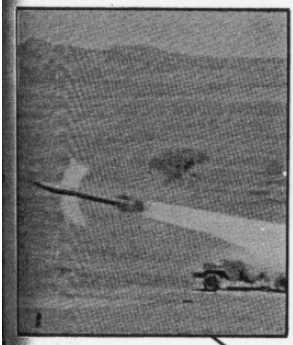
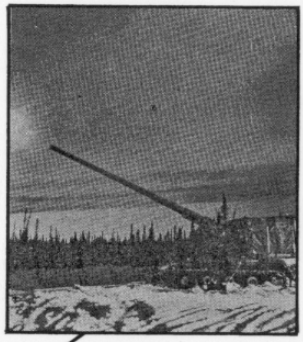
RTILLERY TRENDS

FA EQUIPMENT





FA ORGANIZATIONS

US ARMY
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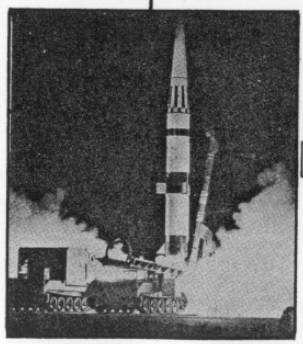

FA OPERATIONS

JULY
1963

Instructional Aid Number 27

INTRODUCTION

This issue of ARTILLERY TRENDS is special in nature, consisting of a ready reference consolidation of frequently-used field artillery data. It is not intended in this consolidation to replace other, more detailed reference books such as "Notes for the Battery Executive." Instead, we have extracted from such references and from pertinent field manuals that information which we feel is most useful in the **broad** analysis of the present day field artillery weapons system. Where research requires the **detailed** investigation of any particular component of the weapons system, or of any particular phase of its organization or operations, it is recommended that **all applicable publications** be consulted.

This represents a "first effort" on the part of the US Army Artillery and Missile School to supplement its resident and nonresident instruction with a handbook of this type. The material contained represents the best information available at the time of publication. All readers and users of this handbook are invited to forward information concerning changes or suggestions for improvement of content and format to:

Commandant
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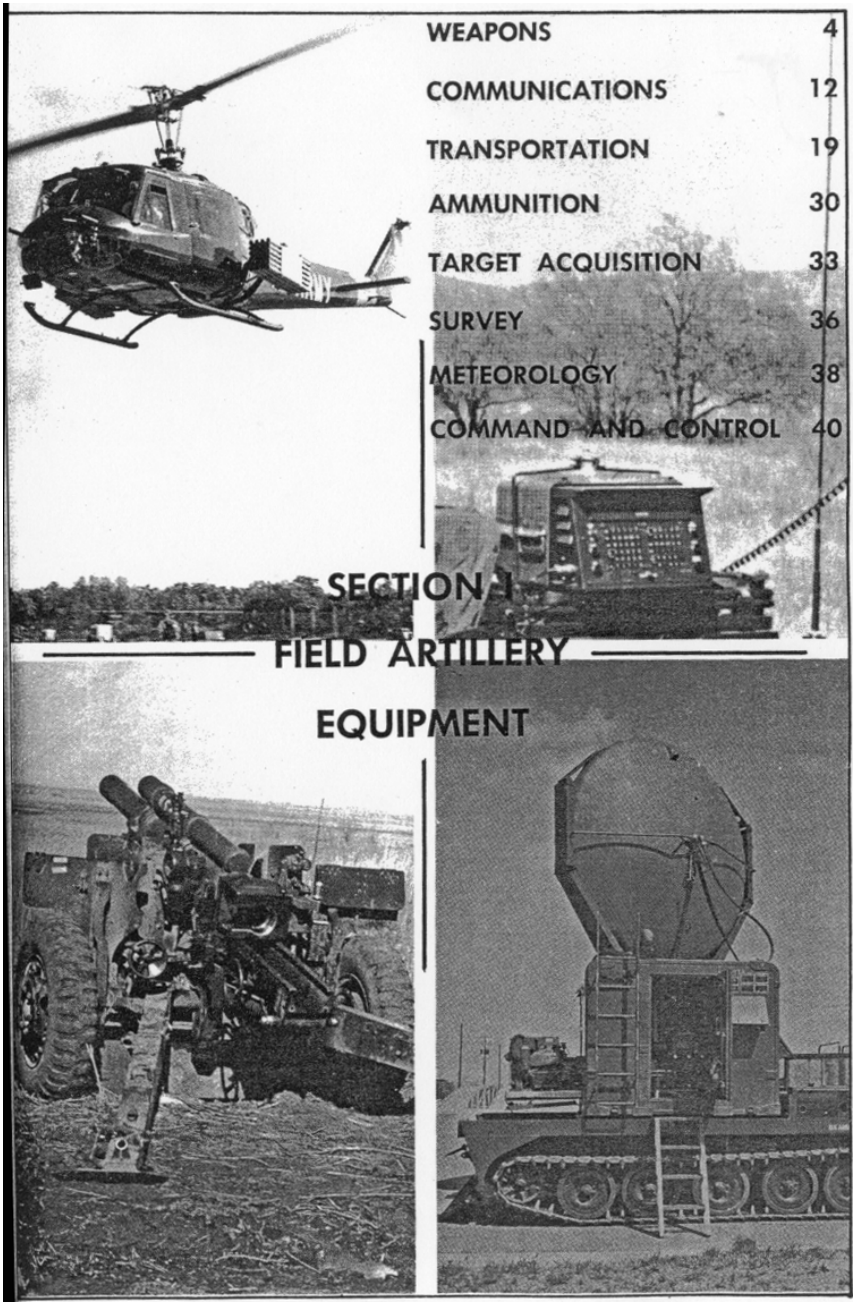
US Army Artillery and Missile School
Fort Sill, Oklahoma



SECTION I

FIELD ARTILLERY EQUIPMENT

TABLE I. CANNON/ROCKETS

Weapon	Max Range (meters)	Traveling Weight (pounds)	Air Transport-ability	Traverse Limits (mils)	Elevation Limits (mils)	Sustained Rate of Fire	Water Crossing Capability	Time to Emplace (min) (3)	Prime Mover	Using TOE	Figure Number
75-mm Pack How M1A1	8,800	1,440	Phase I	53 right and left of center	−106 to +800	2 1/2 rd per min	Floatable	7	1/4-ton truck; Helicopter; Packs	(4) 6-215E; 6-285E	1
105-mm How M101A1	11,000	4,988	Phase I	409 right and 400 left of center	−89 to +1,156	1 1/2 rd per min	Floatable	7	2 1/2-ton truck; Helicopter	6-155E; 6-185E; 6-215E; 6-405D; 6-705T	2
105-mm How XM124 (Aux) (SP)	11,000	5,945	Phase I	409 right and left of center	−89 to +1,156	1 1/2 rd per min	Floatable	7	2 1/2-ton truck; Helicopter; Auxiliary	(Not yet deter-mined)	3
105-mm How M52A1 (SP)	11,000	53,125	Phase III	1,066 right and left of center	−178 to +1,156	1 1/2 rd per min	Fordable (48 inches)	5	SP	6-37D; 6-315D; 6-345E; 6-385E	4
105-mm How XM102	11,000 15,100(1)	3,000	Phase I	6,400	−89 to +1,350	1 1/2 rd per min	Floatable	5	1/4-ton truck; 3/4-ton truck; Helicopter	(Not yet deter-mined)	5
105-mm How T195 (M108) (SP)	11,000 15,100(1)	46,221	Phase III	6,400	−70 to +1,330	1 1/2 rd per min	Amphibious	5	SP	6-37D; 6-315D; 6-345E; 6-385E	6
105-mm How XM104 (SP)	11,000 15,100(1)	8,600	Phase I	398 right and left of center	−89 to +1,342	1 1/2 rd per min	Amphibious	5	SP	(Not yet deter-mined)	7
155-mm How M123A1 (Aux) (SP)	14,600	14,710	Phase I	448 right and 418 left of center	0 to +1,156	1 rd per min	Fordable (30 inches)	12	5-ton truck; Auxiliary	6-225E	8
155-mm How M114A1	14,600	12,950	Phase I	448 right and 418 left of center	0 to +1,156	1 rd per min	Fordable (30 inches)	12	5-ton truck	6-165E; 6-425D	9
155-mm How M44A1 (SP)	14,600	62,500	Phase III	533 right and left of center	−89 to +1,156	1 rd per min	Fordable (42 inches)	9	SP	6-355E; 6-425D	10
155-mm How T196 (M109) (SP)	14,600 18,500(1)	54,461	Phase III	6,400	−20 to +1,333	1 rd per min	Amphibious	9	SP	6-355E; 6-425D	11

8-inch How M115	16,800	29,700	Phase III	533 right and left of center	−36 to +1,156	1 rd per 2 min	Fordable (60 inches)	20	10-ton truck	6-165E; 6-415E	12
8-inch How M55 (SP)	16,800	98,000	Phase III	533 right and left of center	−89 to +1,156	1 rd per 2 min	Fordable (48 inches)	12	SP	6-355E; 6-445E	13
8-inch How M110 (SP)	16,800	58,500	Phase III	533 right and left of center	−35 to +1,156	1 rd per 2 min	Fordable (42 inches)	12	SP	6-355E; 6-445E	14
175-mm Gun M107 (SP)	32,800	62,100	Phase III	533 right and left of center	−35 to +1,156	1 rd per 2 min	Fordable (42 inches)	12	SP	6-435D	15
280-mm Gun M66	28,500	166,630	N/A	6,400	0 to +978	1 rd per 4 min	Fordable (60 inches)	12	M249 and M250 transporters	6-535D	16
2.75-inch Folding Fin Aerial Rocket System XM3	3,000		Phase I	6,400	N/A	4 sec ripple of 48 rds	N/A	N/A	UH-1B Helicopter	6-725T	17
115-mm M91 Multiple Rocket Launcher	10,600	1,200	Phase I	178 right and left of center	+14 to +1,067	15 sec ripple of 45 rds (2)	Fordable (30 inches)	30	2 1/2-ton truck	(4) DS Bn TOE all Div Artys	18
Little John M51	20,400	2,233	Phase I	267 right and left of center	0 to +978	(2)	Fordable (21 inches)	10	1/4-ton truck; Helicopter	6-225E; 6-565T; 6-715T	19
Honest John M50	39,000	38,210	Phase II	267 right and left of center	0 to +1,244	(2)	Fordable (30 inches w/o kit; 60 inches w/kit)	15	M139 5-ton truck chassis M386	6-175E; 6-525D	20
Honest John M31	25,900	40,163	Phase II	267 right and left of center	0 to +1,244	(2)	Fordable (30 inches w/o kit; 60 inches w/kit)	15	M139 5-ton truck chassis M386	6-175E; 6-525D	21

(1) Use this value for extended range ammunition.
(2) Launcher is normally march ordered following each firing.
(3) The time for all pieces of one battery (except 280-mm Gun, Honest John, Little John, and 115-mm Multiple Rocket Launcher, in which cases times are for only one piece) to enter a minimally prepared position and report "Laid and ready to fire." Times given are approximate and subject to change, dependent upon weather, terrain, state of training, etc.
(4) Found within units of indicated TOE's when authorized by Theater of Operations Commander.

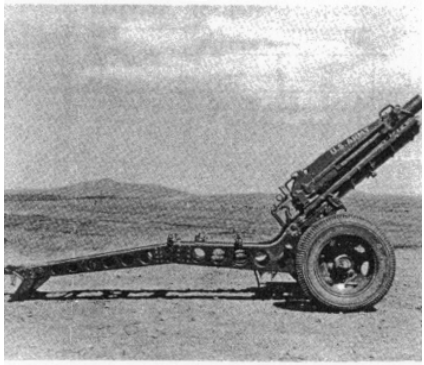


Figure 1. 75-mm How M1A1

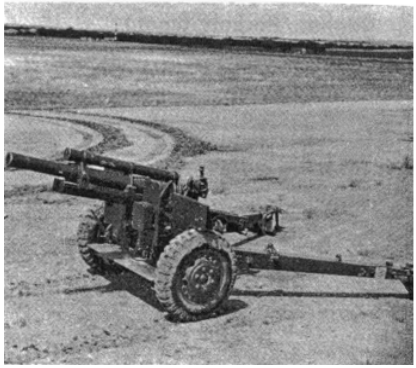


Figure 2. 105-mm How M1O1A1

Figure 3. 105-mm How XM124

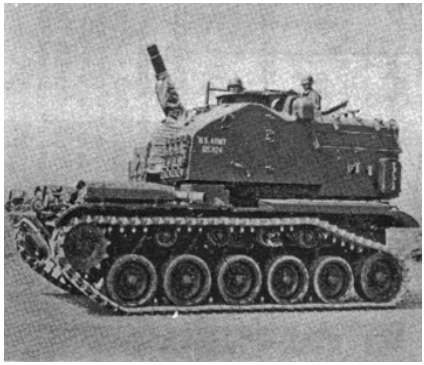


Figure 4. 105-mm How M52A1

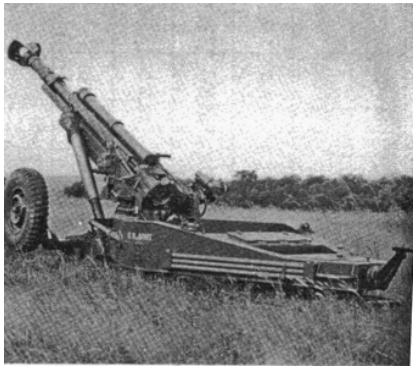


Figure 5. 105-mm How XM102

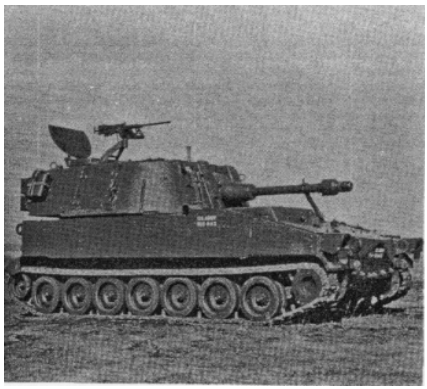


Figure 6. 105-mm How (M108)

Figure 7. 105-mm How XM104

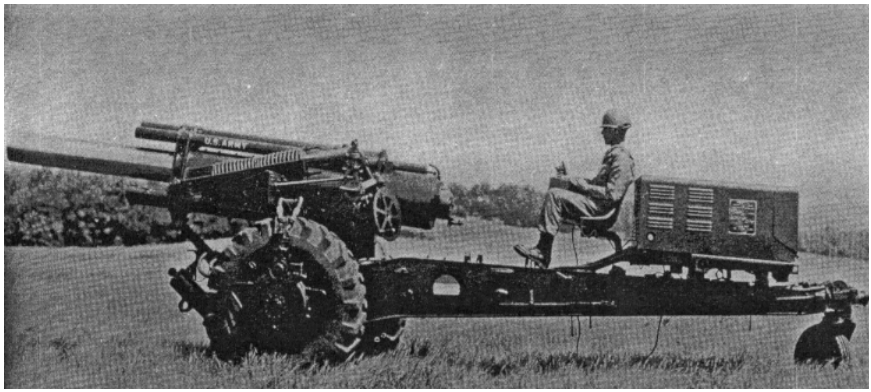


Figure 8. 155-mm How M123A1

Figure 9. 155-mm How M114A1

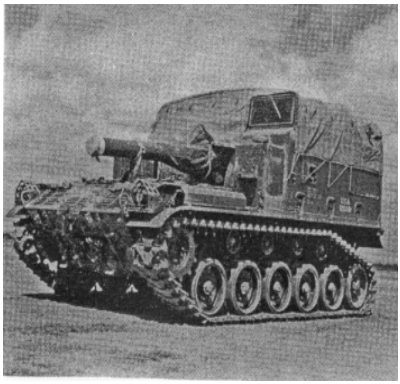


Figure 10. 155-mm How M44A1

Figure 1 1 . 155-mm How (M109)

Figure 12. 8-in How M115

Figure 13. 8-in How M55

Figure 14. 8-in How M110

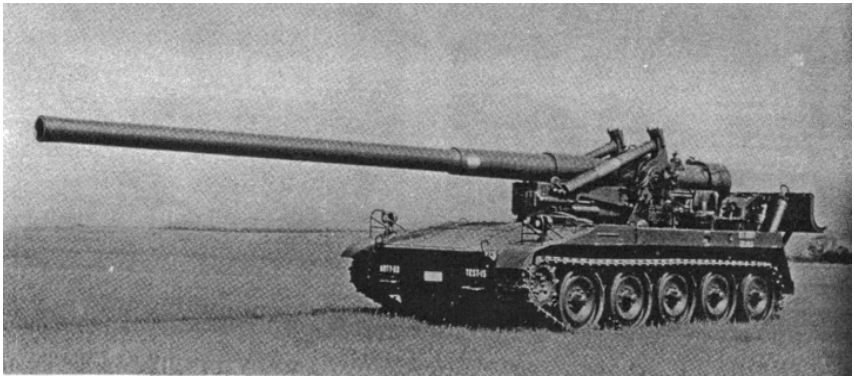


Figure 15. 175-mm Gun M107

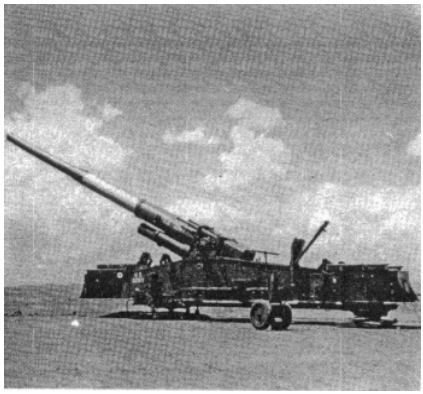


Figure 16. 280-mm Gun M66

Figure 17. 2.75-in Rocket

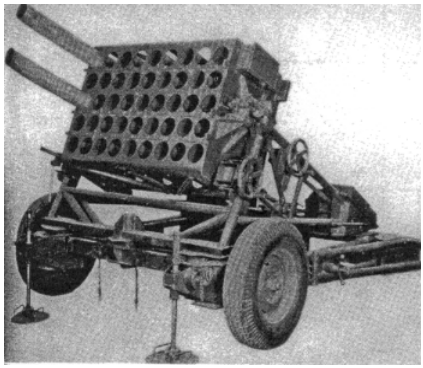


Figure 18. 115-mm M91

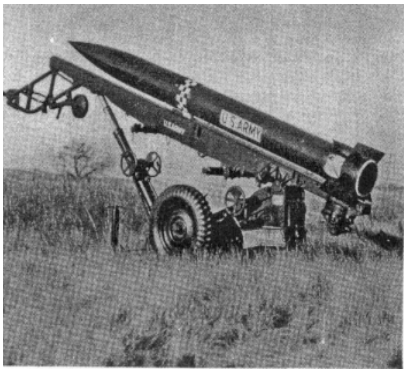


Figure 19. Little John M51

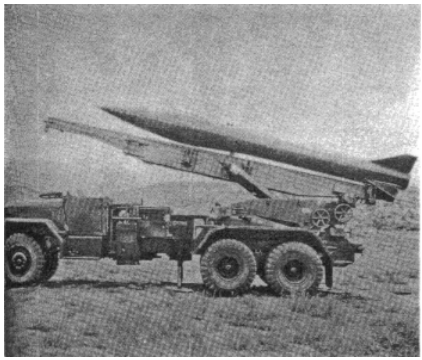


Figure 20. Honest John M50

Figure 21. Honest John M31

TABLE II. GUIDED MISSILES

Weapon (1)	Min and Max Range (approximate)	Water Fording Capability (inches)	Guidance	Propulsion	Mobility	Missile Prime Mover	Field of Fire	Launch Elevation (mils)	Missile			Figure Number
									Length (feet)	Weight (pounds)	Diameter (inches)	
Lacrosse	8.0 Km to 30.1 Km	24	Command	Solid Propellant	Air-Phase II; Veh-100%	2 1/2-ton truck, M398	266 mils right & left of center	+89 to +1,244	19.2	2,344	20.5	22
Corporal	50 Km to 130 Km	60	Command and Preset	Liquid Bi-Propellant	Air-Phase III; Veh-100%	Transporter erector M-2	Classified	+1,600	45	11,500	30	23
Sergeant	30 Km to 135 Km	30	Inertial	Solid Propellant	Air-Phase II; Veh-100%	5-ton tractor, M52	6,329 mils	+1,228	34	9,875	31	24
Redstone	93 Km to 324 Km	30	Inertial	Liquid Bi-Propellant	Air-Phase III; Veh-100%	3 each 5-ton tractor M52	6,400 mils	+1,600	69	62,100	70	25
Pershing	Classified	42	Inertial	Solid Propellant	Air-Phase II; Veh-100%; Helicopter	XM 474 tracked vehicle	6,400 mils	+1,600	34	10,275	40	26
Lance	Classified	Classified	Simplified Inertial	Storable Pre-packaged Liquid Propellant	Highly Mobile	See Artist's Concept Fig 27	Classified	Classified	Classified	Classified	Classified	27

(1) All systems listed have nuclear capability.

