Advantages of Dual Recoil Configuration to Light Weight Towed Tube Artillery

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Baseline For Comparison

- Light tube artillery class became 105mm by end of WW II
- US M101 105mm Towed Howitzer taken as representative of class
- Characteristics
  - Single variable recoil
  - 4978 lb (2258 kg)
  - 11,270 m range
  - Weapon Impulse:
    2016 lbf-sec

Why System Weight Important

- Strategic and tactical mobility to support maneuver elements
  - Provide timely, accurate and effective fires
  - Both in direct and general support
- Transport asset capability not keeping up with demands
  - Limited assets
  - Competition for space
  - Vehicle performance

Approach Limiting Factors

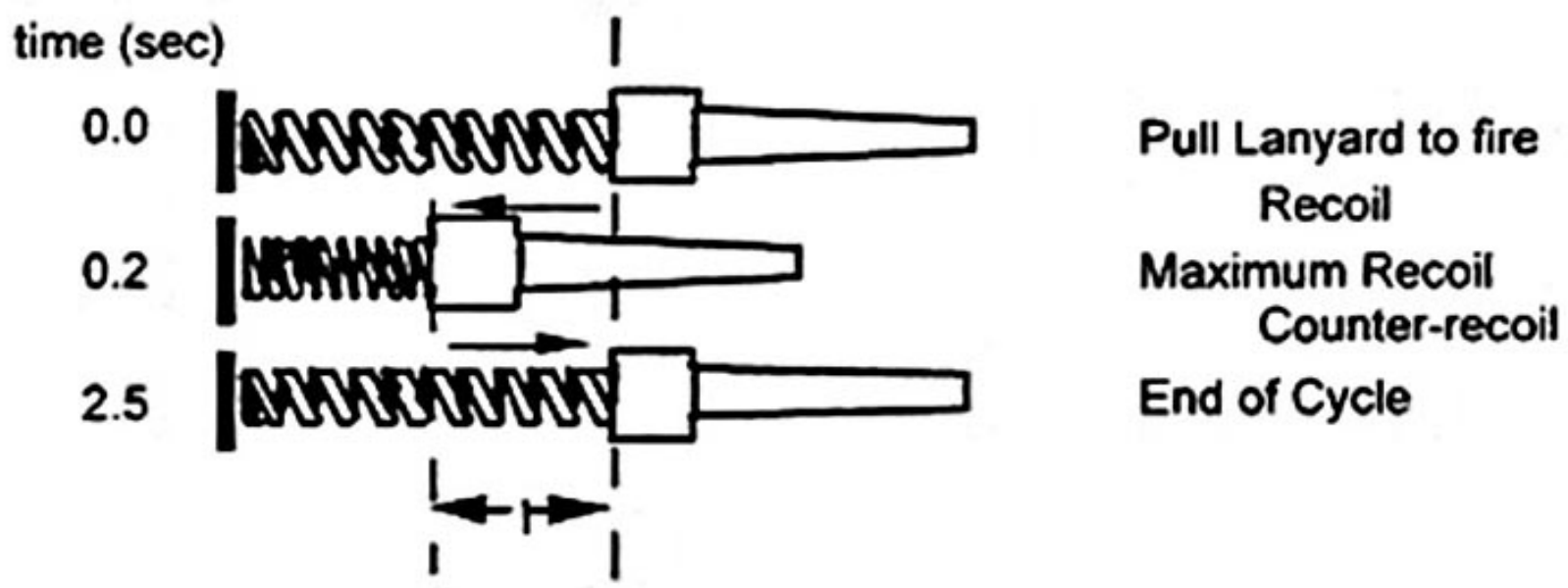
- Limited number of options for recoil management
  - Identified in late 1800's to early 1900's
  - Constrained by principles and laws of Newtonian physics
- Approach defined by dynamic condition at primer firing
  - Stationary
  - Dynamic

System Limiting Factors

- Ballistic performance/requirement
- Effectiveness/Rate of fire
- Stability
- Tactical mobility
- Materials/technology

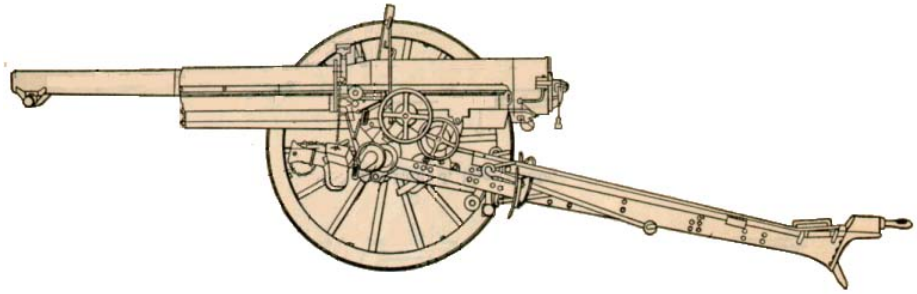
Fire-In-Battery
Single Recoil System

- Recoil impulse countered by resistive force applied over a distance
- Distance completely to the rear of the initial breech location

