002 + 24.716*(\ln(d)))^{1/2}]$
800 ft<d
$NEW = d^3/512$
NEW is in lbs; d is in ft; exp[x] is e^x; ln is natural logarithm
[2] To calculate intraline distance d from NEW:
NEW ≤1,000 lbs
d = 50 ft
1,000 lbs<NEW ≤84,000 lbs
$d=\exp[2.0325 + 0.2488*(\ln(NEW)) + 0.00313* (\ln(NEW))^2]$
84,000 lbs<NEW ≤1,000,000 lbs
$d= \exp[4.338 - 0.1695*(\ln(NEW)) + 0.0221*(\ln(NEW))^2]$
1,000,000 lbs<NEW
$d =5*NEW^{1/3}$
NEW is in pounds; d is in feet; exp[x] is e^x; ln is natural logarithm
To calculate NEW from an intraline distance d:
0 ≤d <50 ft:
Not allowed (d cannot be less than 50 ft) for NEW ≤1000 lbs
50 ft ≤d≤192 ft
$NEW = \exp[-39.744 + (930.257 + 319.49*(\ln(d)))^{1/2}]$
192 ft<d≤500 ft
$NEW = \exp[3.834 + (-181.58 + 45.249*(\ln(d)))^{1/2}]$
500 ft≤d
$NEW = d^3/125$
NEW is in pounds; d is in feet; exp[x] is e^x; ln is natural logarithm

TABLE E–5—ENERGETIC LIQUID EXPLOSIVE EQUIVALENTS [1 2 3]

Energetic liquids	TNT Equivalence	TNT Equivalence
	Static Test Stands	Launch Pads.
LO_2/LH_2	See Note 3	See Note 3.
$LO_2/LH_2 + LO_2/RP–1$	Sum of (see Note 3 for LO_2/LH_2) + (10% for $LO_2/RP1$).	Sum of (see Note 3 for LO_2/LH_2) + (20% for $LO_2/RP1$).
$LO_2/RP–1$	10%	20% up to 500,000 lbs Plus 10% over 500,000 lbs
IRFNA/UDMH	10%	10%.

TABLE E–5—ENERGETIC LIQUID EXPLOSIVE EQUIVALENTS[1 2 3]—Continued

Energetic liquids	TNT Equivalence	TNT Equivalence
N_2O_4/UDMH + N_2H_4	5%	10%.

[1] A launch site operator must use the percentage factors of table E–5 to determine TNT equivalencies of incompatible energetic liquids that are within an intraline distance of each other.

[2] A launch site operator may substitute the following energetic liquids to determine TNT equivalency under this table as follows:

Alcohols or other hydrocarbon for RP–1

H_2O_2 for LO_2 (only when H_2O_2 is in combination with RP–1 or equivalent hydrocarbon fuel)

MMH for N_2H_4, UDMH, or combinations of the two.

[3] TNT equivalency for LO_2/LH_2 is the larger of:

(a) TNT equivalency of $8*W^{2/3}$, where W is the weight of LO_2/LH_2 in lbs; or

(b) 14 percent of the LO_2/LH_2 weight.

TABLE E–6—FACTORS TO USE WHEN CONVERTING ENERGETIC LIQUID DENSITIES

Item	Density (lb/gal)	Temperature (°F)
Ethyl alcohol	6.6	68
Hydrazine	8.4	68
Hydrogen peroxide (90 percent)	11.6	68
Liquid hydrogen	0.59	−423
Liquid oxygen	9.5	−297
Red fuming nitric acid (IRFNA)	12.9	77
RP–1	6.8	68
UDMH	6.6	68
UDMH/Hydrazine	7.5	68

TABLE E–7—SEPARATION DISTANCE CRITERIA FOR STORAGE OF HYDROGEN PEROXIDE IN CONCENTRATIONS OF MORE THAN 91 PERCENT[1 2]

Quantity (lbs)	Intraline distance or distance to public area or distance to public traffic route (ft)
10,000	510
15,000	592
20,000	651
30,000	746

TABLE E–7—SEPARATION DISTANCE CRITERIA FOR STORAGE OF HYDROGEN PEROXIDE IN CONCENTRATIONS OF MORE THAN 91 PERCENT[1 2]—Continued

Quantity (lbs)	Intraline distance or distance to public area or distance to public traffic route (ft)
50,000	884
70,000	989
100,000	1114
150,000	1275
200,000	1404
300,000	1607
500,000	1905

[1] Multiple tanks containing hydrogen peroxide in concentrations of greater than 91 percent may be located at distances less than those required by table E–7; however, if the tanks are not separated from each other by 10 percent of the distance specified for the largest tank, then the launch site operator must use the total contents of all tanks to calculate each intraline distance and the distance to each public area and each public traffic route.