Figure 22. Lacrosse

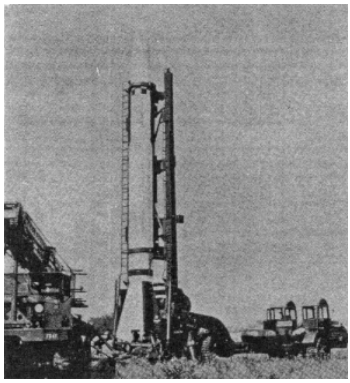


Figure 23. Corporal

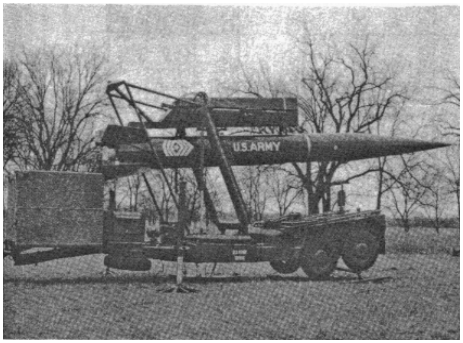


Figure 24. Sergeant

Figure 25. Redstone

Figure 26. Pershing

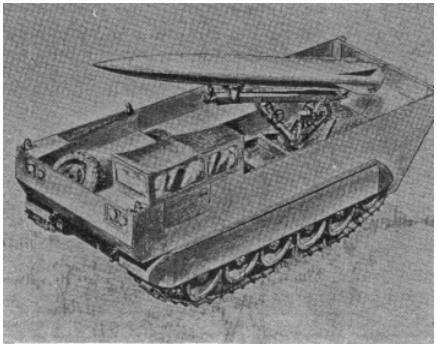


Figure 27. Lance

COMMUNICATIONS

FM Radios

TABLE III. FM RADIOS

Radio Set	Receiver/Transmitter	Frequency (mc)	Operation Modes	Range (km)	Channels Total	Channels Preset	Power Requirement	Reference Manual	Remarks	Figure Number
AN/GRC-3 -5 -7	R-108/RT-66/RT-70 R-109/RT-67/RT-70 R-110/RT-68/RT-70	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-284	3 presets on aux rcvr.; Set utilizes AM-65 AF Amplifier	
AN/GRC-4 -6 -8	RT-66/RT-70 RT-67/RT-70 RT-68/RT-70	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-284	Set utilizes AM-65 AF Amplifier	
AN/VRC-8 -9 -10	RT-66 RT-67 RT-68	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-286		28
AN/VRC-13 -14 -15	RT-66 RT-67 RT-68	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-291	Set utilizes AM-65 AF Amplifier	
AN/VRC-16 -17 -18	R-108/RT-66 R-109/RT-67 R-110/RT-68	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-611	3 presets on aux rcvr.	
AN/VRC-20 -21 -22	R-108/RT-66 R-109/RT-67 R-110/RT-68	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-642	3 presets on aux rcvr.; Set utilizes AM-65 AF Amplifier	
AN/VRQ-1 -2 -3	RT-66/RT-66 RT-67/RT-67 RT-68	20-27.9 27-38.9 38-54.9	Voice	16-24	80 120 170	2 2 2	12/24v DC	TM 11-287	Provide retransmission capability	30
AN/VRC-7	RT-70	47-58.4	Voice	1.6	115	2	12/24v DC	TM 11-285	Common to armor, artillery and infantry.	
AN/PRC-6 -8 -9 -10	RT-196/PRC-6 RT-174/PRC-8 RT-175/PRC-9 RT-176/PRC-10	47.0-55.4 20-27.9 27-38.9 38-54.9	Voice	1.6 8 8 8	 80 120 170	1	BA-270; BA-279 or 12/24v DC w/AM-598	TM 11-296 TM 11-4065 TM 11-4065 TM 11-4065		
AN/TRC-20	RT-111/TRC-20	27-38.9	Voice	8		2	24v DC	TM 11-615	Special purpose; Used in target acquisition bn.	

AM Radios

TABLE IV. AM RADIOS

Radio Set	Receiver/Transmitter	Frequency Range (mc)	Operation Modes	Range (km)	No. Preset Channels	Power Requirement	Reference Manual	Remarks	Figure Number
AN/ARC-27	RT-178/ARC-27	225-399.9	Voice	Line of Sight	18	27.5v DC 16 amps	TM 11-5821-225-10	Replaced by AN/VRC-24 for Army use.	
AN/GRC-19	R-392/URR T-195/GRC-19	0.5-32 1.5-20	Voice CW	80	7 (xmtr)	28.5v DC 44 amps	TM 11-5820-295-10		29
AN/GRC-26 (A,B,C)	R-388/URR BC-610 (A,B,C)	2-18	Voice CW RATT	160 Voice 400 CW & RATT		115v AC 50-60 cps 100 watts	TM 11-5820-202-10		
AN/GRC-46	R-392/URR T-195/GRC-19	0.5-32 1.5-20	Voice CW RATT	80	7 (xmtr)	27.5v DC 100 amps	TM 11-5815-204-10	Mounted in electronic shelter S-144/G.	31
AN/GRR-5	R-174/URR (receiver only)	1.5-18	Voice CW MCW		10	6,12,24v DC w/PP-308; 115v AC; or dry battery	TM 11-295		
AN/URC-4	RT-159/URC-4	Fixed on 1 freq 120-130, harmonic 240-260	Voice MCW Tone		1	BA-1264/U	TM 11-510	USAF radio used in emergency rescue situations; Dropped in survival kit.	
AN/VRC-24	RT-323/VRC-24	225-399.9	Voice	56; line of sight	19	24v DC	TM 11-5820-222-10	For ground-to-air communications; Re-trans for AN/GRC-3 thru 8 series.	32
AN/VRC-29								Same as AN/GRC-46 less Elec Shelter S-144/G.	
AN/VRC-34	RT-77/GRC-9	2-12	Voice CW MCW	16-48		6 or 12v DC w/DY-88/GRC-9; 24v DC w/DY-105/GRC-9	TM 11-263	Vehicular mounted, version of AN/GRC-9, only.	

TABLE V. AM/FM RADIOS

AM/FM Radios

Radio Set	Components	Frequency Range (mc)	Modulation	Operation Modes	Range (km)	Channels Total	Channels Preset	Power Requirement	Reference Manual	Remarks
AN/VRC-30	AN/ARC-27	225-399.9	Amplitude	Voice	Line of Sight	1750	18	27.5v DC	TB SIG 283	For close liaison between ground and air; For off-vehicle use. Provides re-transmission capability; **Optional:** To meet special frequency requirements.
	AN/PRC-9	27-38.9	Frequency	Voice	8	120		BA-279/U	TB SIG 283	
	AN/VRC-14	27-38.9	Frequency	Voice	16-24	120	2	12/24v DC	TB SIG 283	
	AN/TRC-7	100-156	Amplitude	Voice	Line of Sight	561	2	BA-70	TB SIG 283	
AN/VRC-35									TB SIG 283 and TM 11-5820-222-10	Replaces AN/VRC-30; AN/ARC-27 replaced by AN/VRC-24; Other items are unchanged.
AN/VRC-38	AN/GRC-19	1.5-20	Amplitude	Voice	80		7	28.5v DC	TM 11-5820-295-10; TM 11-286	Used as relay station for AN/VRC-30 or AN/VRC-35.
	AN/VRC-9	27-38.9	Frequency	CW	16-24		2	12/24v DC		
				Voice						

TABLE VI. RADIO TERMINAL SETS

Terminal Sets

Radio Set	Receiver Transmitter	Frequency Range (mc)	Modulation	Operation Modes	Range (km)	Channels Total	Channels Preset	Power Requirement	Reference Manual	Remarks	Figure Number
AN/TRC-80	AM3303 AM3308	4400-5000	Frequency	Voice RATT	115-160	333	2(R) 1(T)	120/208v AC 3-phase 400 cycle	TM 11-5820-469-10	Peculiar to Pershing Msl Battalion	33

TABLE VII. ANTENNA EQUIPMENT

Antenna Equipment

AN/GRA-12	A portable half wave antenna (center fed Hertz) assembly designed for the transmission and reception of radio signals between 1.5 and 18 mc. It may be used with sets having power output less than 500 watts and a characteristic impedance of 52 ohms.
AN/GRA-50	A lightweight doublet antenna for use with AM radio sets with a power output not exceeding 100 watts.
RC-292	An elevated, wide band modified ground plane antenna designed to operate with and extend the range of FM radios with frequency range of 20 mc to 70 mc.
AT-791	An elevated, omnidirectional, half wave, whip antenna designed to extend the range of the new family of FM radios.
AT-984	A directional, long wire antenna used to extend the range of tactical FM radio sets.

TABLE VIII. NEW FM RADIOS

Radio Set	Major Components	Frequency Range (mc)	Operation Modes	Range (km)	Channels Total	Channels Preset	Power Requirement	Reference Manual	Remarks	Figure Number
AN/PRC-25	RT 505/PRC 25	30.00-75.95	Voice	8	920	2	Dry battery BA368/U	TM 11-5820-398-10	Replaces PRC-8,9,10 for man pack operation only.	34
AN/GRC-125	RT 505/PRC 25	30.00-75.95	Voice	8	920	2	BA368/U Dry battery or 24v DC amplifier power supply	TM 11-5820-498-10	Replaces PRC-8,9,10 for man pack or vehicular operations	
AN/VRC-53	RT 505/PRC 25	30.00-75.95	Voice	8	920	2	24v DC amplifier power supply	TM 11-5820-498-10	Replaces PRC-8,9,10 for veh opns only	
AN/VRC-43	RT-246/VRC-12	30.00-75.95	Voice	24-32	920	10	24v DC	TM 11-5820-401-10	Replaces VRC-8,9,10; **(1)**	
AN/VRC-12	RT-246/VRC-12 R-442/VRC-12	30.00-75.95	Voice	24-32	920	10	24v DC	TM 11-5820-401-10	Replaces VRC-16,17,18; **(1)** and **(3)**	36
AN/VRC-44	RT-246/VRC-12 2 ea R-442/VRC-12	30.00-75.95	Voice	24-32	920	10	24v DC	TM 11-5820-401-10	Replaces GRC-3,5,7; **(1)**	
AN/VRC-45	2 ea RT-246/VRC-12	30.00-75.95	Voice	24-32	920	10	24v DC	TM 11-5820-401-10	Replaces VRQ-1,2,3; **(1)**	
AN/VRC-46	RT-524/VRC-12	30.00-75.95	Voice	24-32	920		24v DC	TM 11-5820-401-10	Replaces VRC-8,9,10; **(2)**	35
AN/VRC-47	RT-524/VRC-12 R-442/VRC-12	30.00-75.95	Voice	24-32	920		24v DC	TM 11-5820-401-10	Replaces VRC-16,17,18; **(2)**	
AN/VRC-48	RT-524/VRC-12 2 ea R-442/VRC-12	30.00-75.95	Voice	24-32	920		24v DC	TM 11-5820-401-10	Replaces GRC-3,5,7; **(2)**	
AN/VRC-49	2 ea RT-524/VRC-12	30.00-75.95	Voice	24-32	920		24v DC	TM 11-5820-401-10	Replaces VRQ-1,2,3; **(2)**	

(1) Has automatic pushbutton tuning.
(2) The RT-524 is the same as the RT-246 except the RT-524 has no automatic tuning or presets, but has a built-in speaker.
(3) The AN/VRC-12 family were developed to replace the AN/GRC-3 through 8 series, and are now the "Standard A" FM field radios.

TABLE IX.REMOTE CONTROL DEVICES

Nomenclature	Purpose	Distance Limitation	Power Requirement	Reference Manual
Control Group AN/GRA-6	(1) For controlling and operating compatible radio sets (current FM series) from a distance. (2) For two-way telephone communications between remote and local operators. (3) For local control of radio sets. (4) Provides on/off power control from a distance.	2 miles w/WD-1/TT	4 BA-30 1 BA-414/U	TM 11-5038
Radio Set Control Group AN/GRA-39	(1) For controlling and operating compatible radio sets (VRC-12 series) from a distance. (2) For two-way telephone communications between remote and local operators. (3) Provides local control of one radio set.	2 miles w/WD-1/TT	12 BA-30	TM 11-5820-477-12
Radio Set Control Group AN/GSA-7	(1) Provides an electronic switching device for use in integrated wire-radio systems. (2) To connect radios with local battery telephone equipment on a push-to-talk basis. (3) To interconnect two push-to-talk radio sets for automatic relay (two sets required). (4) Provide operator facilities for listening, signalling or talking to either or both ends of the circuit.	Governed by limitations imposed by wire system and radio net the equipment is integrating	22-30v DC; 115v or 230v AC; self-contained requiring only a power source	TM 11-5135-15
Radio Set Control Group OA-1754/GRC	(1) To turn transmitter of GRC-19 or GRC-46 on or off. (2) Provide selection of type of operation. (3) To tune to desired preset frequency (transmitter only). (4) Indicates when transmitter is ready to transmit.	75 feet Imposed by special purpose cable	Furnished by set to which the equipment is connected.	TM 11-806 See Chapter 5, Transmitter Control C-822/GRC-19.

TABLE X. SWITCHBOARDS

Switchboards	Nr of lines accommodated	Type of Operation	Power Requirement	Major Components	Remarks	Figure Number
SB-993/GT	6	Manual, local battery	None	1 ea MT-2156/GT; 7 ea U-184/GT	Uses visual signalling	
SB-86/P	30 including 2 civilian trunks	Manual, local battery, or common battery signalling	4 ea BA-30 10 ea BA-200/U	1 ea SB-248/P; 1 ea TA-207/P; 1 ea PP-990/G	Cannot be used directly for radio wire integration; for 30 line increase add 1 TA-207	
SB-22/PT	12	Manual, local battery with magneto signalling	4 ea BA-30	1 ea SB-22/PT; 1 ea MX-230A/PT	MX-230A/PT contains 3 spare line packs	37
SB-223/GR	12 micro lines; 6 record chan; 4 tele lines	Manual, no ringing on switchboard	BB-53 or other 12v DC source	SB-223/GR	For use with sound micro bases in tgt acq battalion	