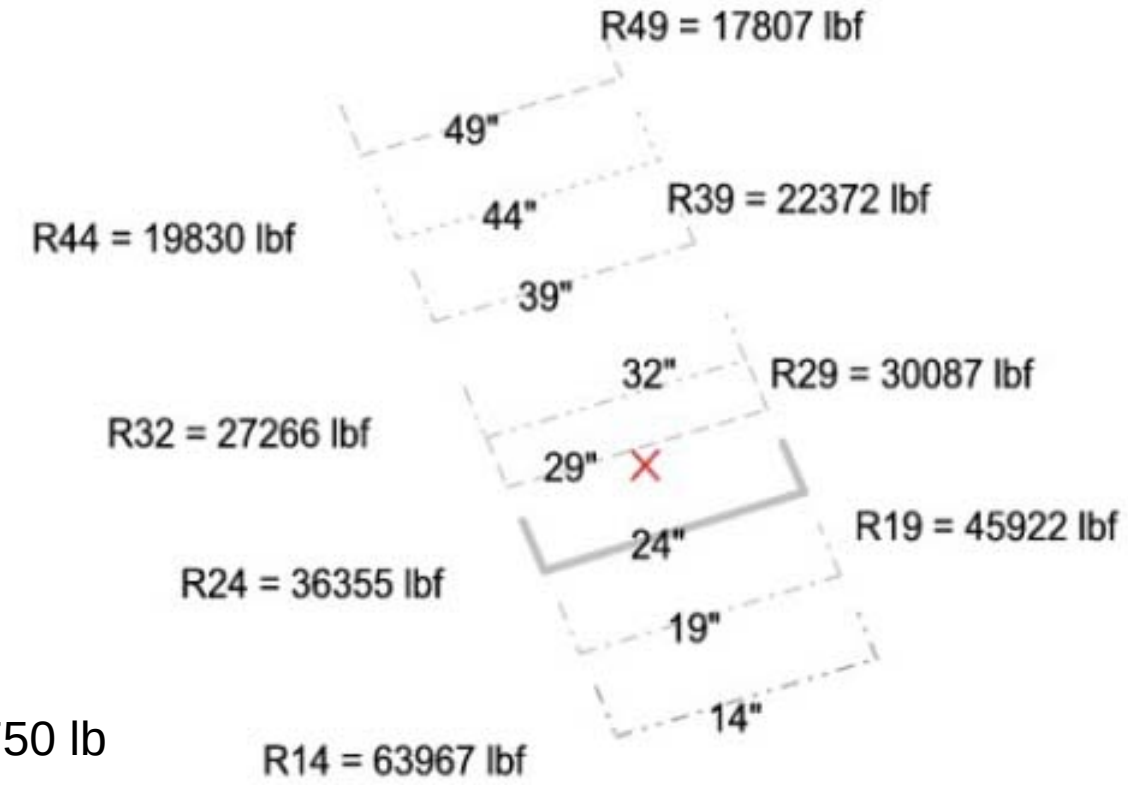


Fire-In-Battery Single Recoil Origins

- France 1894
  - 75mm Gun Mle 1897 “French 75”
- Germany 1896
  - 77mm FK96



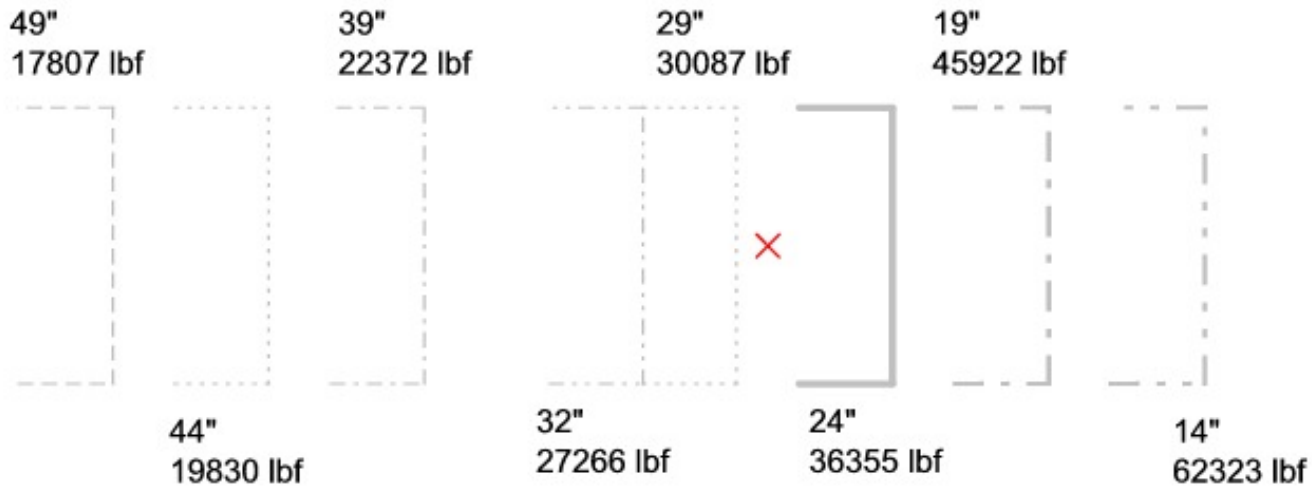
Single Recoil Loading Reduction
High Quadrant Elevation



Recoiling Mass - 1750 lb

Weapon Impulse – 2542 lbf-sec

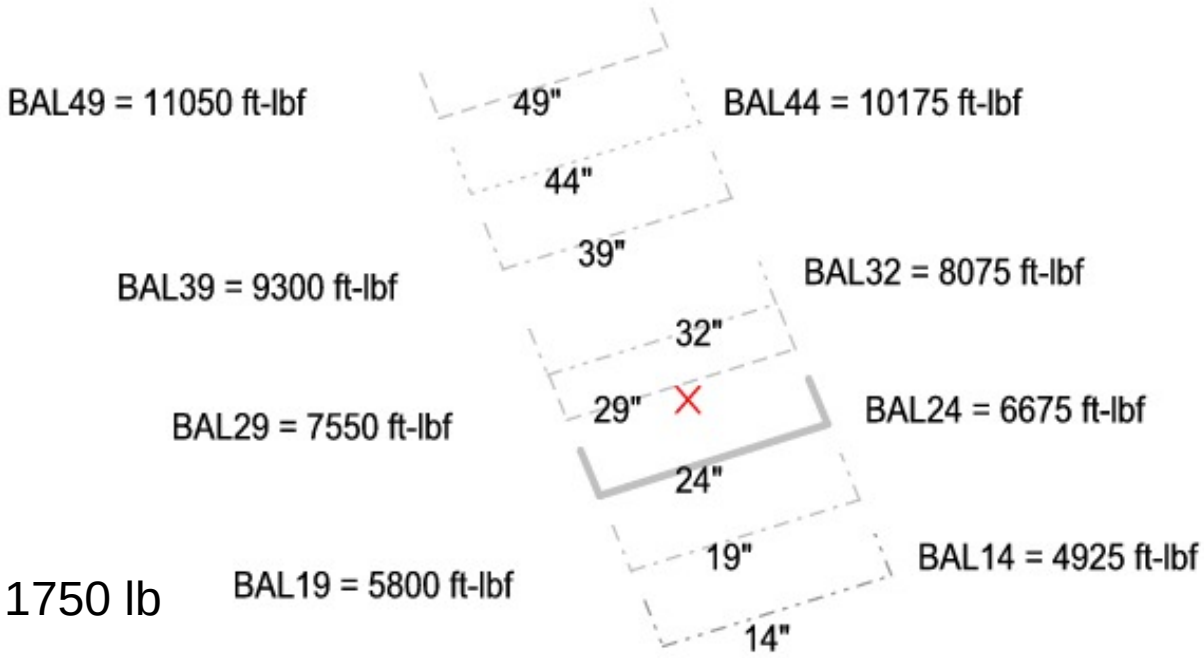
Single Recoil Loading Reduction
Low Quadrant Elevation