[2] A launch site operator may use the equations below to determine permissible distance or quantity between the entries of table E–7:

W >10,000 lbs Distance = $24 * W^{1/3}$

Where Distance is in ft and W is in lbs.

To calculate weight of hydrogen peroxide from a distance d:

d >75 ft

$W = \exp[-134.286 + 71.998*(\ln(d)) - 12.363*(\ln(d))^2 + 0.7229*(\ln(d))^3]$

TABLE E–8—SEPARATION DISTANCE CRITERIA FOR STORAGE OF LIQUID HYDROGEN AND BULK QUANTITIES OF HYDRAZINE

Pounds of energetic liquid	Pounds of energetic liquid	Public area and intraline distance to incompatible energetic liquids	Intraline distance to compatible energetic liquids	Pounds of energetic liquid	Pounds of energetic liquid	Public area and intraline distance to incompatible energetic liquids	Intraline distance to compatible energetic liquids
Over	Not Over	Distance in feet	Distance in feet	Over	Not Over	Distance in feet	Distance in feet
				60,000	70,000	1,200	130
100	200	600	35	70,000	80,000	1,200	130
200	300	600	40	80,000	90,000	1,200	135
300	400	600	45	90,000	100,000	1,200	135
400	500	600	50	100,000	125,000	1,800	140
500	600	600	50	125,000	150,000	1,800	145
600	700	600	55	150,000	175,000	1,800	150
700	800	600	55	175,000	200,000	1,800	155
800	900	600	60	200,000	250,000	1,800	160
900	1,000	600	60	250,000	300,000	1,800	165
1,000	2,000	600	65	300,000	350,000	1,800	170
2,000	3,000	600	70	350,000	400,000	1,800	175
3,000	4,000	600	75	400,000	450,000	1,800	180

TABLE E–8—SEPARATION DISTANCE CRITERIA FOR STORAGE OF LIQUID HYDROGEN AND BULK QUANTITIES OF HYDRAZINE—Continued

Pounds of energetic liquid	Pounds of energetic liquid	Public area and intraline distance to incompatible energetic liquids	Intraline distance to compatible energetic liquids	Pounds of energetic liquid	Pounds of energetic liquid	Public area and intraline distance to incompatible energetic liquids	Intraline distance to compatible energetic liquids
4,000	5,000	600	80	450,000	500,000	1,800	180
5,000	6,000	600	80	500,000	600,000	1,800	185
6,000	7,000	600	85	600,000	700,000	1,800	190
7,000	8,000	600	85	700,000	800,000	1,800	195
8,000	9,000	600	90	800,000	900,000	1,800	200
9,000	10,000	600	90	900,000	1,000,000	1,800	205
10,000	15,000	1,200	95	1,000,000	2,000,000	1,800	235
15,000	20,000	1,200	100	2,000,000	3,000,000	1,800	255
20,000	25,000	1,200	105	3,000,000	4,000,000	1,800	265
25,000	30,000	1,200	110	4,000,000	5,000,000	1,800	275
30,000	35,000	1,200	110	5,000,000	6,000,000	1,800	285
35,000	40,000	1,200	115	6,000,000	7,000,000	1,800	295
40,000	45,000	1,200	120	7,000,000	8,000,000	1,800	300
45,000	50,000	1,200	120	8,000,000	9,000,000	1,800	305
50,000	60,000	1,200	125	9,000,000	10,000,000	1,800	310

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PARTS 421–430 [RESERVED]

PART 431—LAUNCH AND REENTRY OF A REUSABLE LAUNCH VEHICLE (RLV)

Subpart A—General

Sec.

Subpart B—Policy Review and Approval for Launch and Reentry of a Reusable Launch Vehicle

Subpart C—Safety Review and Approval for Launch and Reentry of a Reusable Launch Vehicle

Subpart D—Payload Reentry Review and Determination

Subpart E—Post-Licensing Requirements—Reusable Launch Vehicle Mission License Terms and Conditions