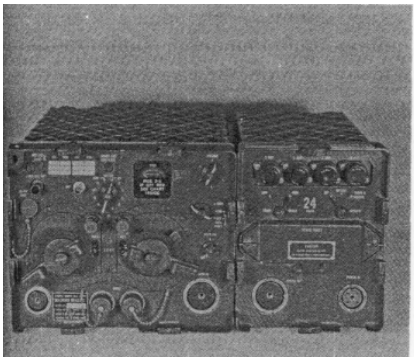


Figure 28. AN/VRC-9

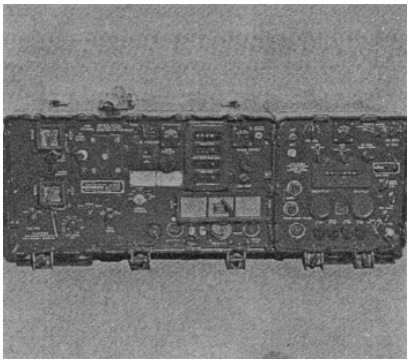


Figure 29. AN/GRC-19

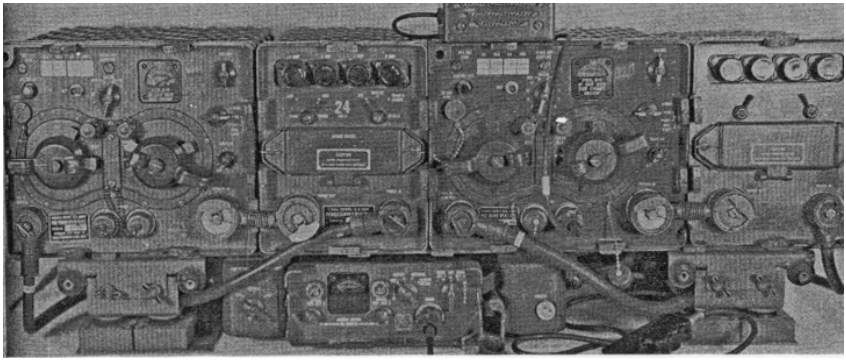


Figure 30. AN/VRQ-2

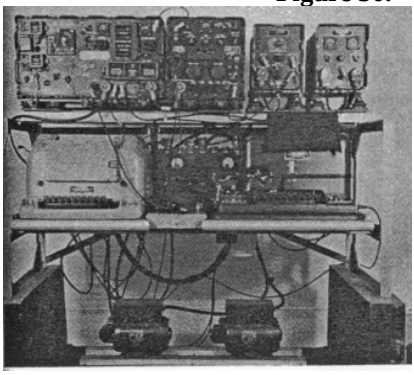


Figure 31. AN/GRC-46

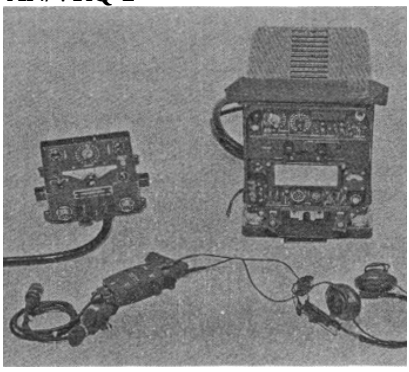


Figure 32. AN/VRC-24

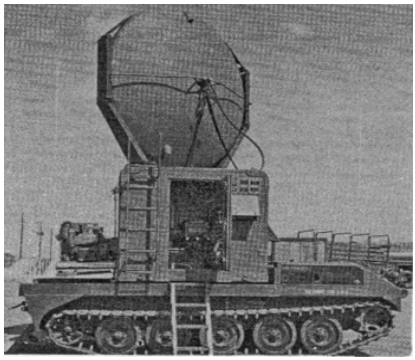


Figure 33. AN/TRC-80

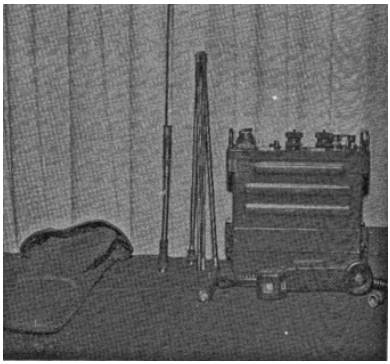


Figure 34. AN/PRC-25

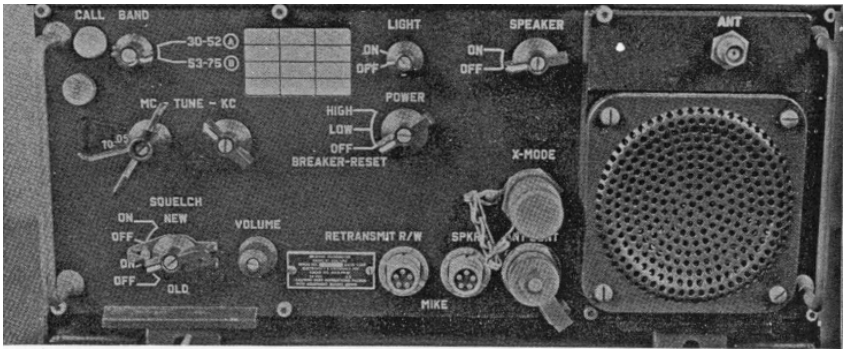


Figure 35. AN/VRC-46

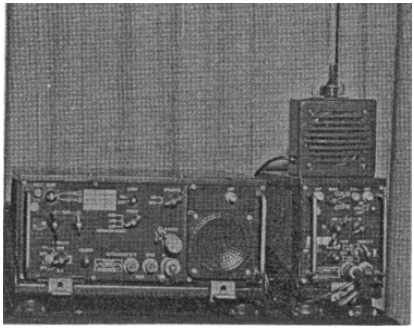


Figure 36. AN/VRC-12

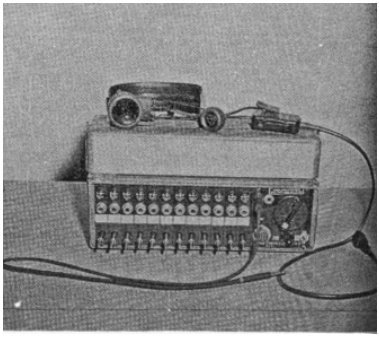


Figure 37. SB-22/PT

TABLE XI. FIELD ARTILLERY SURFACE VEHICLES

A. WHEELED VEHICLES

Nomenclature	Classification	Purpose	Weight (pounds)		Max Allowable Speed (mph)	Cruising Range (miles)	Fuel Capacity and type (gal)	Water Crossing Capability (inches)		Air Transportability (7)		Using TOE (1)		Figure Number
			Net	Payload (highway)				w/kit	w/o kit	Ph	Aircraft	ROAD and Sep units	Air Assault	
1/4-ton M38A1	B	Utility	2,665	1,200	55	280	17 gas	70	37.5	I	C-130A	(2)	(2)	
1/4-ton M151E1	A	Utility	2,273	1,200	66	300	17.7 gas	60	21	I	C-130A	(2)	(2)	38
1/4-ton M170	B	Ambulance	2,963	1,200	Not Governed	300	20 gas	70	15	I	C-130A	525D (6)		
3/4-ton M43	B	Ambulance	7,150	1,400	55	225	25 gas	84	42	I	C-130A	(2) Except 558D (6)		
3/4-ton M37B1	A	Cargo Truck	5,700	2,000	55	225	24 gas	84	42	I	C-130A	(2)	702T; 725T	39
1/2-ton M274	A	Carrier, Lt Weapons	795	1,000	25	107.5	8 gas	N/A	18	I	C-130A		May be included	
2 1/2-ton M135	B	Cargo Truck	12,330	10,000	58	350	56 gas	78	30	I	C-130A	(2) Except 500T (6)	702T; 725T	
2 1/2-ton M34	B	Cargo Truck	11,775	10,350	58	350	50 gas	72	30	I	C-130A	(2) Except 500T (6)	702T; 725T	
2 1/2-ton M35	A	Cargo Truck	12,465	10,350	58	300	50 gas	72	30	I	C-130A	(2) Except 500T	702T; 725T	40
2 1/2-ton M36	A	Cargo Truck	14,230	10,000	58	300	50 gas	72	30	I	C-130A			
2 1/2-ton M211	B	Cargo Truck	13,170	10,000	55	300	56 gas	78	30	I	C-130A	(2) Except 500T (6)		
2 1/2-ton M49C	A	Tanker Gas with Segregator Kit	13,955	8,000 (1,200 gal)	58	350	50 gas	72	40	I	C-130A	100E; 201E; 300E; 401E; 435D; 545E; 615T	702T; 725T	
2 1/2-ton M217	B	Fuel Servicer w/ Segregator Kit	14,805	8,000 (1,200 gal)	55	300	56 gas	80	30	I	C-130A	100E; 201E; 300E; 401E; 435D; 545E; 615T (6)	702T; 725T	
2 1/2-ton M50	A	Tanker, Water	15,038	8,500 (1,000 gal)	58	350	50 gas	72	40	I	C-130A	545E		

Wheeled Vehicles (Cont)

Nomenclature	Classification	Purpose	Weight (pounds) Net	Weight (pounds) Payload (highway)	Max Allowable Speed (mph)	Cruising Range (miles)	Fuel Capacity and Type (gal)	Water Crossing Capability (inches) w/kit	Water Crossing Capability (inches) w/o kit	Air Transportability (7) Ph	Air Transportability (7) Aircraft	Using TOE (1) ROAD & Sep Units	Figure Number
2 1/2-ton M222	B	Tanker, Water	14,100	8,500 (1,000 gal)	55	300	56 gas	80	30	I	C-130A	545E (6)	
2 1/2-ton M221	B	Truck Tractor	11,695	12,000	55	300	56 gas	72	30	I	C-130A	555T (6)	
2 1/2-ton M275	A	Truck Tractor	11,179	12,000	58	350	50 gas	72	30	I	C-130A	555T	
2 1/2-ton M109	B	Shop Van	15,231	5,350	35-50	350	50 gas	72	30	III	C-124A	(2) Except 175E 225E; 401E; 435D; 558D; 585T; 615T (6)	41
2 1/2-ton M220	A	Shop Van	15,085	7,500	55	300	56 gas	80	30	III	C-124A	Same as above	
2 1/2-ton M108	A	Wrecker, Crane	19,785	3,850	62	350	50 gas	72	40	I	C-130A	585T	
2 1/2-ton M60	A	Wrecker, Light	23,960	3,500	60	300	50 gas	72	40	I	C-130A	215E; 225E; 565T	
2 1/2-ton M35A1	A	Cargo Truck	13,443	10,000	58	350	50 gas diesel, or kerosene	N/A	30	I	C-130A	To replace certain 2 1/2-ton cargo trucks.	
2 1/2-ton M135	B	Searchlight Set	12,330	6,695	58	350	56 gas	78	30	I	C-130A	558D (6)	
2 1/2-ton M292	A	Expansible Bulky Equip Office	20,609	5,000	58	300	50 gas	72	40	III	C-133A	May replace M109 van in some units	
5-ton M41	B	Cargo Truck	19,119	15,000	59	280	78 gas	78	30	I	C-130A	(2) Except 155E; 185E; 201E; 215E; 558D; 565T; 575D(6)	
5-ton M54	A	Cargo Truck	19,580	20,350	52.6	214	78 gas	78	30	I	C-130A	(2) Except 155E; 185E; 201E; 215E; 225E; 558D; 565T; 575D	
5-ton M55	A	Cargo Truck	24,064	20,000	52.6	214	78 gas	78	30	I	C-130A	(2) Except 155E; 185E; 565T	
5-ton M52	A	Truck Tractor	18,813	25,000	52	300	78 gas	78	30	III	C-124A	525D; 535D; 545E; 555T; 615T	
5-ton M246	A	Tractor Wrecker	32,830 w/winch	16,000	52	229	78 gas	78	30	III	C-124A	545E	
5-ton M62	B	Wrecker	33,675	12,000	52.6	214	78 gas	78	30	III	C-124A	(2) Except 215E; 225E; 565T (6)	42

5-ton M543	A	Wrecker	34,440	12,000	52.6	217	78 gas	78	30	III	C-124A	(2) Except 215E; 225E; 565T	
10-ton M125	B	Cargo Truck	30,000	30,000	42	330	166 gas	78	30	III	C-124A	100E; 165E; 415D (6)	43
10-ton M123	B	Tractor	32,250	35,000	42	300	166 gas	78	30	III	C-124A	635D (6)	
M250	B	Gunlifting Truck, Hv	35,910	45,330	30	165	140 gas	N/A	60	III	C-133A	535D (6)	44
M249	B	Gunlifting Truck, Hv	37,950	51,675	30	165	140 gas	N/A	60	III	C-133A	535D (6)	

B. TRACK LAYING RECOVERY VEHICLES

M74	B	Recovery Vehicle	(4) 93,750	(5) Lift 50,000; Tow 90,000	21	100	168 gas	72	36	III	C-133A	225D; 300E; 345E; 355E; 415D; 425D; 535D (6)	
M88	A	Recovery Vehicle	(4) 112,000	(5) Lift 50,000; Tow 90,000	30	222	445 gas	72	64			to replace M74	
M578	A	Recovery Vehicle	(4) 54,000	(5) Lift 30,000; Tow 60,000	34	450	320 diesel	72	42	III	C-133A	435D; 615T to replace M88	45

C. ARMORED PERSONNEL, CARGO, AND EQUIPMENT CARRIERS

M59	B	Armored Personnel Carrier	39,504	3,096	32	120	136.5 gas	Am-phib	N/A	III	C-133A	345E; 355E; 435D (6)	
M113	A	Armored Personnel Carrier	20,000	3,860	40	200	80 gas	Am-phib	N/A	I	C-130A	345E; 355E; 435D	
M116E1	A	Cargo Carrier	7,880	3,000	40	200-300	65 gas	Am-phib	N/A	I	C-130A	Possible prime mover for light artillery	

D. GUN, SELF-PROPELLED

M107 175-mm	A	SP, Gun	62,100	N/A	34	450	300 diesel	N/A	42	III	C-133A	435D	15

E. HOWITZER, SELF-PROPELLED AND AUXILIARY PROPELLED

Nomenclature	Classification	Purpose	Weight (pounds) SEE Pg 4 Net	Payload (highway)	Max Allowable Speed (mph)	Cruising Range (miles)	Fuel Capacity and Type (gal)	Water Crossing Capability (inches) w/kit	w/o kit	Air Transportability (7) Ph	Type	Using TOE (1) ROAD and Sep Units	Figure Number
M55 8-inch	A	Heavy SP Howitzer	98,000	N/A	30	160	380 gas	72	48			355E; 445E	13
M52A1 105-mm	B	Light SP Howitzer	53,125	N/A	42	100	179 gas	72	48	III	C-133A	37D; 315E; (6) 345E; 385E	4
M44A1 155-mm	B	Medium SP Howitzer	62,500	N/A	35	76	150 gas	72	42	III	C-133A	425D (6)	10
T195E1 (M108) 105-mm	LP (3)	SP Howitzer	46,221	N/A	35	220	130 diesel	Amphib	42	III	C-133A	Scheduled to replace M52A1	6
T196E1 (M109) 155-mm	LP (3)	SP Howitzer	54,461	N/A	35	220	130 diesel	Amphib	42	III	C-133A	Scheduled to replace M44A1	11
M110 8-inch	A	SP Howitzer	58,500	N/A	34	450	300 diesel	72	42	III	C-133A	355E; 445E	14
M123A1 155-mm	A	AP-Abn and Amph Op	14,710	N/A	6	6.5	3.5 gas	N/A	30	I	C-130A	225E	8

F. VEHICLES PECULIAR TO ROCKET AND MISSILE UNITS

XM474E2	LP (3)	Msl Equipment Carrier, Pershing	11,900	12,000	38	200	85 gas		42	II	C-123B	615T	46
Launcher Sergeant Msl (Trailer)	A	Launcher, Sergeant	16,800	N/A	See 5-ton M52, truck tractor on page 20.			N/A	30	II	C-130A	555T	47
OMTS or FMTS, Sergeant (Trailer)	A	Organizational Maint Test Station or Field Maint Test Sta.	15,000	N/A	See 2 1/2-ton M275 truck tractor on page 20.			N/A	30	II	C-130A	555T	48
3/4-ton M506		H_2O_2 Servicer, Redstone	7,197	1,066	55	225	24 gas	84	42	III	C-133A	635E	
M572 2 1/2-ton M36	A	Rkt Hdlg Unit, LJ Rkt	15,155	10,000	58	300	50 gas	72	30	I	C-130A	225E; 565T	

Rocket/Missile Vehicles (cont.)

2 1/2-ton AN/MSE-1	B	Firing Sta GM Corporal	10,665	8,455	62	350	50 gas	72	40	III	C-133A	545E (6)	
2 1/2-ton M398	B	Lchr, GM, Lacrosse	16,000	2,344	58	300	50 gas		40	III	C-133A	585T (6)	22
2 1/2-ton M185	B	Repair Shop, Trk Mtd, Pershing & Redstone	15,646	N/A	30-50	350	50 gas	72	30	III	C-133A	615T (6)	
2 1/2-ton M478	B	Erector Servicer, Redstone	16,420	4,850	58	350	50 gas	72	40	III	C-133A	635E (6)	
M289, 5-ton chassis M139D	B	Lchr Rkt, HJ	41,800	5,913	59	220	70 gas	78	30	III	C-133A	175E; 525D (6)	
M386, 5-ton chassis M139	A	Launcher, HJ	34,250	5,913	59	224	70 gas	60	30	II	C-130A	175E; 525D	
M46, 5-ton chassis M55		Heating and Tie Down Unit, HJ Rkt	24,264	20,000	52.6	214	78 gas	78	30	II	C-130A	175E; 525D	
M301, 5-ton chassis M41		Compressor, Corporal & Redstone	32,019	N/A	59	280	78 gas	78	30	III	C-133A	545E; 635E	
M350, 5-ton chassis M39	B	Air Servicer, Corporal	32,944	N/A	59	248	78 gas	78	30	III	C-133A	545E (6)	
AN/MSM-4, 5-ton chassis M39	B	Msl Test Sta, Corporal	29,280	N/A	60	248	78 gas	78	30	III	C-133A	545E (6)	
M280, 5-ton chassis M39	LP (3)	Servicing Platform, Corporal	24,462	600	59	248	78 gas	78	30	III	C-133A	545E	
M2 Erector	B	Transport & Erector, Corporal	59,510	11,650	30	165	235 gas		60	III	C-133A	545E (6)	23

(1) The prefix "6-" has been omitted from designations.
(2) All artillery battalion TOE's include at least one model of this type of vehicle, unless an exception is noted.
(3) Type classified for limited production only. Listed in indicated TOE's as a developmental item.
(4) Includes crew and equipment.
(5) Tow capabilities are based on main winch and bare drum.
(6) Standard B equipment is in process of replacement by Standard A equipment and may or may not be on hand in units of the TOE's indicated.
(7) Based upon definitions contained in AR 705-35, 3 April 1963. For certain equipment, lesser capabilities than are individually attainable are indicated, to conform to those of other major items of the systems concerned. All data shown are subject to modification, in accordance with local policies and other conditions.

Figure 38. 1/4-ton M151E1

Figure 39. 3/4-ton M37B1

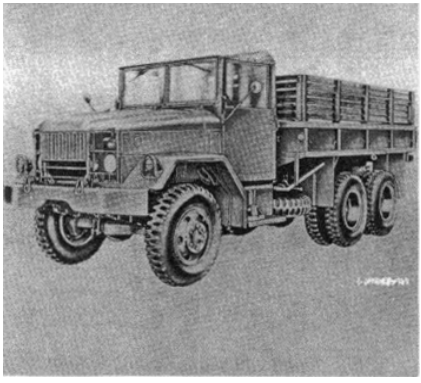


Figure 40. 2 1/2-ton M35

Figure 41. 2 1/2-ton M109

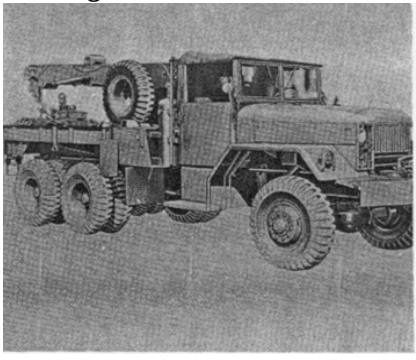


Figure 42. 5-ton M62

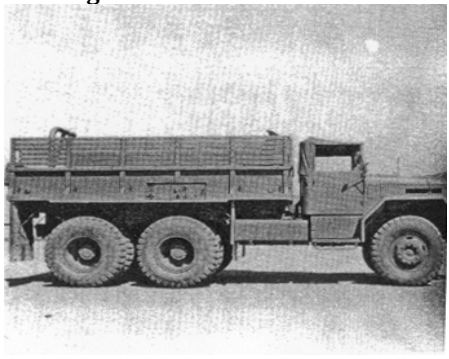


Figure 43. 10-ton M125

Figure 44. M250

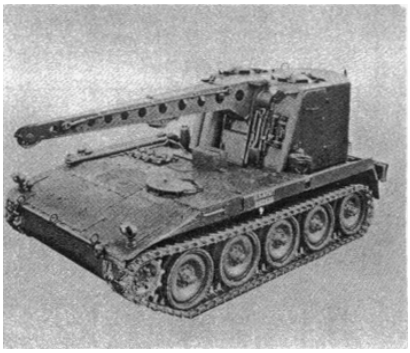


Figure 45. M578

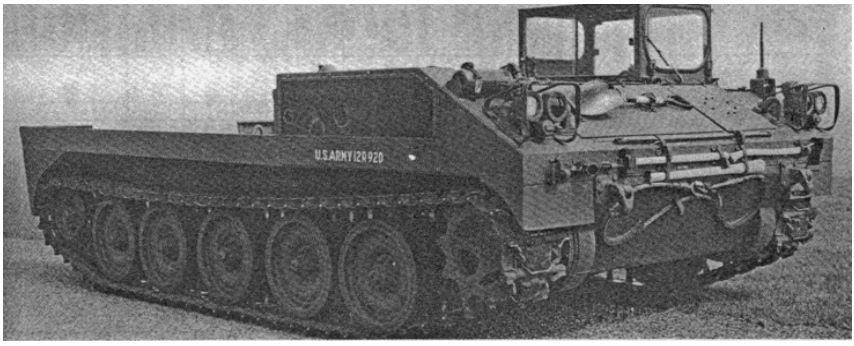


Figure 46. XM474E2

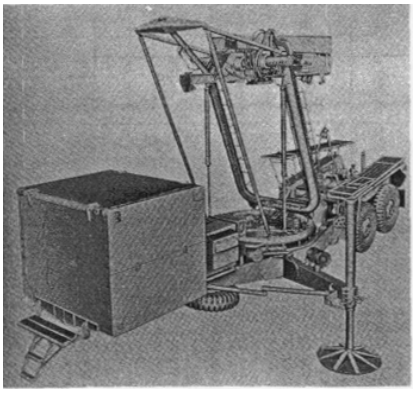


Figure 47. Launcher, Sgt.

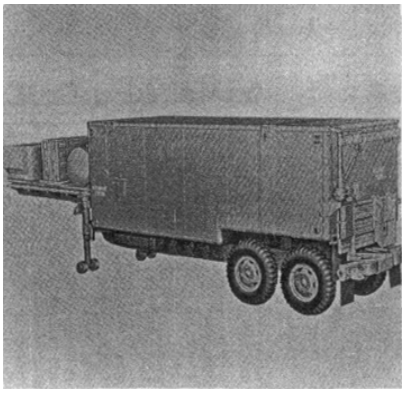


Figure 48. OMTS or FMTS, Sgt.