Recoiling Mass - 1750 lb

Weapon Impulse – 2542 lbf-sec

Single Recoil Loading Reduction Equilibration Impact



Recoiling Mass - 1750 lb

CG distance from breech rear face - 48.6 in

Fire-In-Battery Single Recoil Recent Efforts

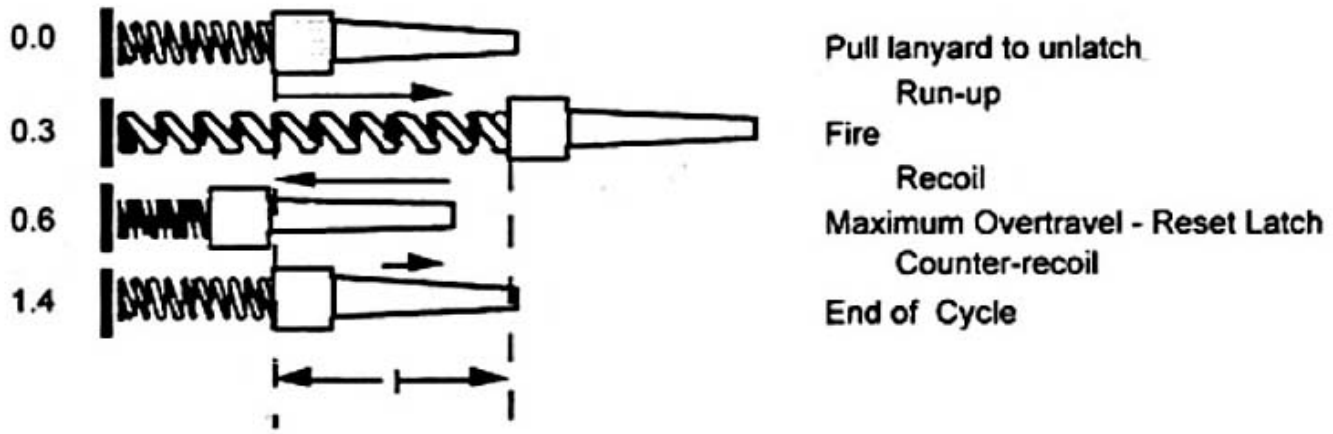
- Material enhancement
- Weapon impulse reduction
- Recoil distance extension

Fire-Out-Of-Battery Single Recoil Origins

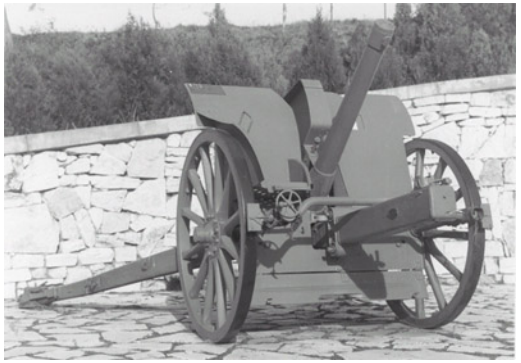
- Invented France
  - Schneider-Ducrest 65mm mountain gun
- Germany WW II
  - 55mm anti-aircraft gun
- M204 105mm towed howitzer
  - Type Classified mid 1970's
  - Not produced/fielded

Fire-Out-of-Battery Single Recoil System

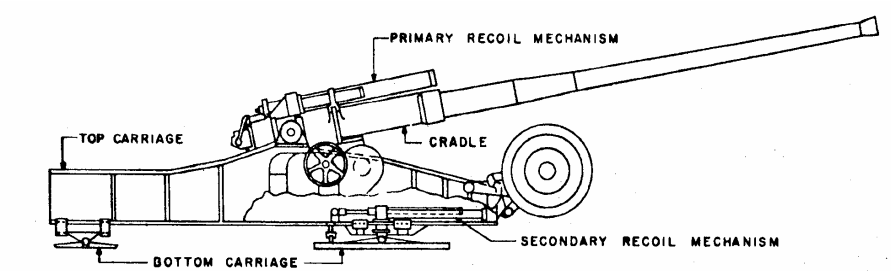
- Recoil impulse partially countered by inducing forward momentum prior to weapon firing
- Performance affected by temperature, forward velocity, and position along orifice control