Present Aircraft

TABLE XII. PRESENT FIELD ARTILLERY AIRCRAFT (1)

Nomenclature; Current (Former)	Purpose	Aircraft, Crew, & Oil (pounds)	Crew (200-pounds each)	Payload w/full fuel aboard (pounds)	Max Internal fuel Capacity (pounds)	Cruise Speed (knots)	Endurance at Cruise Speed (hrs/min)	Optimum Cargo Space (cubic feet)	Approximate Takeoff Distance (feet)	Approximate Landing Distance (feet)	Special Equipment Available	Troop Seats	Using TOE: ROAD and Sep Units	Using TOE: Air Assault Units	Figure Number
O-1A (L-19A) Bird Dog	Reconnaissance; Observation; Trainer; Radio relay; Radiological survey; Wire laying; Message drop	1,837	200	311	252	87	4/30	N/A	600	600	Camera, still picture KA-39A	1	6-401E; 6-415E; 6-445E; 6-514D		
U-6A (L-20A) Beaver	Personnel-cargo transport; Recon photo duties; Resupply; Medical evacuation; Wire laying; Camouflage checking	3,337	200	935	828	105	6/30	125	600 to 1200	600 to 1200	Camera, still picture KA-39A; AN/UVS-1 VATL system (test only); 2 litters	5	6-100E; 6-200E; 6-300E		
U-1A Otter	Cargo and personnel transporter; (battlefield illumination U-1A only);	5,180	200	1,540	1,280	100	8/50	293	500 to 2000	500 to 2000	Camera, still picture KA-39A; 6 litters	10			
CV-2B Caribou	Transport of Specialized teams; Medical evacuation; Resupply; (CV-2B to replace U-1A)	19,392	600	4,140	4,968	157	7/30	1,150	700 to 2500	700 to 2500	20 litters	32	6-100E; 6-200E; 6-300E		
OV-1A (AO-1A) Mohawk	Close combat surveillance	9,911	200	504	1,930	200	1/56	N/A	700 to 1500	600	Camera, still picture KA-30A	1			
OV-1B (AO-1B) Mohawk	Close combat surveillance	10,888	200	500	1,930	200	1/56	N/A	700 to 1500	600	Camera, still picture KA-30A; AN/APS-94 SLAR	1	6-100E; 6-200E; 6-300E; 6-517D	6-700T	
OV-1C (AO-1C) Mohawk	Close combat surveillance	10,342	200	404	1,930	200	1/56	N/A	700 to 1500	600	Camera, still picture KA-30A; Infrared detector AN/UAS-4	1			49

Present Aircraft (Cont)

OH-13H (H-13H) Sioux	Observation; Reconnaissance; Radiological survey; Wire laying	1,941	200	263	246	70	2/00	N/A	0	0	XM1 Dual Machinegun System; 2 litters	1	6-100E; 6-200E; 6-300E; 6-401E; 6-415E; 6-435D 6-445E		
OH-23D (H-23D) Raven	Observation; Reconnaissance; Radiological survey; Wire laying	2,038	200	386	276	67	2/05	N/A	0	0	XM1 Dual Machinegun System; 2 litters	2	6-100E; 6-200E; 6-300E; 6-435D	6-702T	
CH-47A (HC-1B) Chinook	Cargo and personnel transport	16,936	600	11,977	4,087	130	1/45	1,462	0	0	24 litters	33		55-305T	50
CH-37B (H-37B) Mojave	Cargo and personnel transport	22,415	600	6,197	2,388	86	1/05	1,252	0	0	24 litters	23			
UH-1D (HU-1D) Iroquois	Utility/ Tactical; Transport Cargo and Personnel	4,881	200	2,289	1,430	104	2/30	220	0	0	XM3, 2.75 Rkt Sys; XM5 Grenade Lchr; XM6 Quad	12	6-615T		
UH-1B (HU-1B) Iroquois	Utility/ Tactical; Wpns aircraft; Transport Cargo and Personnel	4,914	400	2,578	1,008	104	1/40	140	0	0	Machinegun (7.62mm); SS-11, antitank Msl Sys; AN/UVS-1, VATL Sys; 3-6 litters	8		6-702T 6-725T	17

(1) Performance characteristics figures in this table assume that the aircraft is carrying full fuels and payloads indicated in respective columns. Since atmospheric and other conditions greatly influence aircraft performance, the values provided in this table should be regarded as approximations. All data were computed at standard conditions at sea level.

Future Surface Vehicles

TABLE XIII. FUTURE FIELD ARTILLERY TRANSPORTATION
A. DEVELOPMENTAL SURFACE VEHICLES

Nomenclature	Purpose	Weight (pounds)		Max Allowable Speed (mph)	Cruising Range (miles)	Fuel Capacity and Type (gals)	Water Crossing Capability (inches)		Air Transportability		Figure Number
		Net	Payload				w/kit	w/o kit	Phase	Type	
1 1/4-ton Gama Goat	Cargo Transport	3,900	2,900	53	Unk	Unk diesel	Amphib		I	C-130A	51
2 1/2-ton XM410	Cargo Truck	9,000	5,000	55	Unk	Unk diesel	Floatable		I	C-130A	52
5-ton M54E4	Cargo Truck	20,000	20,350	55	Unk	78 gas, diesel, ker.	78	30	I	C-130A	
8-ton GOER, XM520E1	Cargo Truck	20,190	16,400	30	400	80 diesel	Amphib		III	C-133A	

ARTILLERY TRENDS is an instructional aid, published by the US Army Artillery and Missile School (USAAMS) to supplement resident and nonresident training. Its purpose is to keep all field artillerymen abreast of the latest tactical and technical developments within their branch. Issues are published whenever sufficient suitable material becomes available, rather than on a fixed schedule.

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Commandant
ATTN: AKPSIPL-ARTILLERY TRENDS
US Army Artillery and Missile School
Fort Sill, Oklahoma

Future Surface Vehicles (cont)

Nomenclature	Purpose	Weight (pounds) Net	Weight (pounds) Payload	Max Allowable Speed (mph)	Cruising Range (miles)	Fuel Capacity and Type (gal)	Water Crossing Capability (inches) w/kit	Water Crossing Capability (inches) wo/kit	Air Transportability Phase	Air Transportability Type	Figure Number
8-ton GOER, XM559	Tanker (2500 gal)	Unk	Unk	31	400	80 diesel	Amphib		III	C-133A	
10-ton GOER, XM553	Wrecker	39,725	8,500	30	400	80 diesel	Amphib		III	C-133A	
20-ton GOER, XM554	Wrecker	57,140	8,800	32.5	300	160 diesel	Amphib		III	C-133A	
16-ton GOER, XM437E1	Cargo Truck	39,580	32,000	31	300	170 diesel	Amphib		III	C-133A	
16-ton GOER, XM438E2	Tanker, fuel	38,670	32,000	31	300	170 diesel	Amphib		III	C-133A	
XM577 (1)	Command Post	18,600	4,300	40	200	160 gas	Amphib		III	C-124A	53
M113E2	Armd Per Carrier	19,755	2,260	40	300	Unk diesel	Amphib		I	C-130A	
XM548	Cargo Tractor	12,080	11,920	40	300	Unk diesel	Amphib		Unk	Unk	
XM491	Ammo/Cargo	32,000	32,000	35	500	320 diesel	Unk	42	III	C-124A	
Univ Engr Tracked Armd	Excavation	28,000	16,200	32	Unk	97 diesel	Amphib		I	C-130A	

(1) Diesel power plant planned.

B. DEVELOPMENTAL FIELD ARTILLERY AIRCRAFT

Future Aircraft

Nomenclature	Purposes	Manufacturer	Figure Number
LOH-4, 5, or 6 Light Observation Helicopter	Observation; Target Acquisition; Reconnaissance; Command and Control; XM6 Weapons System	Bell; Hiller; Hughes	
CV-7A	Tactical transport; future replacement for CV-2B	De Havilland	
S-64, Sky Crane	Crane and Cargo, Personnel, and Armament Transport	Sikorsky	
XV-4A Hummingbird	High Speed VTOL surveillance aircraft	Lockheed-Marietta	54
PIAC, 59H Skycar	Aerial Jeep; Cargo; Observation	Piasecki	
Rocket Belt	Personnel transport	Bell	
Paraglider Flex Wing	Equipment and personnel delivery; Reconnaissance	Ryan	

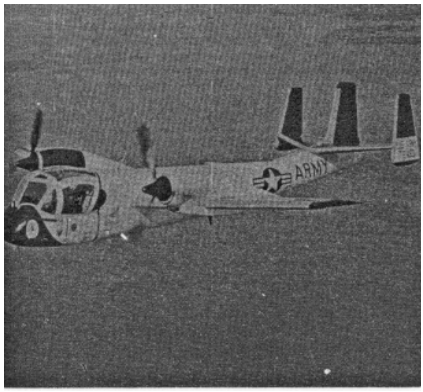


Figure 49. Mohawk

Figure 50. Chinook

Figure 51. Gama Goat

Figure 52. XM410

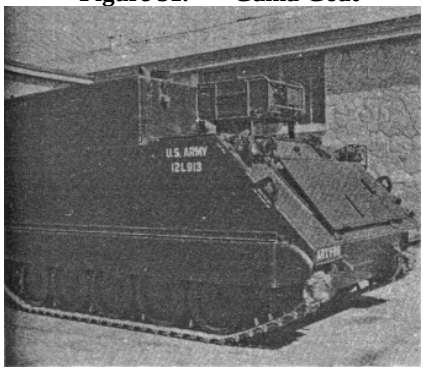


Figure 53. XM577

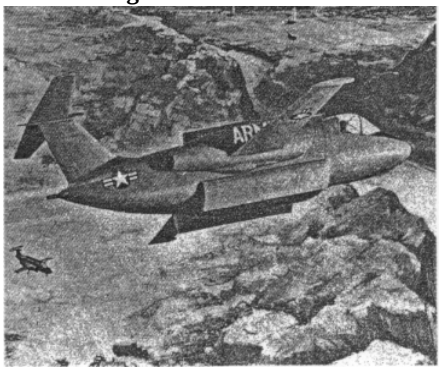


Figure 54. Hummingbird

TABLE XIV. AMMUNITION

Weapons	Ammunition Type	Item Description	Weight of Projectile (pounds)	Weight of Complete Round (pounds)	How Shipped	Fuzes			
						Point Detonating	Base Detonating	Time (Mech)	VT
75-mm Pack Howitzer, M1A1	HE	Cartridge, HE, M48	14.70	18.24	Unfuzed or Fuzed	M51A1; M535; M78, M78A1CP		M501A1; M500; M500A1; M520	M97A1; M513 Series
(1) 105-mm Howitzer, M101A1; M52A1; XM124;	HE	Cartridge, HE, M1	33.00	42.00	Unfuzed or Fuzed	M51A5; CP M78; M535 (A1)		M500; M500A1; M520	M513 Series
	HE Antitank	Cartridge, HEAT (-T) M67	28.80	37.06	Fuzed		M62A1; M91A1 (tracer)		
		Cartridge, HEP (-T), M327	23.38	33.35					
	Smoke	Cartridge, Smoke, HC, BE, M84B1; M84	32.86	41.93	Fuzed			M501A1	
		Cartridge, Smoke, WP, M60	34.83	43.81		M51A5			
	Colored Smoke	Cartridge, Smoke, BE, M84B1; M84	Yellow 30.29; Red 30.68	Yellow 39.38; Red 33.78	Fuzed			M501A1	
	Gas	Cartridge, Gas, Persistant, M60, H or HD	33.94	42.92	Fuzed	M51A5			
		Cartridge, Gas, Nonpersistant, GB, M360	35.59	43.86	Fuzed	M508			
	Leaflet	Cartridge, Leaflet, BE, M84; M84B1	33.00	42.00	Fuzed			M501A1	
		Cartridge, Leaflet, M488	33.00	42.00	Fuzed				
	Illuminating	Cartridge, Illuminating, M314A1	36.55	46.43	Fuzed			M501A1	

	Target Practice	Cartridge, TP-T, M67	28.80	37.06	Complete				
	Blank	Cartridge, Blank, M395		5.74(1.5lb) 6.24(2.0lb)					
	Dummy	Cartridge, Dummy, M14	42.06	42.06	Complete	M59 inert		M54 inert	
	HE (2)	Cartridge, HE, XM482	28.05	39.03	Complete				
155-mm Howitzer, M114A1; M123A1; M44A1; T-196 (M109)	HE	Projectile, HE, M107	96.75	104.4-GB 112.1-WB	Unfuzed	M51A5, CP, M78, M78A1		M500A1, M520, M564	M514 Series
	Smoke	Projectile, Smoke, HC, BE, M116	86.43	94.1-GB 101.77-WB	Unfuzed			M501A1	
		Projectile, Smoke, WP, M110	97.50	105.15-GB 112.84-WB	Unfuzed	M51A5 M508 Series			
	Colored Smoke	Projectile, Smoke, M116	86.43	94.1-GB 101.77-WB	Unfuzed			M501A1	
	Gas	Projectile, Gas, Nonpersistent, GB, M121; VX, M121E1	99.70	107.35-GB	Unfuzed	M508 Series			M514A1
		Projectile, Gas, Persistent, H or HD, M110	98.49	106.14-GB 113.83-WB	Unfuzed	M557 M51A5 M508 Series		M501A1 M520	
	Illuminating	Projectile, Illuminating, M118A1	103.06	110.71-GB 118.40-WB	Unfuzed			M501A1	
		Projectile, Illuminating, M485	95.07	111.04	Unfuzed			M562	
	Dummy	Projectile, Dummy, M7	95.00	100.05-GB 108.19-WB	Complete				
	HE (3)	Projectile, HE, M470	95.07	114.04	Unfuzed	M51A5; M557			

(1) Fuzes to be used with the XM102, XM104, and T195 (M108) are presently undergoing tests.
(2) Extended range 105-mm cartridge used only with T195 (M108), XM102, and XM104 105-mm Howitzer.
(3) Extended range 155-mm projectile used only with T196 (M109), 155-mm Howitzer.

AMMUNITION

8-inch 175-mm 280-mm 2.75-inch 115-mm

Weapons	Ammunition Type	Item Description	Weight of Projectile (pounds)	Weight of Complete Round (pounds)	How Shipped	Fuzes			
						Point Detonating	Base Detonating	Time (Mech)	VT
8-inch Howitzer, M115, M55; M110	HE	Projectile, HE, M106	200.00	215.45-GB 230.45-WB	Unfuzed	M51A5; CP, M78; M78A1		M500A1; M520; M564	M514 Series
	Gas	Projectile, Gas M426	200.00	215.45-GB 230.45-WB	Unfuzed	M508 Series			
	HE Spotting	Projectle, HES, M424	242.00					M543	
	Nuclear Explosive	Projectile, AE, M422	242.00						
	Dummy	Projectile, Dummy, M14	188.06	213.03-GB 228.03-WB	Complete				
175-mm Gun (SP), M107	HE	Projectile, HE, M437	147.00	202.00	Unfuzed	M557			
280-mm Gun, M66	HE	Projectile, HE, M124; M124A1	600.00	759.07	Unfuzed	M51A1; M51A5; M78; M78A1 CP; M535		M520; M564	M514 Series
	Nuclear Explosive	Projectile, AE, M366							
2.75-inch Folding Fin Aerial Rocket	HE		18.00	18.00	Unfuzed				
115-mm Multiple Rocket Lchr M91	Chemical	Rocket, Chemical, M55	57.00	57.00	Complete	M417			

Army Aircraft

The characteristics of Army aircraft are listed on page 26 of this section. All Army aircraft have target acquisition capabilities.

Visual Airborne Target Locator System (VATLS) (fig 55)

The VATL system consists of ground tracking and support equipment and airborne equipment mounted in organic Army aircraft. The ground station continually tracks the position of an aircraft and successive angle measurements are made from the aircraft to a given target. The ground station determines two or more positions of the aircraft and by triangulation, the positions and corresponding measurements from the aircraft establish the target location.

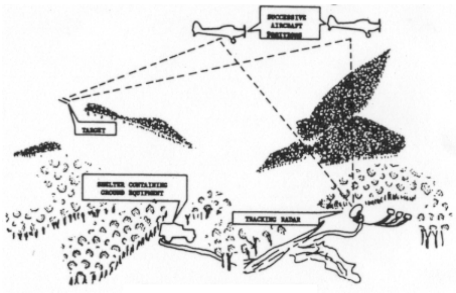


Figure 55. VATLS

Drone System, AN/USD-1 (figs 56 & 57)

The AN/USD-1 drone (fig 56) is a radio controlled, unmanned aircraft designed to provide identification and location of targets by means of aerial photography. It has an operational range of 65 kilometers and is recoverable by parachute. The KA-39A camera carried by the drone is capable of taking up to 95 daylight photographs or 10 night photographs. The photographs are taken, and in case of night photography flash cartridges are ejected, on command from the ground. The AN/USD-1 system includes the AN/MPQ-29 tracking and plotting radar (fig 57) and other ground support equipment. Prior to launch the controller places the flight plan on a standard scale map mounted in the radar van. After the drone is airborne and the AN/MPQ-29 radar has locked onto it, the controller flies the mission by radar plot. The average time from request of mission to completion of prints in a mobile darkroom is approximately one hour and 15 minutes.

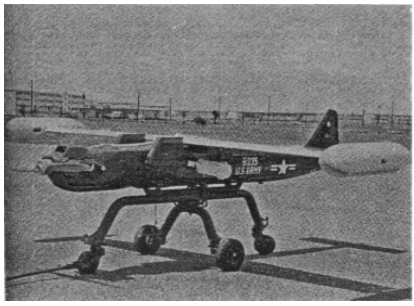


Figure 56. AN/USD-1 Drone

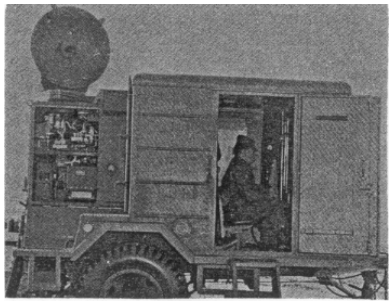


Figure 57. AN/MPQ-29 Radar

TARGET ACQUISITION

Radar Set AN/TPS-25 (fig 58)

The AN/TPS-25 is a transportable ground surveillance radar capable of detecting moving ground targets at ranges between 450 and 18,280 meters. The set utilizes a noncoherent doppler technique, in which the return from stationary objects (clutter) is used as a reference. Frequency differences in return signals are amplified and applied to earphones and/or a loudspeaker, enabling the operator to detect and identify moving objects by means of sound. Target locations are presented in the form of map coordinates on a counter at the operator's panel and as dots of light shining through a battle-map. A seven man crew can emplace the set in 15 minutes, if the antenna is mounted on the transmitter receiver unit, and in approximately 45 minutes if mounted on three mast sections.

Radar Set AN/MPQ-10A (fig 59)

The AN/MPQ-10A radar is used in the counterbattery role. It is capable of locating artillery pieces with 150-400 meters accuracy at ranges up to 10,000 meters. The AN/MPQ-10A scans a 200- to 800-mil sector until an artillery projectile is detected. It then is positioned in range and azimuth to an approximate position in space through which the projectile passed. When a second round is fired by the same weapon, the AN/MPQ-10A locks on the proiectile and tracks it through a portion of its trajectory, permitting determination of the location of the weapon that fired. The AN/MPQ-10A can be emplaced in 45 to 60 minutes.

Radar Set AN/MPQ-4A (fig 60)

The AN/MPQ-4A is a mobile, short-range, dual-beam-intercept, nontracking radar used by the artillery to locate mortars and other high-angle weapons. The set has the capability of locating mortars with 50 meter accuracy at ranges up to 10,000 meters. When a projectile passes through the dual beam, two separate echoes appear on a scope. The operator then positions azimuth and range strobes over the echoes, and an analog computer computes the coordinates of the weapon that fired. The AN/MPQ-4A can be emplaced in 30 to 45 minutes.

Periscope Battery Command, M43 (fig 61)

The M43 periscope is used to locate targets by visual observation and intersection from two or more observation posts (flash ranging). Trained observers using the M43 and employing proper flash ranging techniques can locate hostile artillery and other targets at distances up to 15,000 meters, depending upon visibility limits from individual observation posts. Flash ranging is also used for the collection of battlefield information and for the calibration, adjustment, registration, and location of friendly artillery fires. Flash ranging techniques are accurate to within 50 meters.

Sound Ranging Set, GR-8 (fig 62)

The GR-8 is used to locate hostile artillery by measuring the relative times at which sound waves generated by firings reach accurately located microphone positions on the ground. Targets may be located by sound ranging to accuracies of 50 to 150 meters and to ranges of 20,000 meters, dependent upon the intensities of the sounds they produce.