Fire-In-Battery Dual Recoil Origins



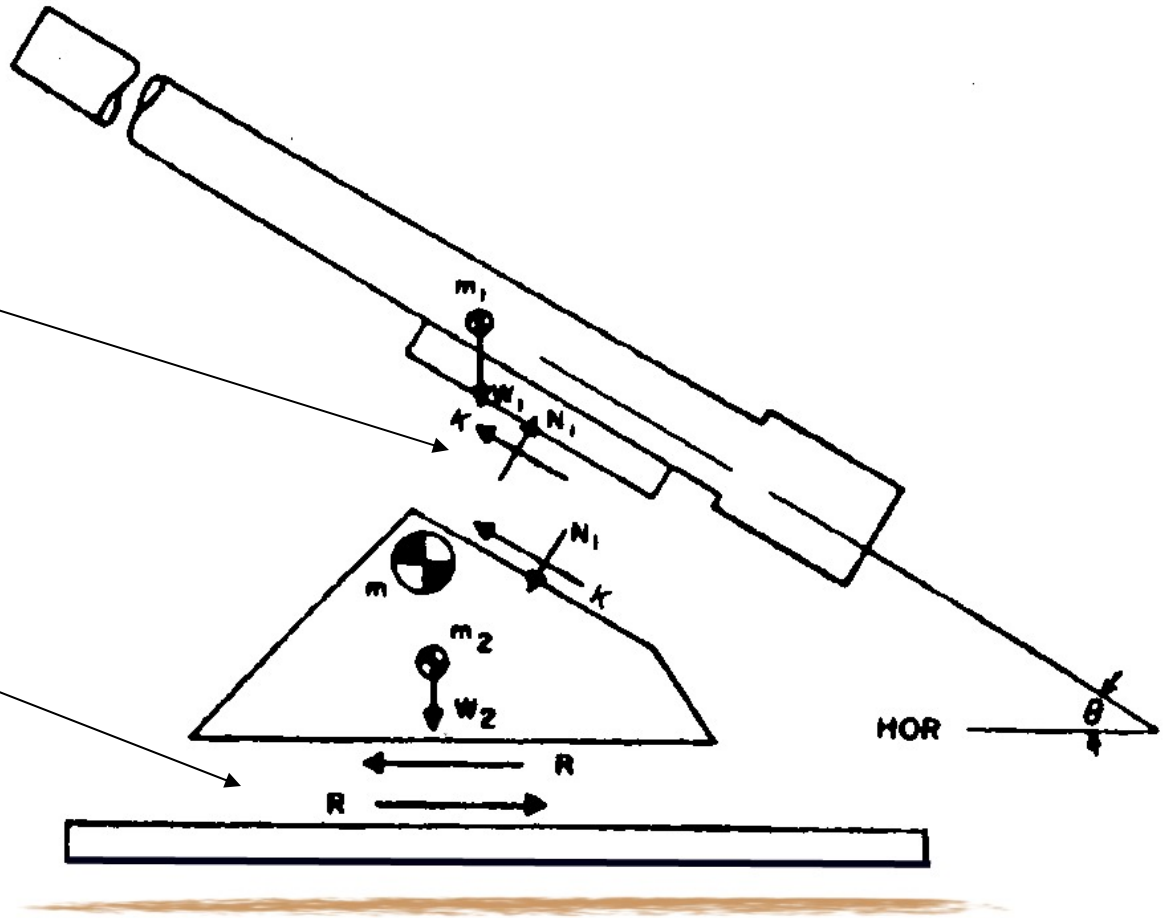
- Invented France 1912
  - Canonne da 75/27
- Germany WW II
  - 17cm K18 towed gun
  - 80cm K(E) railway gun "Dora"
- M59 280mm towed gun



Fire-In-Battery
Dual Recoil System

Primary Recoil

Secondary Recoil



Uniform Reaction Matrix @ 0 mils QE

K

L1(in) \ L2(in)	18	19.8	21	22.2	23.4	24.6	25.8	27
19.2	22899	22350	22017	21707	21418	21147	20894	20655
21	21417	20906	20596	20306	20035	19781	19542	19317
22.2	20544	20057	19760	19482	19223	18979	18749	18533
23.4	19747	19283	18999	18733	18483	18249	18028	17820
24.6	19018	18573	18301	18046	17807	17582	17369	17169
25.8	18346	17921	17660	17415	17185	16968	16764	16571
27	17725	17318	17068	16832	16611	16402	16205	16019
28.2	17149	16758	16518	16292	16079	15878	15688	15508

R

L1(in) \ L2(in)	18	19.8	21	22.2	23.4	24.6	25.8	27
19.2	15175	14328	13814	13336	12889	12472	12080	11713
21	14615	13828	13348	12901	12483	12091	11723	11376
22.2	14264	13513	13055	12627	12226	11850	11496	11162
23.4	13930	13213	12774	12364	11979	11618	11278	10957
24.6	13611	12925	12505	12112	11743	11395	11067	10758
25.8	13306	12650	12248	11870	11515	11181	10865	10567
27	13014	12386	12000	11637	11296	10974	10670	10382
28.2	12735	12133	11762	11414	11085	10775	10482	10204

Uniform Reaction Matrix @ 1244 mils QE

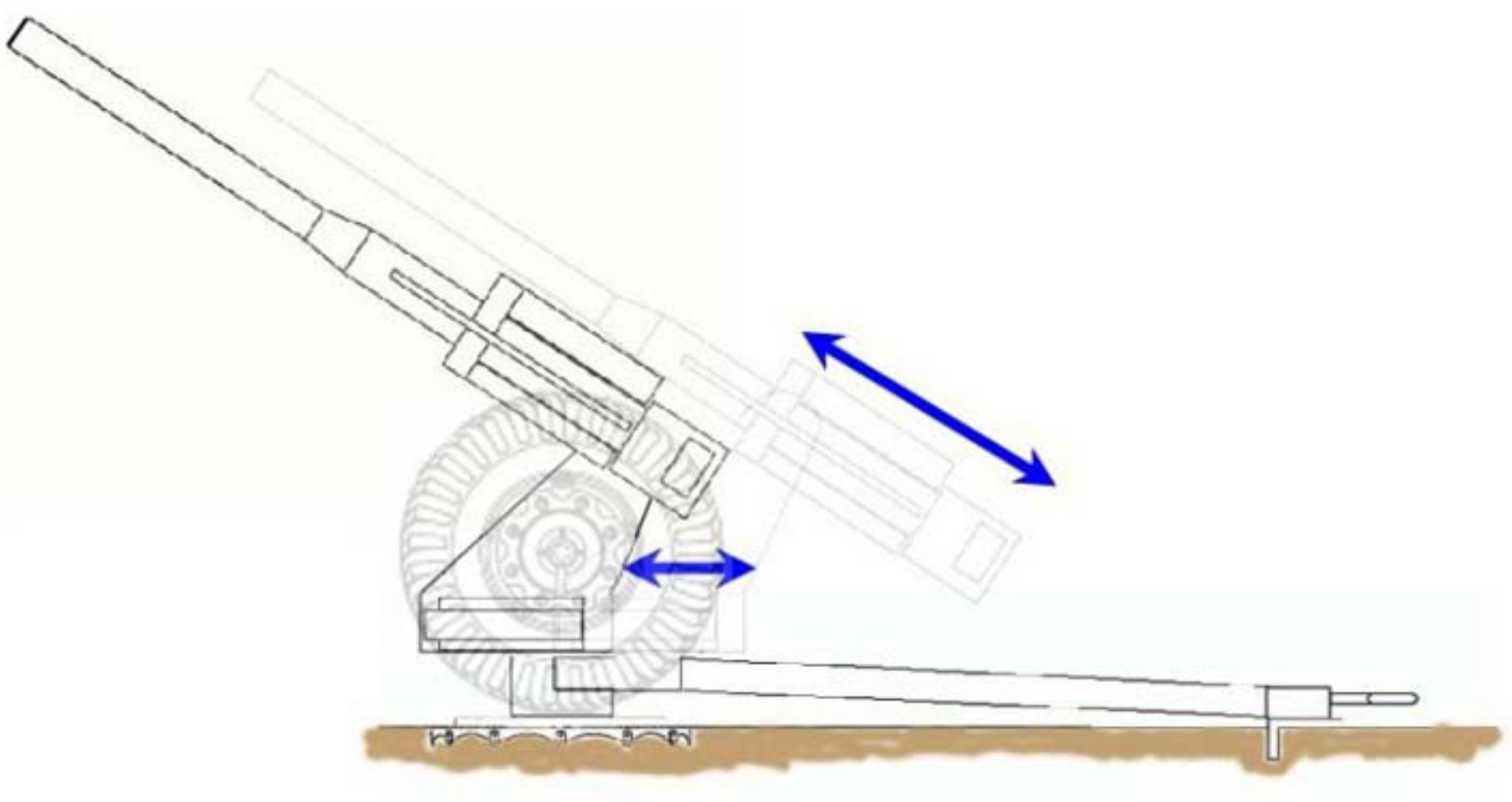
K

L1(in) \ L2(in)	18	19.8	21	22.2	23.4	24.6	25.8	27
19.2	36489	36449	36425	36403	36384	36366	36349	36334
21	33539	33500	33477	33456	33437	33419	33403	33388
22.2	31838	31799	31777	31756	31738	31720	31704	31690
23.4	30310	30273	30251	30231	30212	30195	30180	30165
24.6	28931	28895	28873	28853	28835	28819	28803	28789
25.8	27680	27644	27623	27604	27586	27570	27555	27541
27	26540	26505	26484	26465	26448	26432	26417	26403
28.2	25496	25462	25442	25423	25406	25390	25376	25362

R

L1(in) \ L2(in)	18	19.8	21	22.2	23.4	24.6	25.8	27
19.2	2434	2251	2145	2047	1958	1877	1802	1733
21	2391	2215	2111	2017	1931	1851	1778	1711
22.2	2363	2191	2089	1997	1912	1835	1763	1697
23.4	2336	2168	2068	1978	1895	1818	1748	1683
24.6	2309	2145	2047	1959	1877	1802	1733	1669
25.8	2283	2122	2027	1940	1860	1786	1718	1655
27	2258	2100	2007	1922	1843	1771	1704	1642
28.2	2233	2079	1987	1904	1827	1756	1690	1629

Concept System Utilizing Dual Recoil System



Proposed Requirements
Forcible Entry Weapon (FEW)

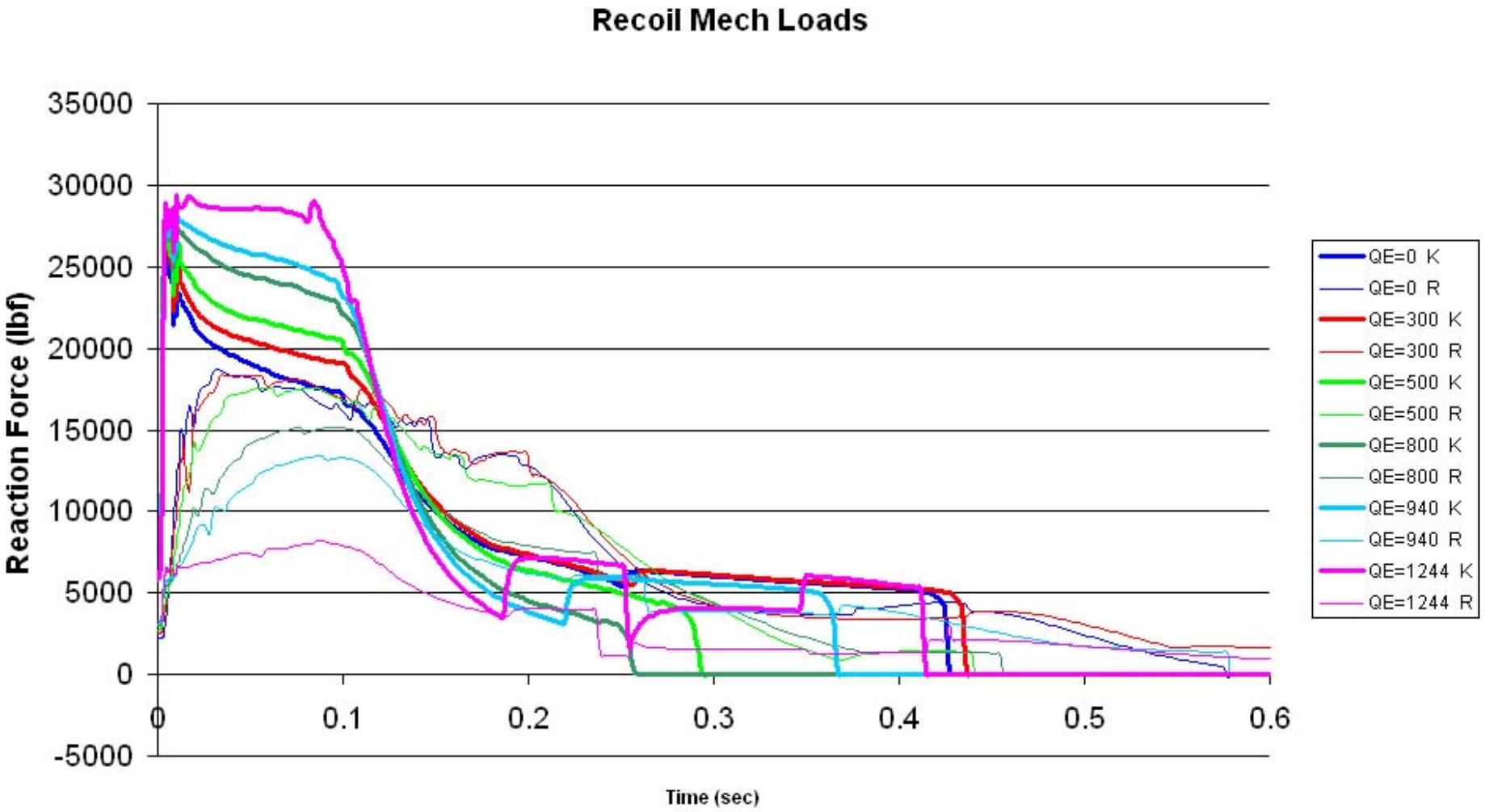
Criterion	**Threshold**	**Objective**
Weight	3,300 lbs	3,000 lbs
Max. Range	19.5 km with M913	20 km with CCF/BB 21 km without CCF
Rate-of-Fire	8	10
Shift Fire Azimuth	6400 mils	6400 mils
Emplacement/Displacement	60 sec.	30 sec.