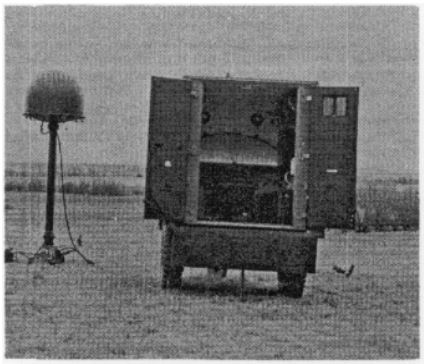


Figure 58. AN/TPS-25

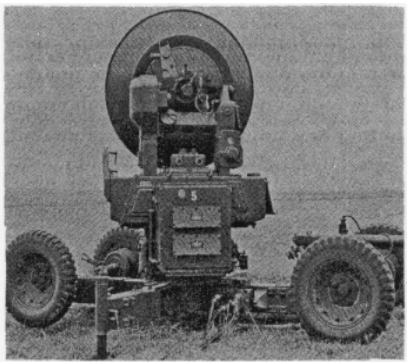


Figure 59. AN/MPQ-10A

Figure 60. AN/MPQ-4A

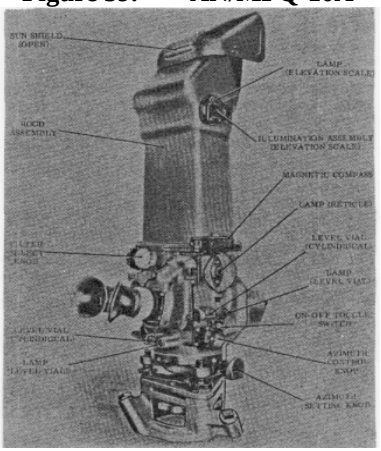


Figure 61. Periscope, M43

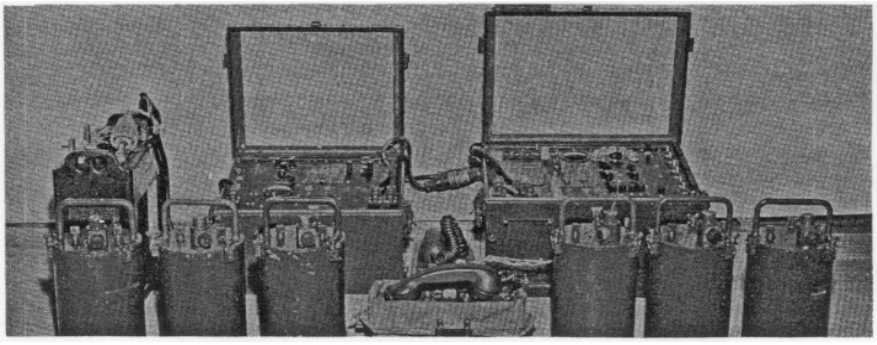


Figure 62. Sound Ranging Set, GR-8

SURVEY

Artillery Gyro Azimuth Surveying Instrument (fig 63)

In the absence of established directional control and lacking sufficient time to obtain such from other conventional sources, the artillery gyro azimuth surveying instrument is used at all echelons from battalion to corps to obtain the direction of orienting lines, initiate surveys, and establish declinating stations. It consists of an alinement head, an electronic package, a tripod, and cabling. The alinement head contains a highly sensitive, single-axis, rate gyroscope and mounts a T-2 theodolite. The electronic package provides gyro controls and panels and is operable by 24-volt DC or 110-volt AC sources. The alinement head is oriented by applying corrections to measured earth rotational effects on the gyroscope. The theodolite is then used to measure the azimuth of any line.

Tellurometer Electronic Distance Measuring Equipment (fig 64)

By means of the tellurometer, division and corps artillery survey parties are capable of electronically measuring distances from 152 to 64,000 meters, under all conditions of visibility and weather. The system employs a master unit and two remote units. One master and one remote unit are required to measure a given distance. Although the master and remote units are similar in weight and appearance, they cannot be used interchangeably. Distance is determined by employing a phase comparison technique to measure microwave transit time from one point to another and return. Built-in equipment permits voice communications between units to distances approaching 38 miles, when master and remote units are alined on each other. The complete operation from setting up equipment to computing distance can be accomplished in 30 minutes.

Theodolites, T-16 and T-2 (figs 65 and 66)

The T-16 theodolite (fig 65) is used to obtain angular values in artillery surveys executed to fifth-order (1:1000) accuracy. Its scales are readable directly to 0.2 mil and by estimation to 0.1 mil. Vertical and horizontal scales may be read simultaneously and may be illuminated by either sunlight or self-contained, artificial light. An optical plumb system is provided. The 28-power telescope produces inverted images. The universal field artillery tripod is used to support the instrument. The T-2 theodolite (fig 66) provides greater accuracy than the T-16, permitting execution of fourth-order (1:3000) surveys. Its scales are readable directly to 0.002 mil and by estimation to 0.001 mil. Vertical and horizontal scales must be individually viewed by means of a selector knob. Its other characteristics are essentially the same as those of the T-16.

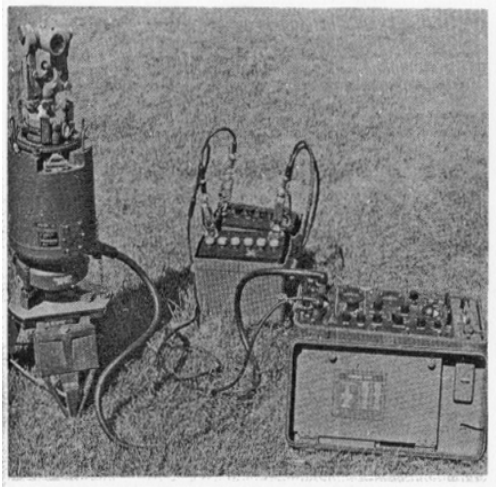


Figure 63. Artillery Gyro Azimuth Surveying Instrument

Figure 64. Tellurometer Electronic Dist Measuring Device

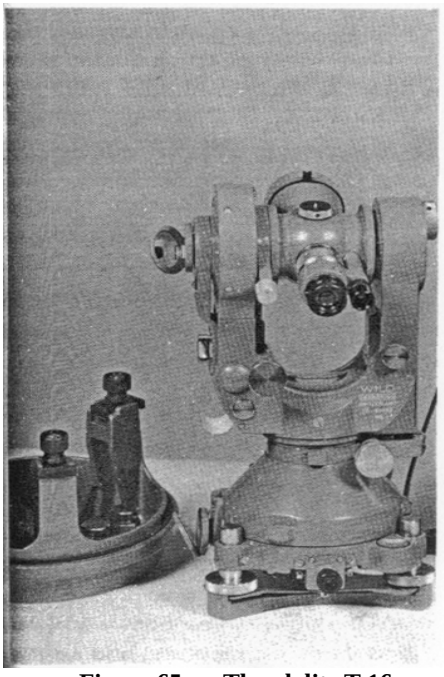


Figure 65. Theodolite T-16

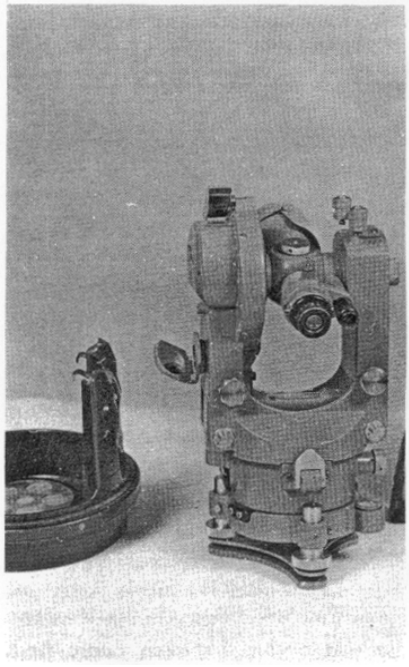


Figure 66. Theodolite T-2

METEOROLOGY

Radiosonde AN/AMT-4 (figs 67 and 68)

The radiosonde AN/AMT-4 is a meteorological instrument which is carried aloft by a balloon to obtain soundings of the temperature, pressure, and relative humidity of the lower atmosphere. This instrument automatically transmits radio-frequency signals, amplitude modulated at a frequency that varies in accordance with the conditions of temperature and humidity encountered during the flight. A baroswitch connects the circuits of the transmitter successively, so that a repeating sequence of temperature, humidity, and reference signals is transmitted. These data are used in calculating corrections to compensate for the effects of nonstandard meteorological conditions for artillery fire.

Rawin Set AN/GMD-1 (fig 69)

The rawin set AN/GMD-1 is a transportable radio direction finder which automatically tracks the radiosonde, tunes itself to the transmitted frequency, and records angles to the radiosonde at a maximum rate of 10 times each minute. Recordings of time versus progressive elevation and azimuth positions are later converted to wind speed and direction. Received radiosonde signals are detected, amplified, and transmitted to a separate piece of equipment, the radiosonde recorder, for conversion to atmospheric values of temperature, humidity and pressure.

Radiosonde Recorder AN/TMQ-5 (fig 70)

The radiosonde recorder, AN/TMQ-5, is an assembly of electronic and electromechanical devices which receives meteorological data from the rawin set, AN/GMD-1. The input signal for the recorder consists of audio-frequency pulses that normally range from 10 to 200 cycles per second. These incoming signals are converted to direct current voltages which, by means of a servo system, position a pen on a calibrated chart. The operation is continuous, so that the pen always marks the chart at a point corresponding to the data received from the balloonborne radiosonde. A preflight calibration establishes the relationship between audio frequency and both temperature and relative humidity.

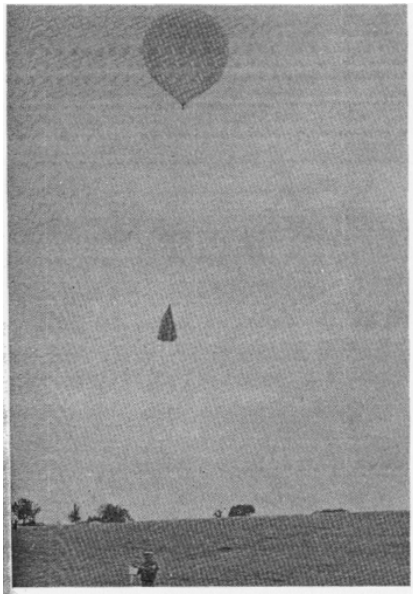


Figure 67. Radiosonde Balloon

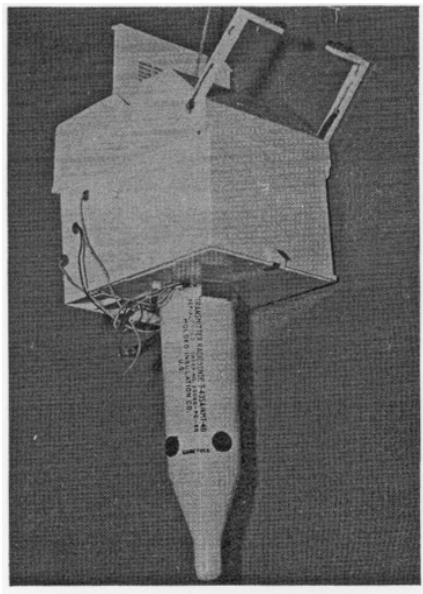


Figure 68. Radiosonde Transmitter

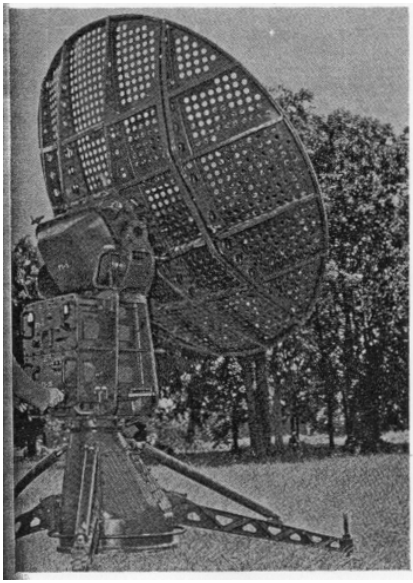


Figure 69. Rawin Set

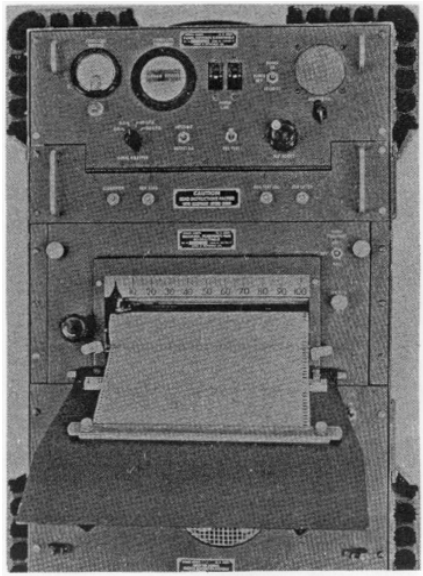


Figure 70. Radiosonde Recorder

Gun Direction Computer M18 (FADAC)

The gun direction computer M18 (FADAC) and its related equipment are designed to electronically process fire missions, solve missile and gunnery problems, plot targets on an electrical tactical map and transmit fire commands to the firing battery. The entire process is accomplished in a matter of seconds. Since meteorological and other effects are automatically applied to the solution of the gunnery problem, fire for effect is permitted without adjustment when input data is accurate. FADAC is the hub of the automated fire control system. The major components of the FADAC system are depicted in figures 71-74.

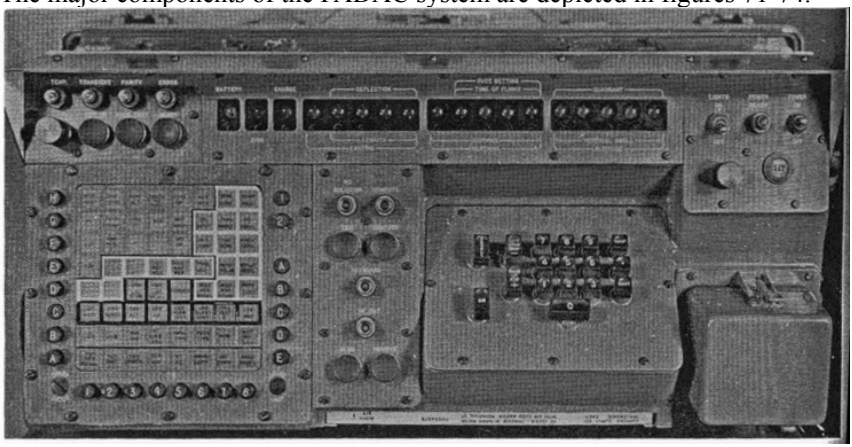


Figure 71. Gun Direction Computer M18 (FADAC)

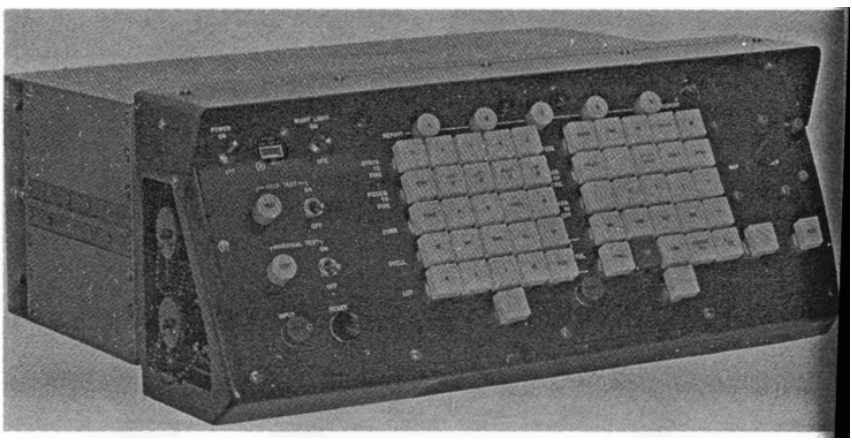


Figure 72. Gunnery Officer's Console

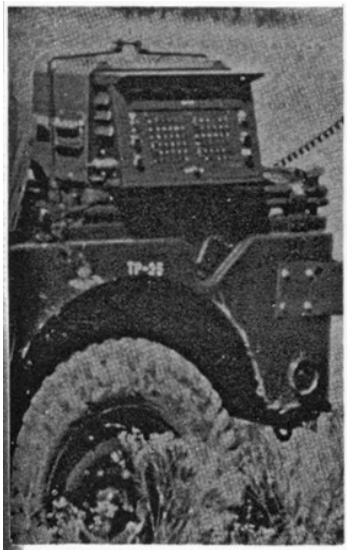


Figure 73. Battery Display Unit

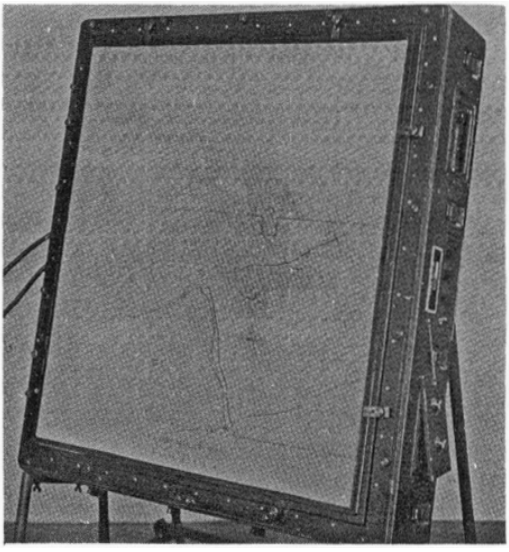


Figure 74. Electrical Tactical Map

FADAC is a compact digital computer which weighs 232 pounds. It is designed to operate under field conditions within temperatures ranging from minus 40ºF to plus 125°F. Computer circuitry is mounted on a series of circuit boards which can be replaced easily if a component becomes defective. The computer automatically checks itself for proper parity or loss of information. Trouble lights on the operator's panel indicate errors as they are detected.

When FADAC is solving the fire direction problem for missiles and rockets, its greatest advantage is in the speed of the solution. The problem is solved at electronic speeds, providing precise and timely answers. With survey application, FADAC again gives speed and accuracy. In the processing of cannon fire missions, FADAC provides increased accuracy and predicted fire capabilities by accomplishing a more detailed solution of the gunnery problem. FADAC applies corrections for all conditions operating on the projectile for approximately each second of the time of flight and stops only when it has computed a trajectory to within 10 meters of the target location. The final solution takes into account the latest powder temperatures, exact weights of projectiles, muzzle velocities achieved by particular weapon-ammunition combinations, and earth rotation. The accuracy of the firing data provided (deflection, fuze setting, quadrant, and charge) is limited only by the accuracy of the data input.

As a mission enters a battalion fire direction center, equipped with the complete FADAC system, it is manually entered into the FADAC computer. Controls are operated on the computer and the gunnery officer's console to cause the target location to be displayed on the electrical tactical map as a

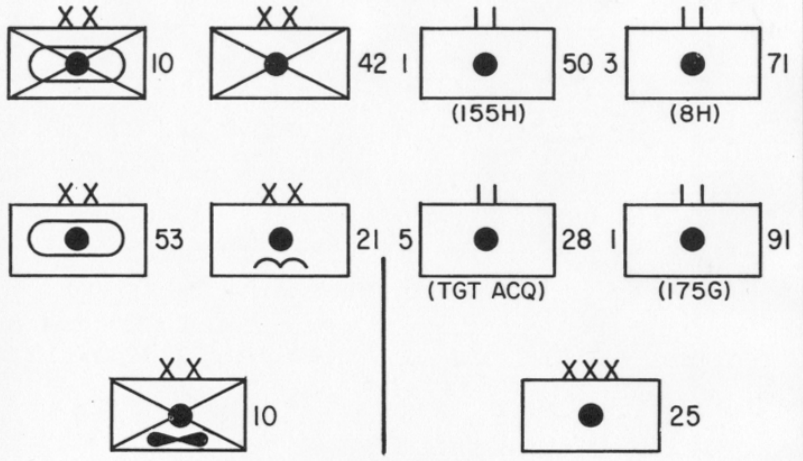
pip of light. The gunnery officer thus obtains an indication of target location in relation to gun position, no-fire line, boundaries, and other items of importance to artillerymen. Using the GOC, the gunnery officer next enters the fire order for transmission to the battery. Depending on the commands entered at the gunnery officer's console and the time required for the computer to determine the solutions, fire commands and firing data are presented at the battery on the battery display unit. Fire commands can then be acted upon by the battery to deliver accurate fire on the target.