Concept System Characteristics

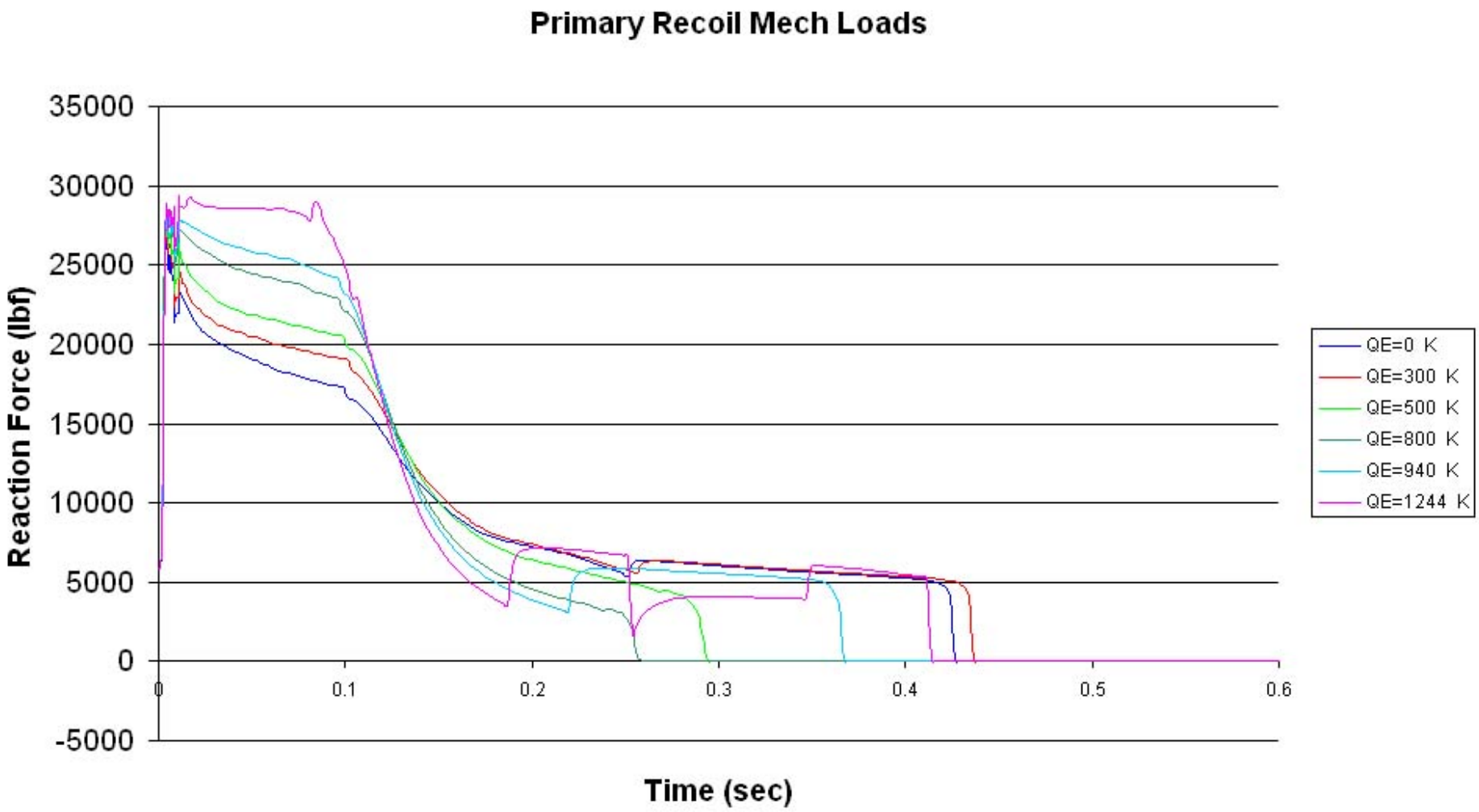
- Weight
  - Recoiling (primary) - 1710 lb.
  - Recoiling (secondary) - 915 lb.
  - System – 3230 lb.
- Max. rate of fire

  10+ rounds per minute
- Ammunition – All compatible with M119A2 howitzer
- Range
  - M760 Ballistic-14.5km
  - M913 RAP Ballistic-21km
- Recoil cycle time – 0.64 seconds