Fire Support System

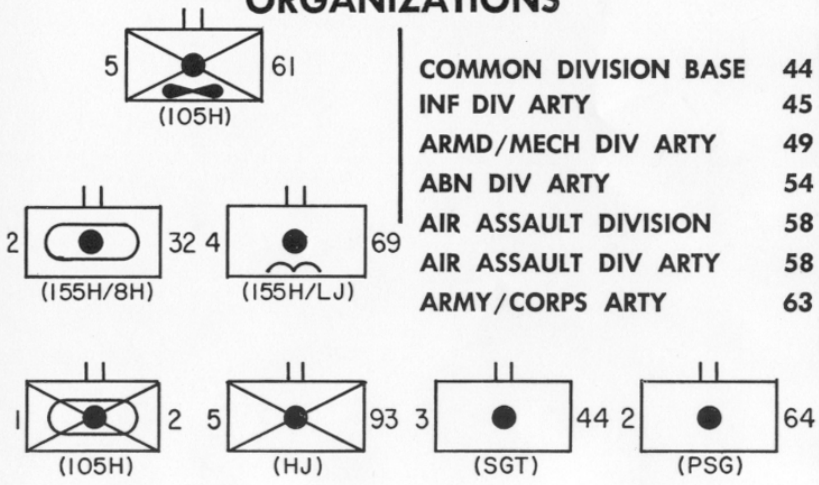
The Fire Support System (FSS) is a component system of the Field Army Command Control Information System, 1970 (CCIS-70), presently under development by the Electronics Command with guidance furnished by the US Army Combat Development Command Artillery Agency. When fully developed, the FSS will be capable of applying automatic data processing to the functional areas of ammunition and fire unit status, artillery fire planning, artillery target intelligence, artillery survey, fire support coordination, meteorological data, nuclear target analysis, tactical fire control, and technical fire control.

In March 1961, the "White Plan" was conducted at Fort Huachuca by Artillery and Signal Corps Project personnel. The "White Plan" consisted of a demonstration of the FSS's capabilities in the functional areas of technical fire control, nuclear target analysis, and artillery fire planning. During the demonstration, a complete artillery fire plan, integrating nuclear target analysis and both nuclear and nonnuclear schedules of fires, was developed in less than 30 minutes. The fire control capabilities of the system were also successfully demonstrated, achieving excellent first volley accuracy on assigned targets.

Work is continuing in the Electronics Command to extend the FSS's capabilities to the remaining functional areas and to integrate all areas into a system employing digital data transmission between computers. A concept evaluation of the FSS is scheduled for March 1964, at Fort Huachuca. This evaluation will examine the feasibility of an automated FSS by evaluating a system design based on a division structure using a test package of some militarized and some commercial equipment.



SECTION II
FIELD ARTILLERY ORGANIZATIONS



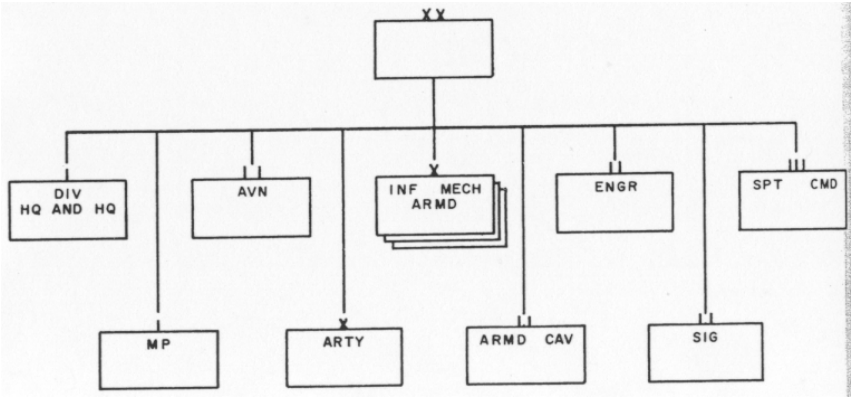
SECTION II
FIELD ARTILLERY ORGANIZATIONS

The block diagrams and strength figures contained in this section represent the best information available at the US Army Artillery and Missile School at the time the issue was being prepared for publication. Due to the recent reorganization of Reserve and National Guard divisions and the current reorganization of Regular Army divisions, it has been decided to provide the block diagrams for the newer organizations (ROAD), even though the TOE's for such have not yet been published. The block diagrams and strength figures shown are representative of the statuses of the ROAD draft TOE's, as reported to USAAMS by the Combat Developments Command, on 17 June 1963, at which time this issue of ARTILLERY TRENDS was sent to press. The strength figures for the Airborne Division Artillery were not known at that time.

The information provided in this section pertaining to non-divisional units represents an abbreviation of those Army and Corps Artillery unit TOE's which can be expected to continue in existence in the field for at least one year. This means that, in some cases in which TOE's are currently under revision, the older, approved TOE's are provided rather than the newer, unapproved drafts.

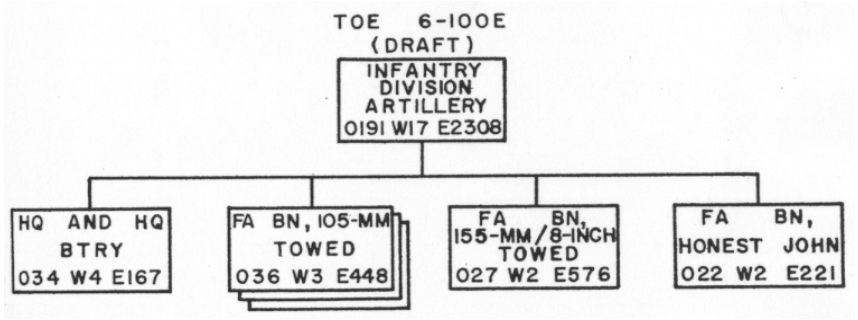
Each block diagram is identified by its appropriate TOE number designation. Block diagrams representing TOE's which have not yet been published by the Department of the Army carry the parenthetical term "draft" under their number designations. Approved TOE's carry the dates of publication of the TOE's, and changes subsequently published. In cases where TOE's are currently under revision or tentative, a notation is made to such effect. A broken line (- - - - - -) represents an augmentation to a unit. The TOE's for the Air Assault Division Artillery organizations are test TOE's.

COMMON DIVISION BASE (ROAD)

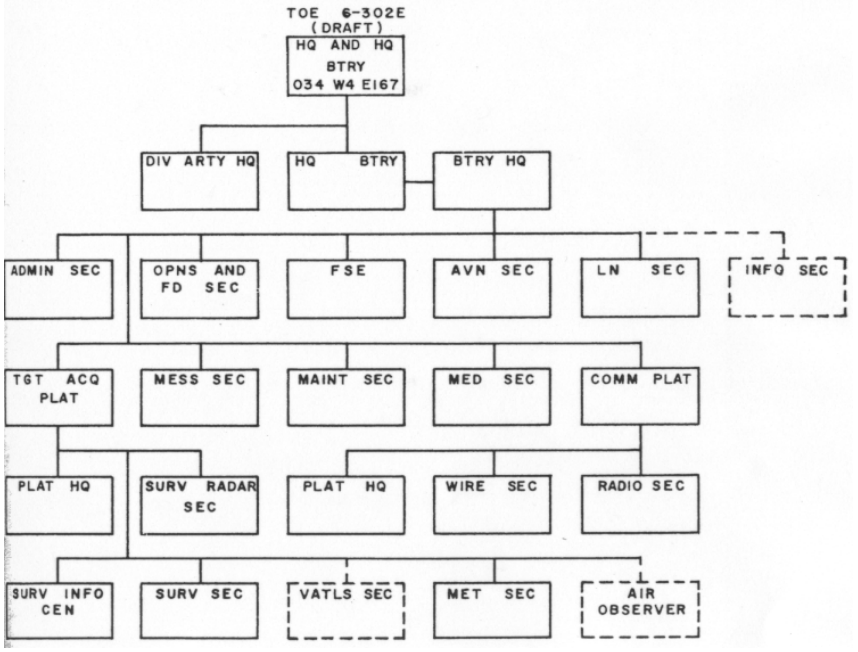


Division base common to Infantry, Armored, Mechanized, and Airborne Divisions

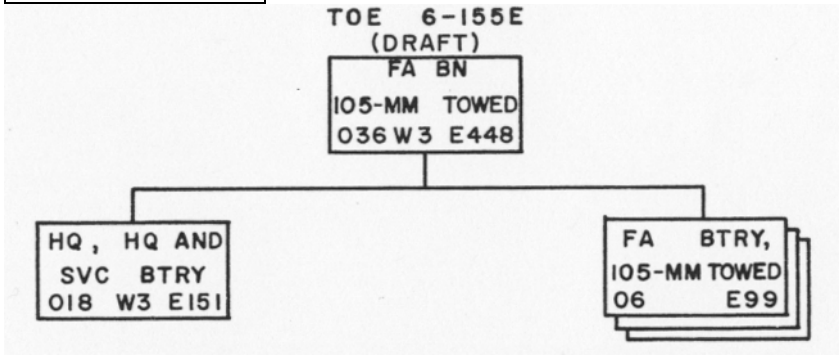
INFANTRY DIVISION ARTILLERY



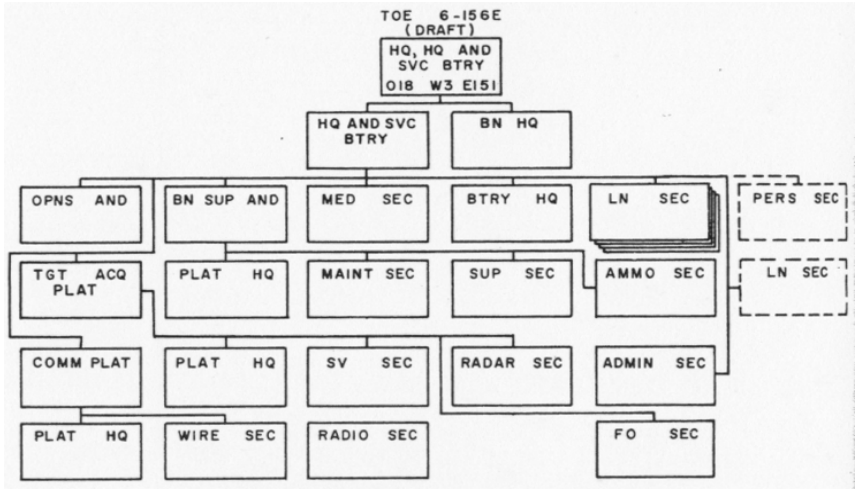
Division Artillery, Infantry Division



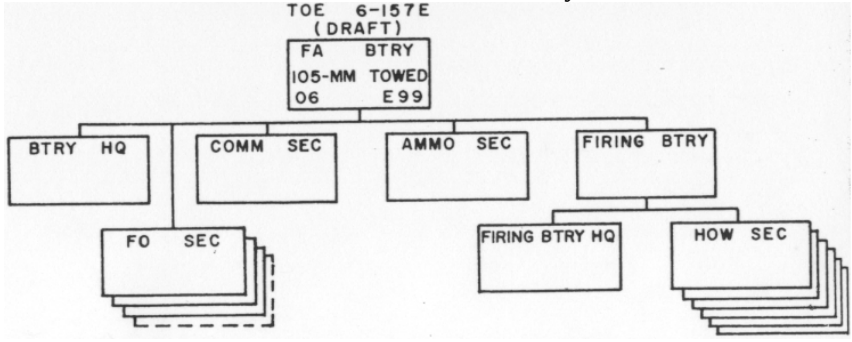
Headquarters and Headquarters Battery, Division Artillery, Infantry Division



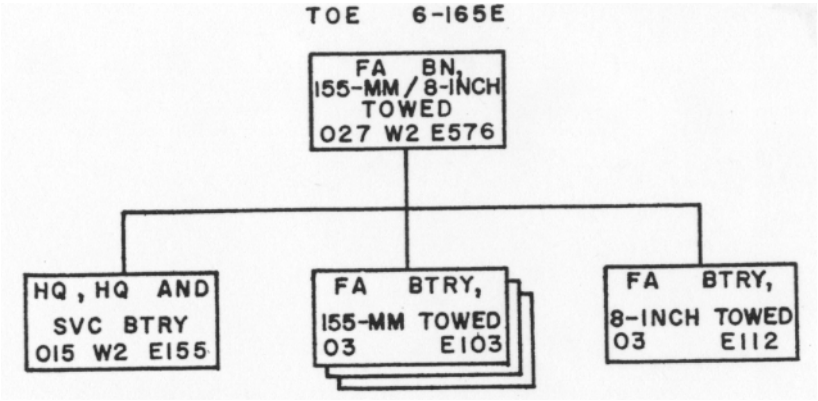
FA Battalion, 105-mm towed, Infantry Division



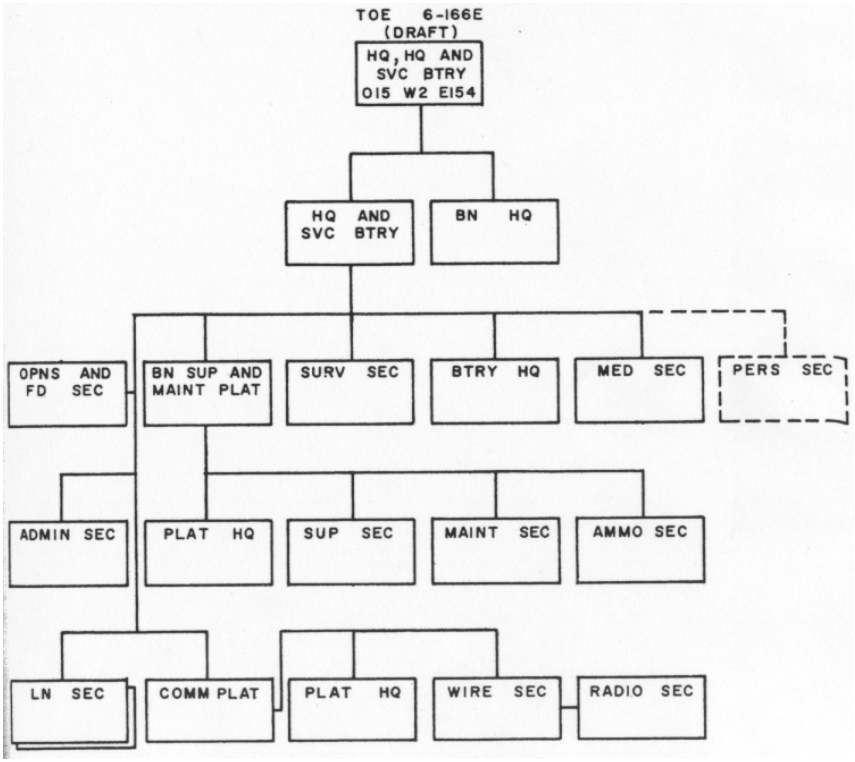
Headquarters, Headquarters and Service Battery, FA Battalion, 105-mm towed, Infantry Division



FA Battery, 105-mm towed, Infantry Division

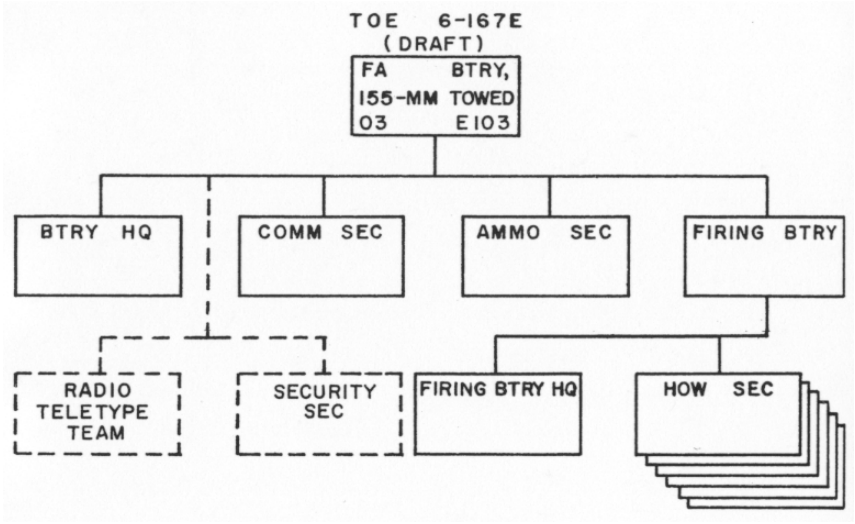


FA Battalion, 155-mm/8-in towed, Infantry Division

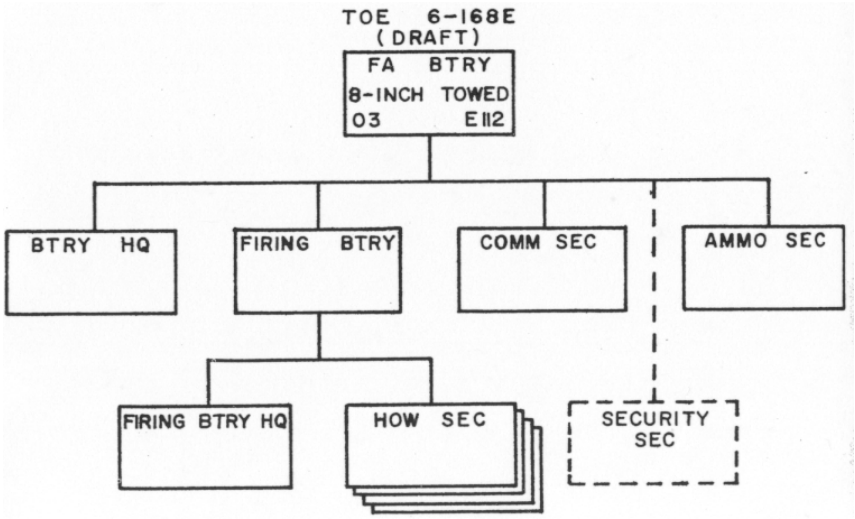


Headquarters, Headquarters and Service Battery, FA Battalion, 155-mm/8-in towed, Infantry Division

INF DIV ARTY

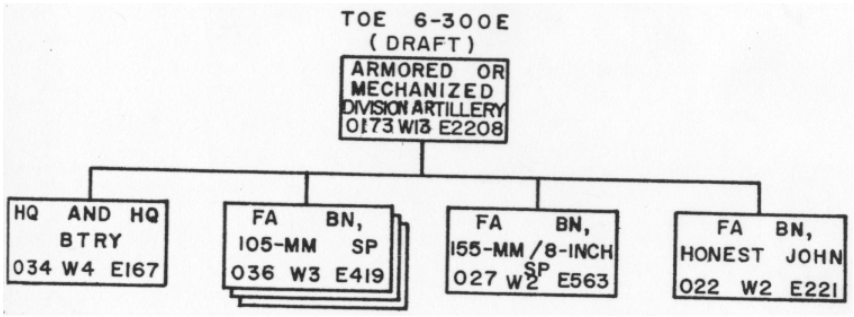


FA Battery, 155-mm towed, Infantry Division

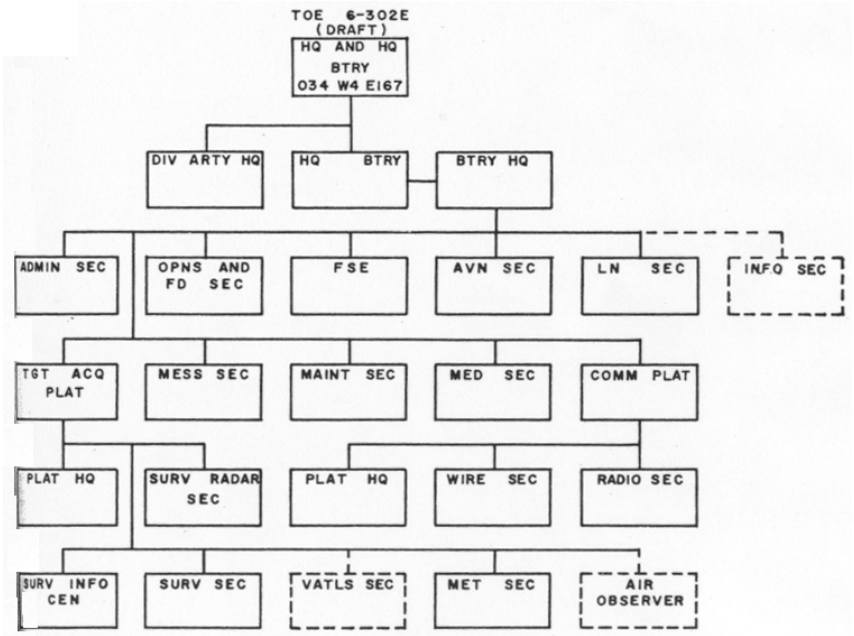


FA Battery, 8-in towed, Infantry Division

ARMORED OR MECHANIZED DIVISION ARTILLERY

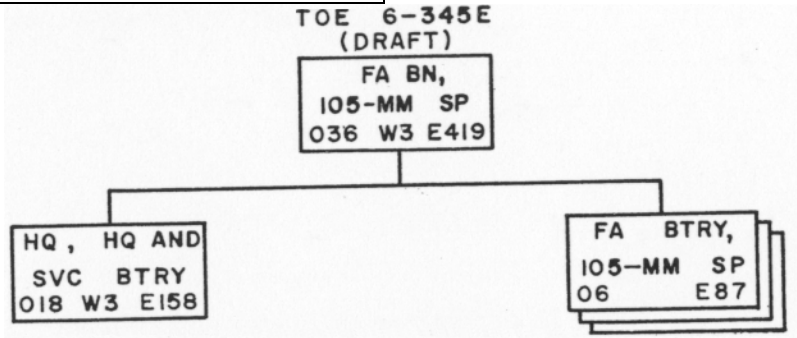


Division Artillery, Armored/Mechanized Division

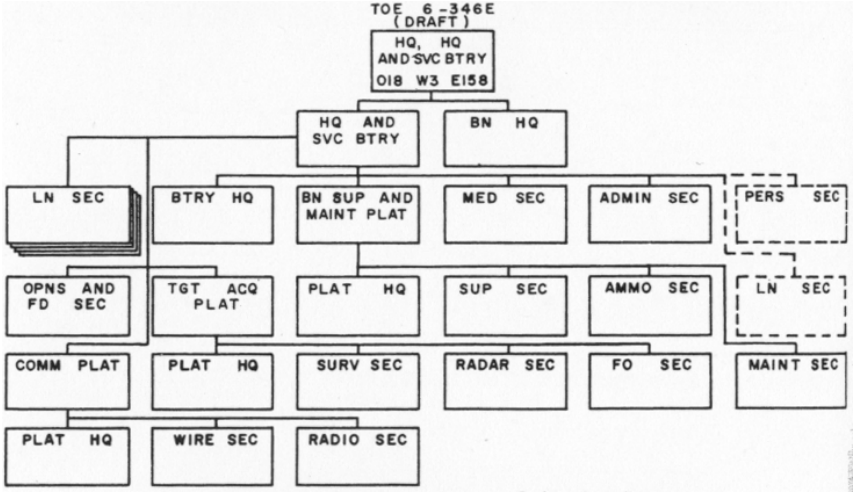


Headquarters and Headquarters Battery, Division Artillery, Armored/Mechanized Division

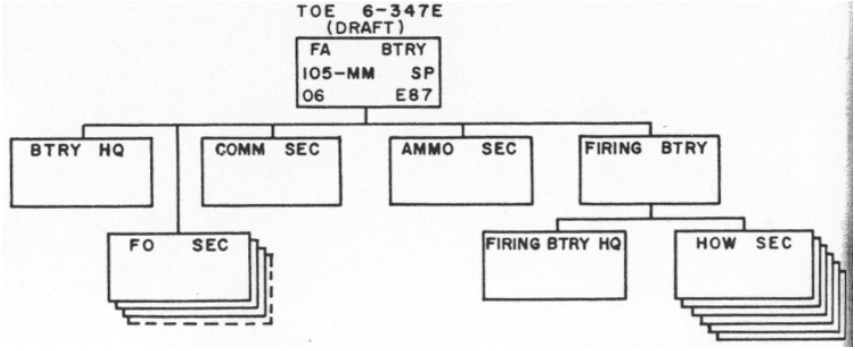
ARMD/MECH DIV ARTY



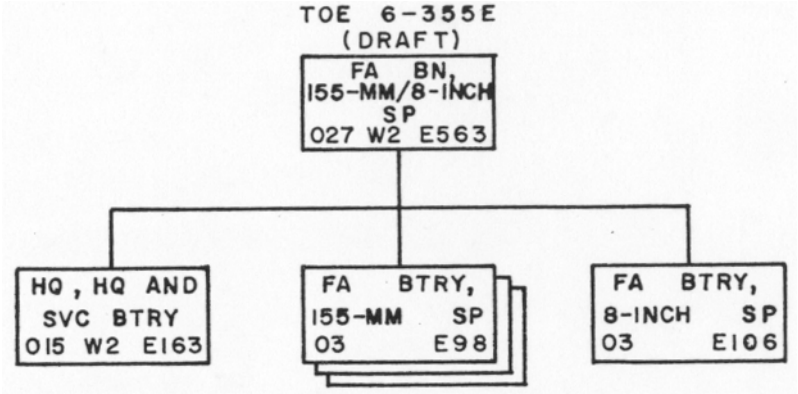
FA Battalion, 105-mm SP, Armored/Mechanized Division



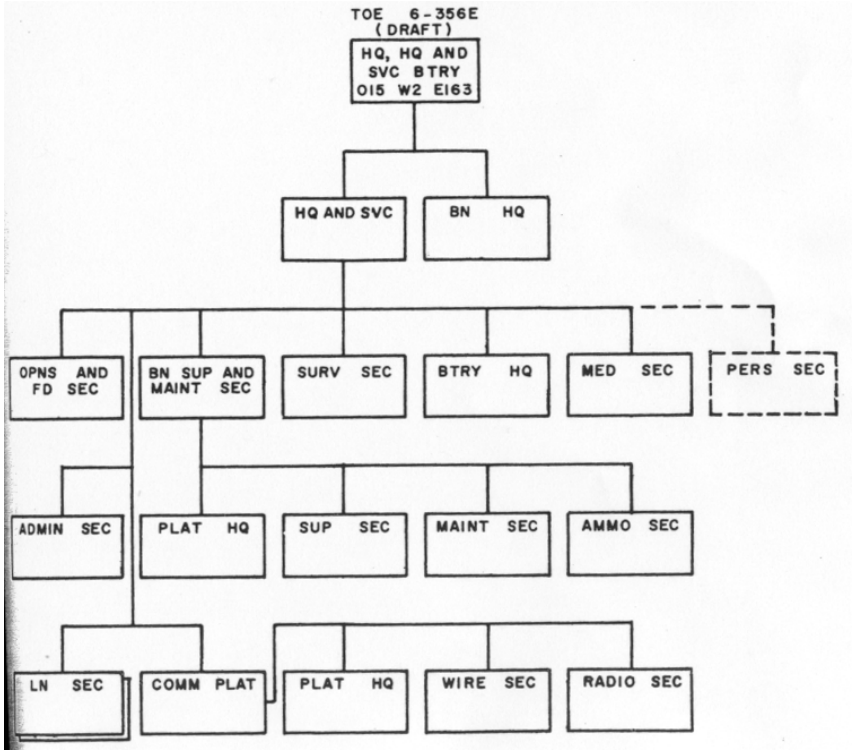
Headquarters, Headquarters and Service Battery, FA Battalion, 105-mm SP, Armored/Mechanized Division



FA Battery, 105-mm SP, Armored/Mechanized Division

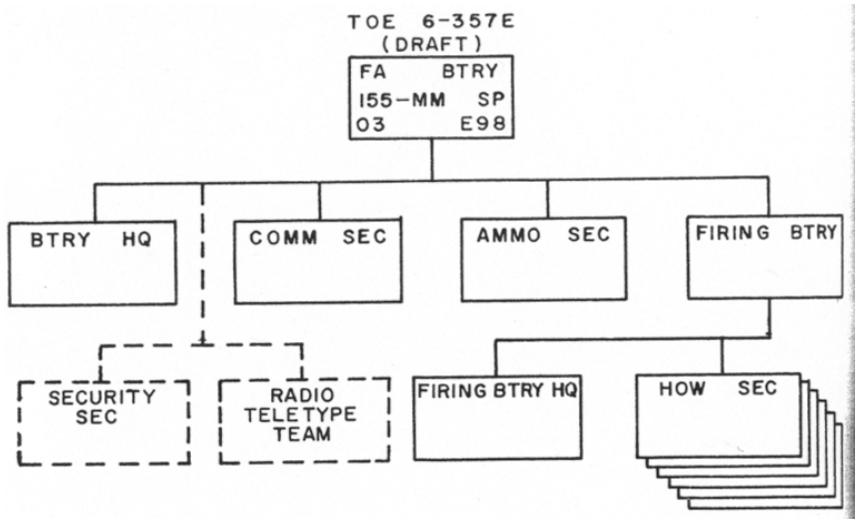


FA Battalion, 155-mm/8-in SP, Armored/Mechanized Division

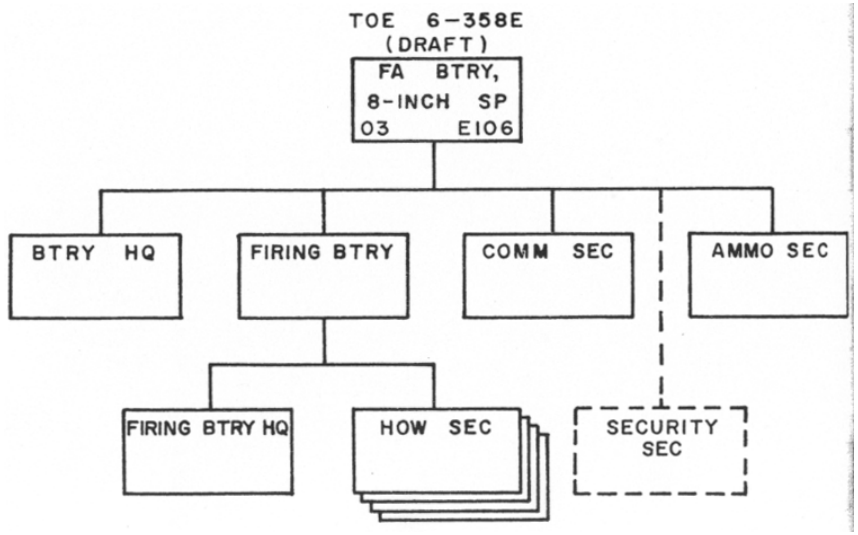


Headquarters, Headquarters and Service Battery, FA Battalion, 155-mm/8-in SP, Armored/Mechanized Division

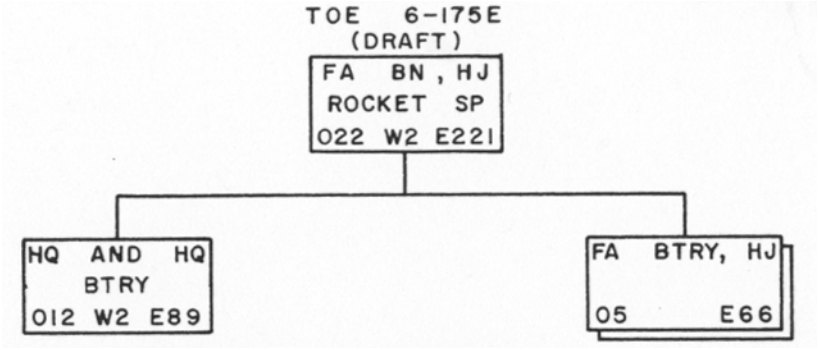
ARMD/MECH DIV ARTY



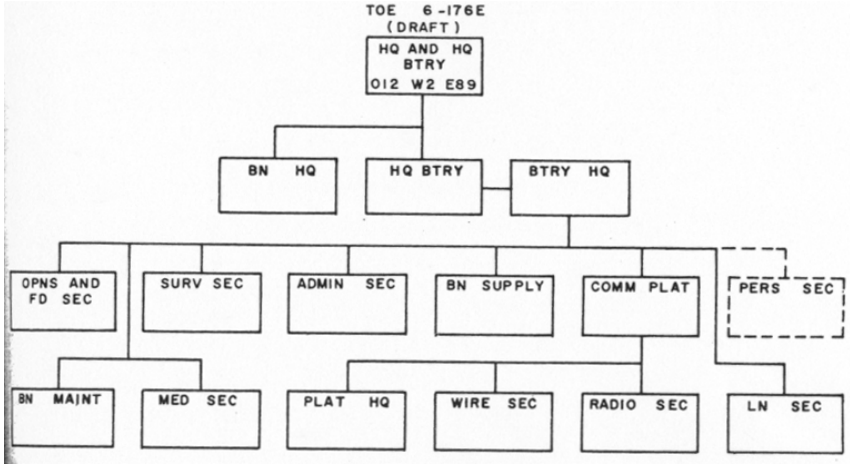
FA Battery, 155-mm SP, Armored/Mechanized Division



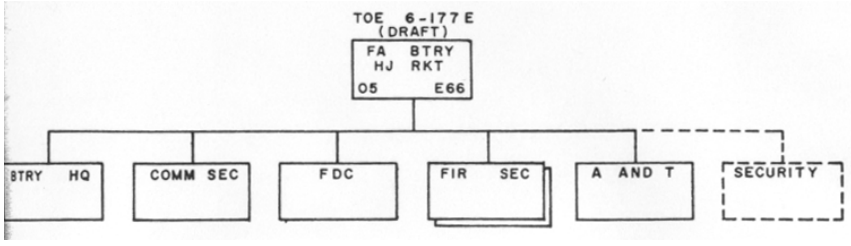
FA Battery, 8-in SP, Armored/Mechanized Division



FA Battalion, Honest John, Infantry, Armored or Mechanized Divisions



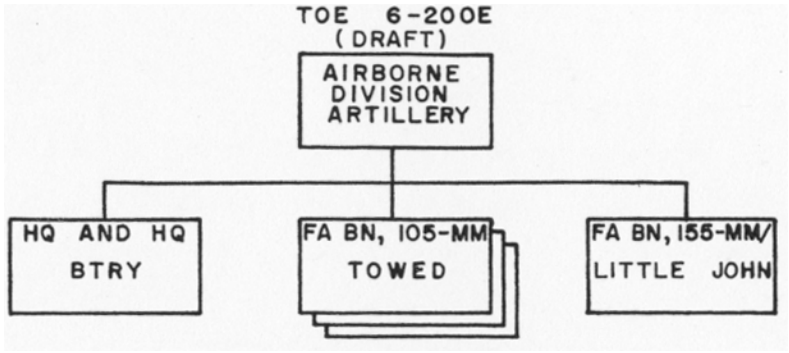
**Headquarters and Headquarters Battery, FA Battalion,
Honest John, Infantry, Armored or Mechanized Divisions**



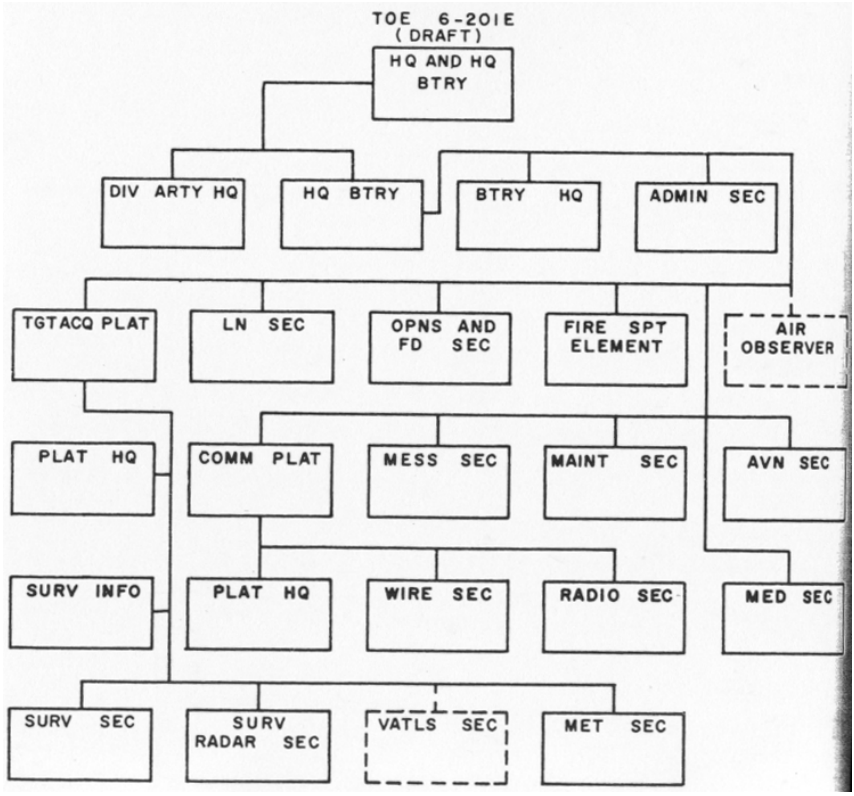
FA Battery, Honest John, Infantry, Armored or Mechanized Divisions

ABN DIV ARTY

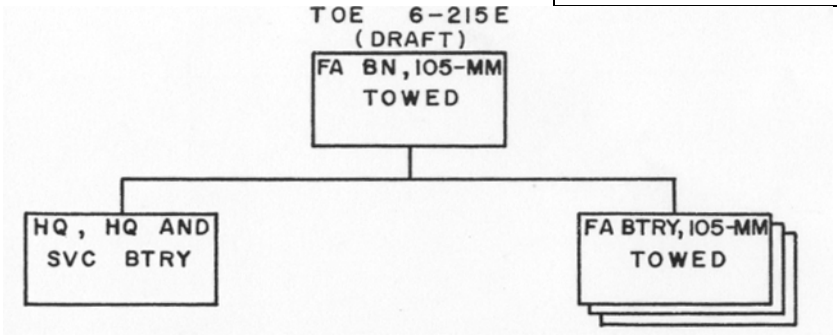
AIRBORNE DIVISION ARTILLERY



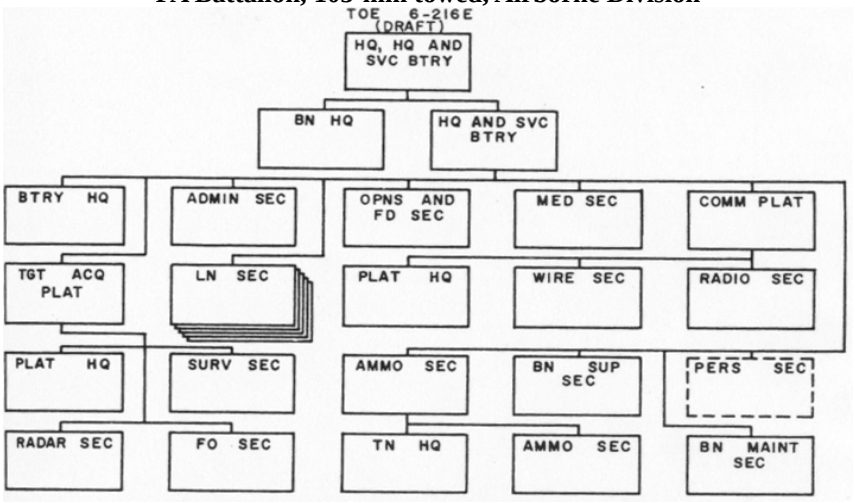
Division Artillery, Airborne Division



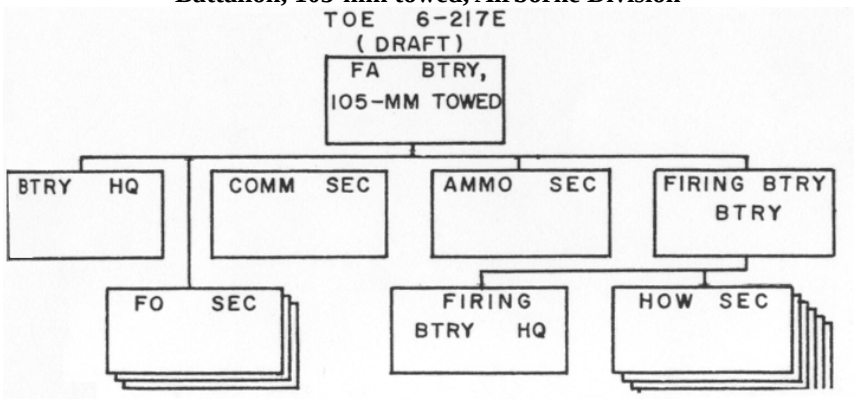
Headquarters and Headquarters Battery,
Division Artillery, Airborne Division