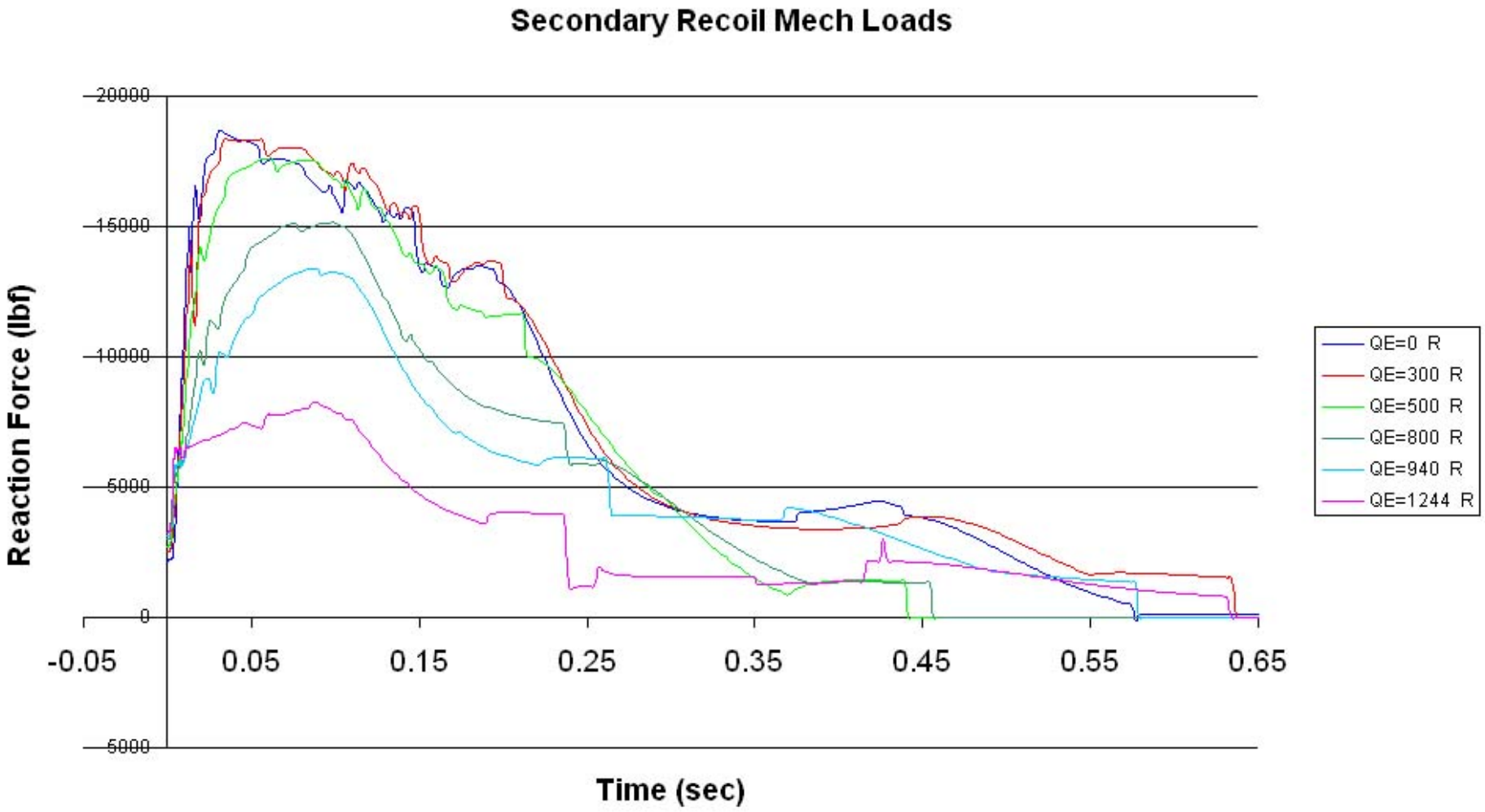
Concept Recoil Load



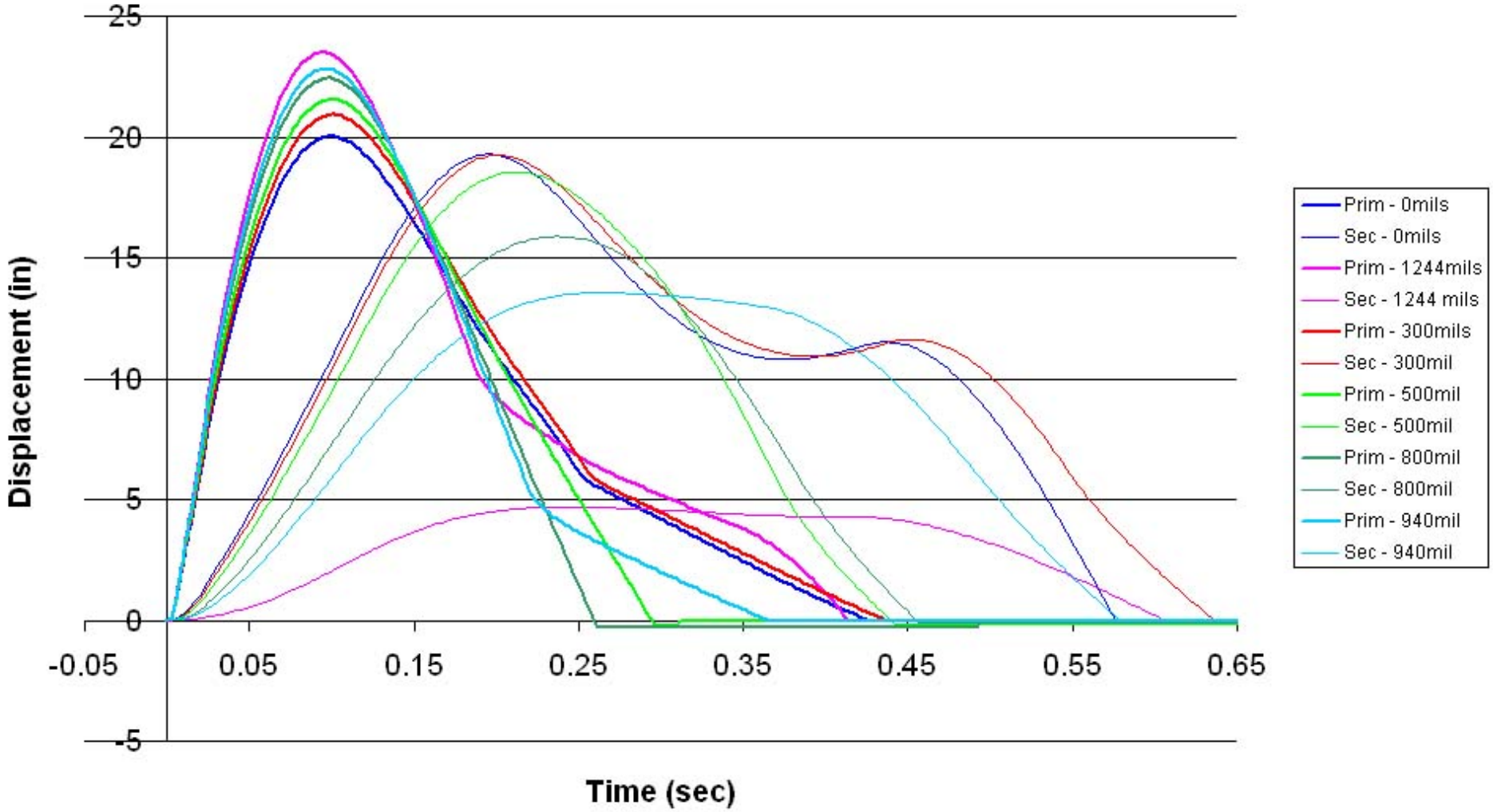
Concept Recoil Load



Concept Recoil Load



Concept Recoil Displacement



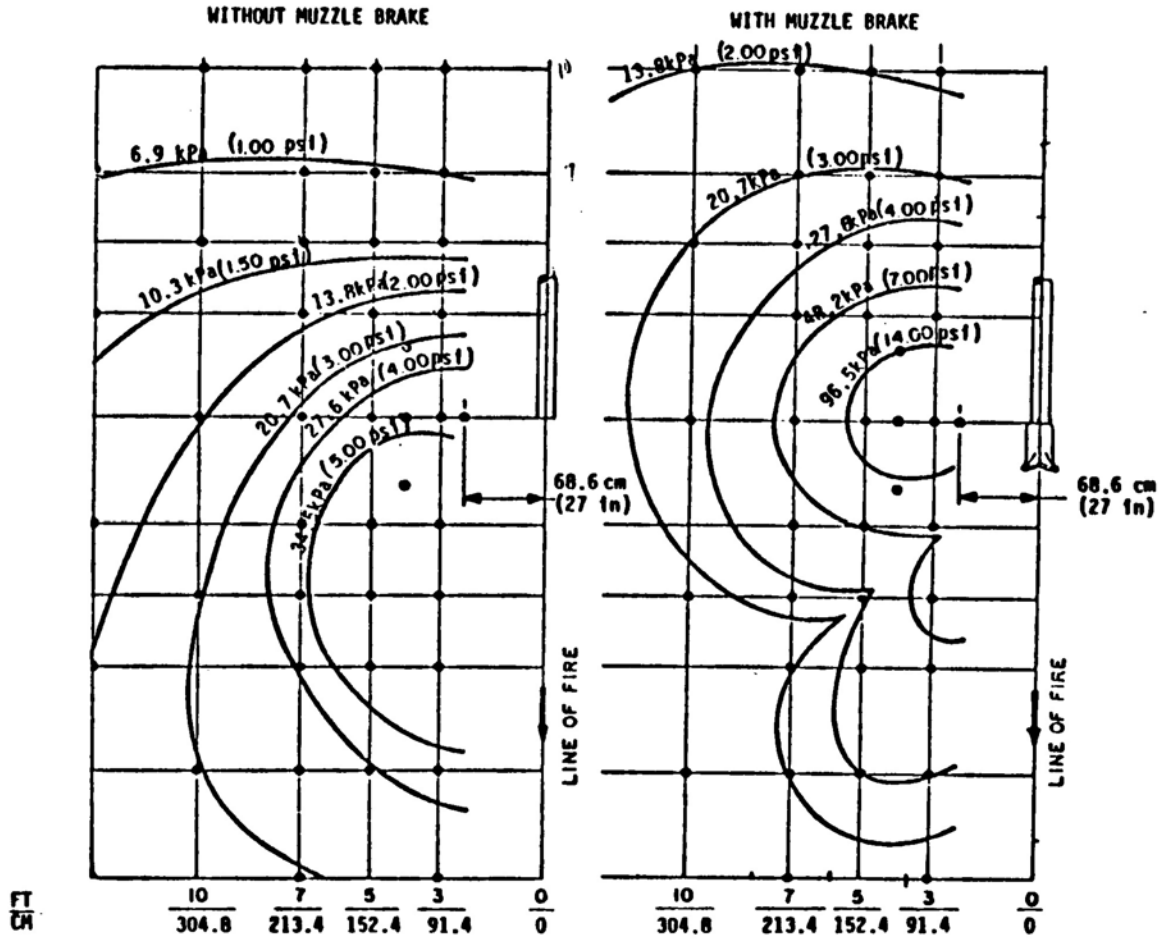
Dual Concept Compared to M119A2 Howitzer

Parameter	Dual Concept	M119A2
System Weight	3230 lb	4270 lb
Weapon Impulse	2908 LB-SEC	2349 lb-sec
Range M760/M913	14.5km/21km	14km/19.5km
Max Rate of Fire	10+	8
Muzzle Brake	None	Med. Single Baffle
Primary Recoil Max. (1244 mils)	29300 lbf	63200 lbf
Lateral ground reaction – Max (0 mils)	18600 lbf	24,800 lbf (est)

Dual Concept Compared to M119A2 Howitzer

Blast Overpressure

Dual Concept



M119A2

SIGNIFICANCE: A MEDIUM EFFICIENCY BRAKE WILL TRIPLE CREW AREA OVERPRESSURE

Dual Recoil Advantage Summary

- Multiple solutions to requirements/limitations
- Lower recoil loads
- Lower recoil cycle time
- Increased stability
  - Lower recoil torque
  - Lower lateral ground reaction
- Reduced cradle structure
- Reduced equilibration load/size

Dual Recoil Challenge Summary

- Elevation/elevation drive control
- Two recoil mechanisms not one – RAM

Brief Info

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