FA Battalion, 105-mm towed, Airborne Division

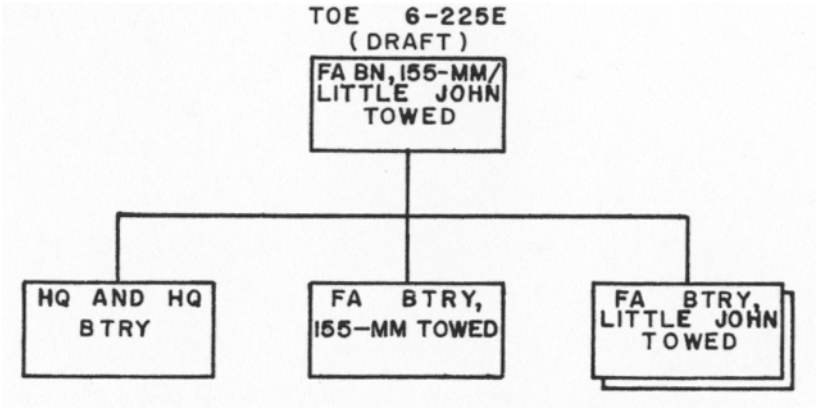


Headquarters, Headquarters and Service Battery, FA Battalion, 105-mm towed, Airborne Division

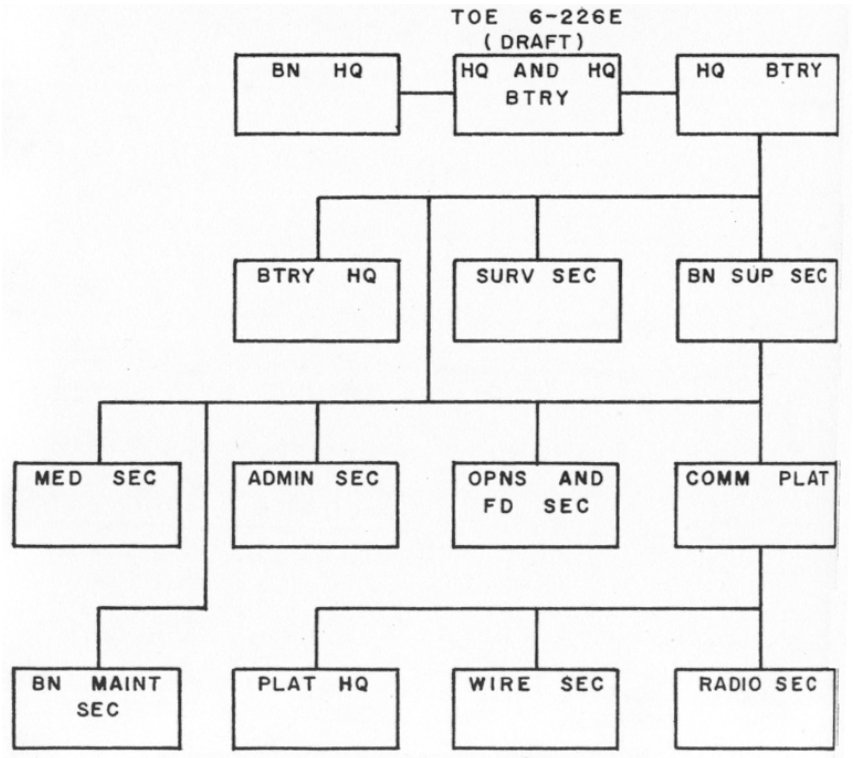


FA Battery, 105-mm towed, Airborne Division

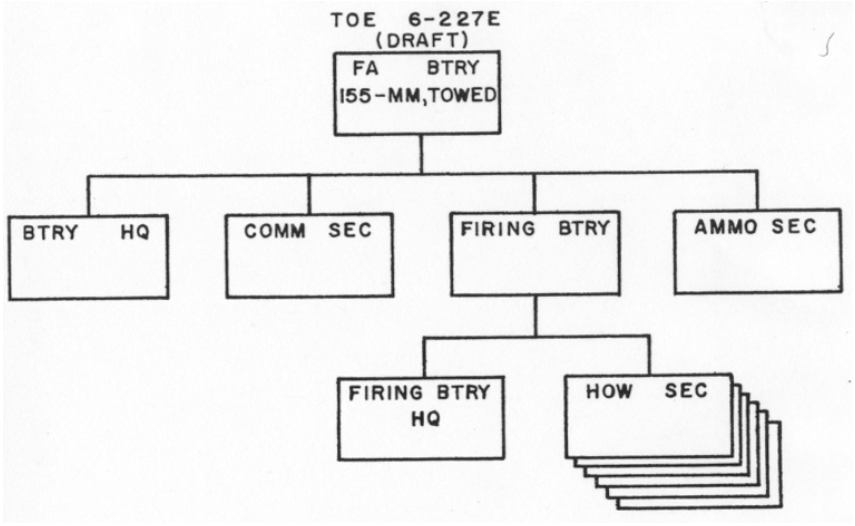
ABN DIV ARTY



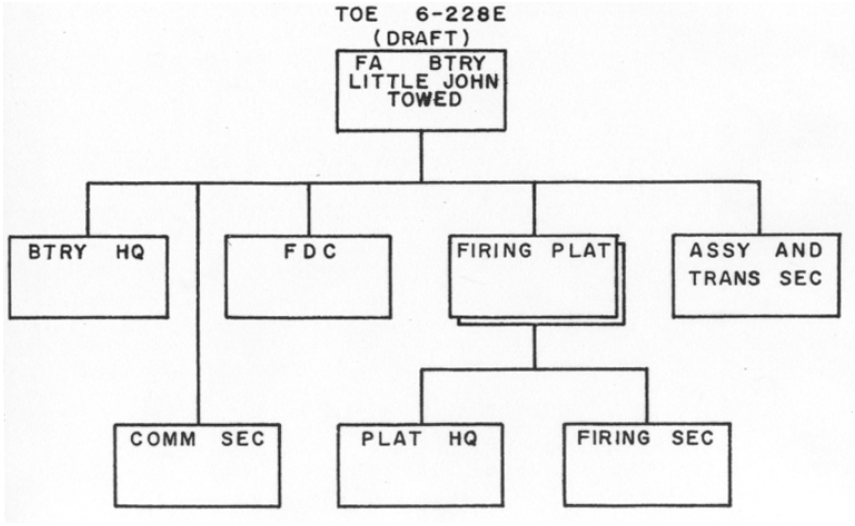
FA Battalion, 155-mm/LJ towed, Airborne Division



**Headquarters and Headquarters Battery, FA Battalion,
155-mm/LJ towed, Airborne Division**



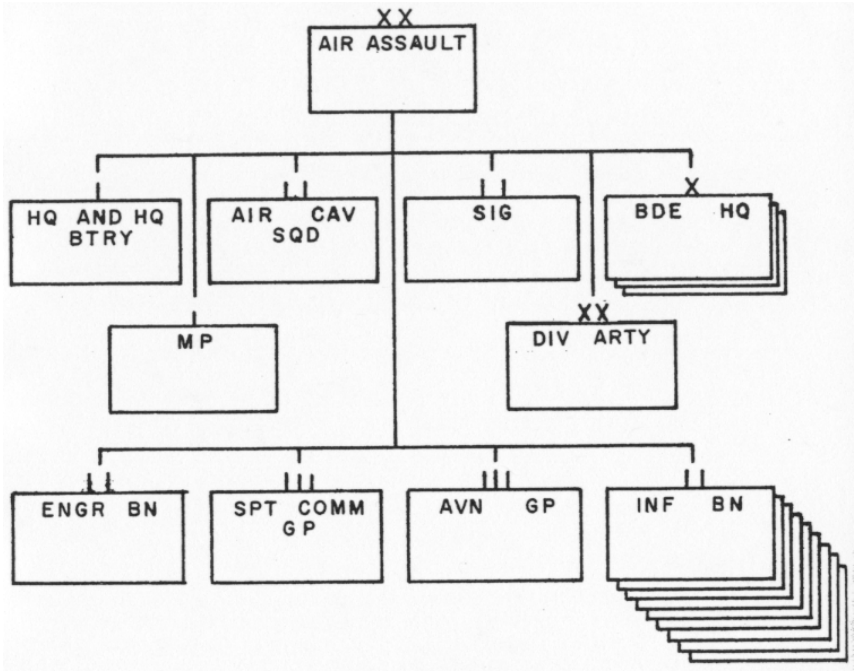
FA Battery, 155-mm towed, Airborne Division



FA Battery, Little John towed, Airborne Division

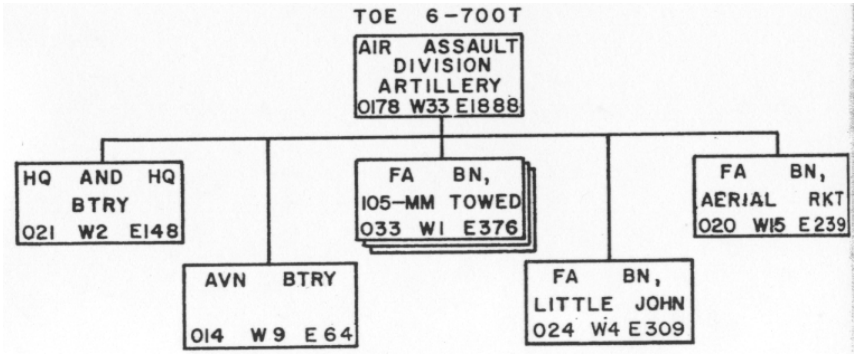
AA DIV

AIR ASSAULT DIVISION

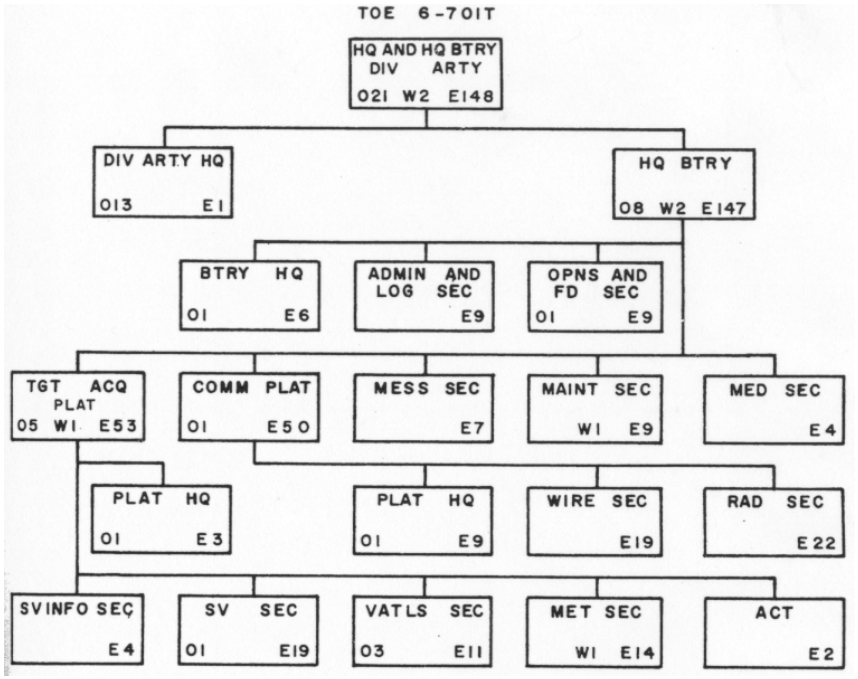


Air Assault Division

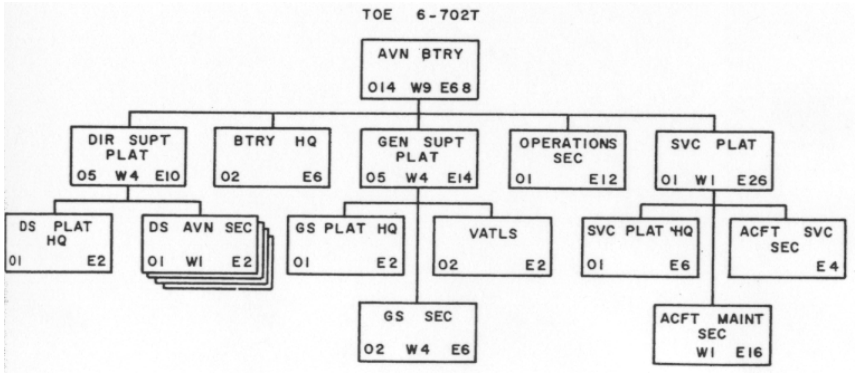
AIR ASSAULT DIVISION ARTILLERY



Division Artillery, Air Assault Division

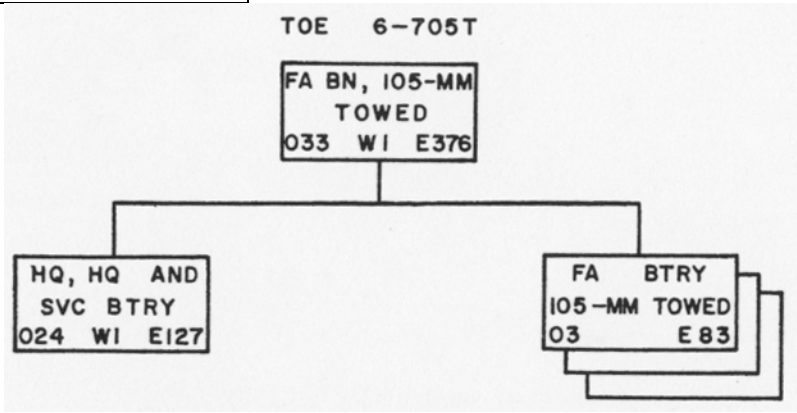


Headquarters and Headquarters Battery,
Division Artillery, Air Assault Division

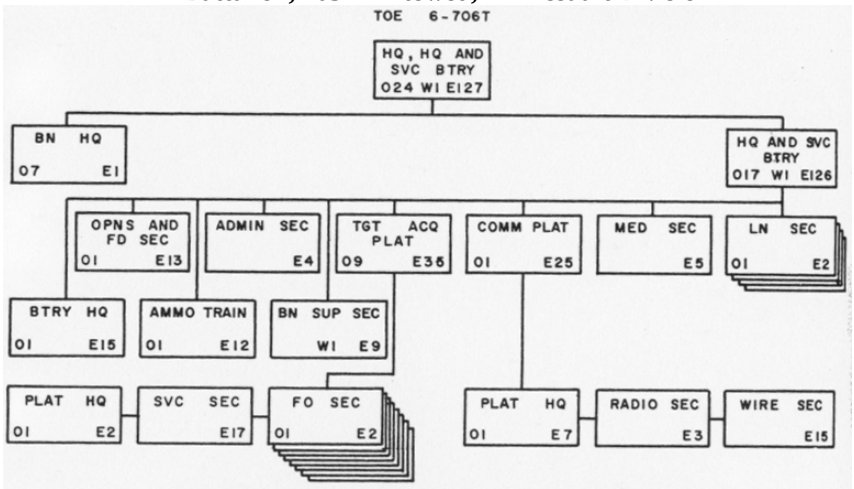


Aviation Battery, Division Artillery, Air Assault Division

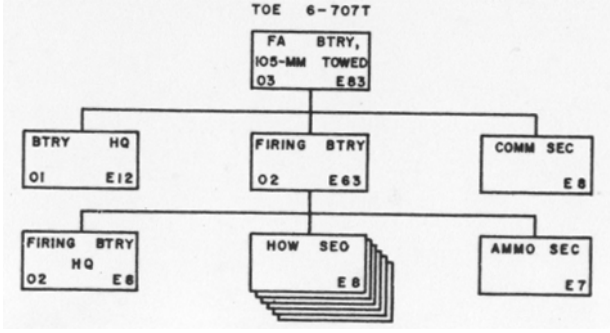
AA DIV ARTY



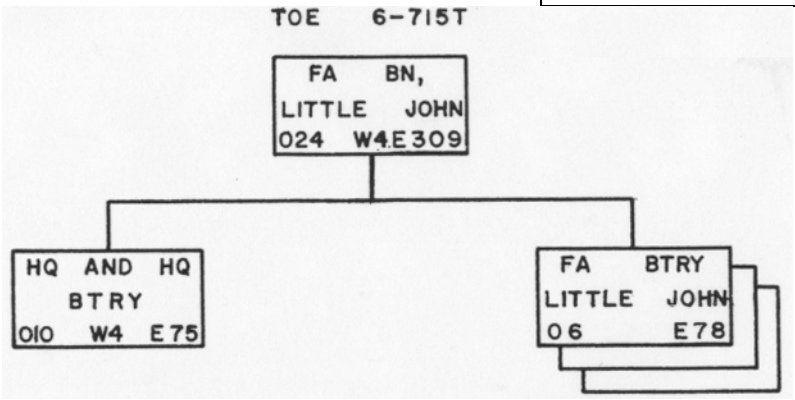
FA Battalion, 105-mm towed, Air Assault Division



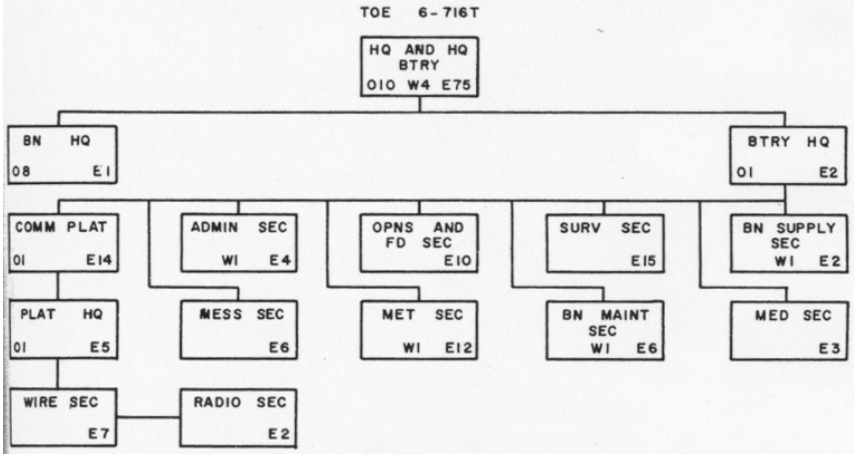
Headquarters, Headquarters and Service Battery, FA Battalion, 105-mm towed, Air Assault Division



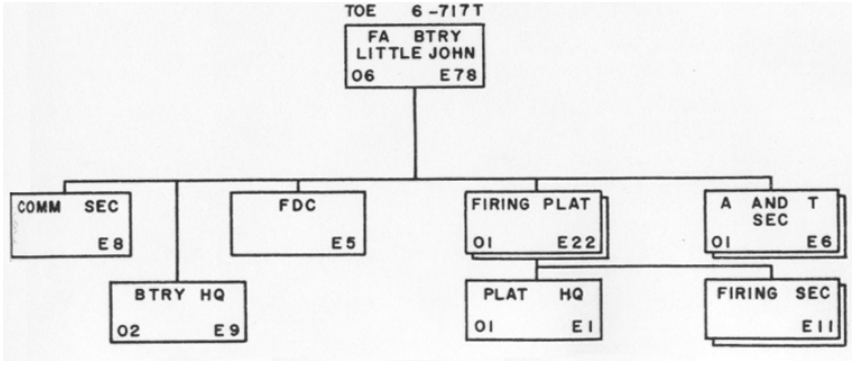
FA Battery, 105-mm towed, Air Assault Division



FA Battalion, Little John, Air Assault Division

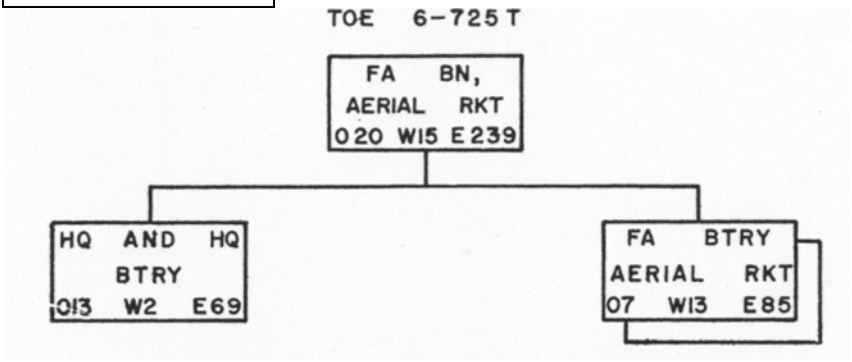


Headquarters and Headquarters Battery, FA Battalion, Little John, Air Assault Division

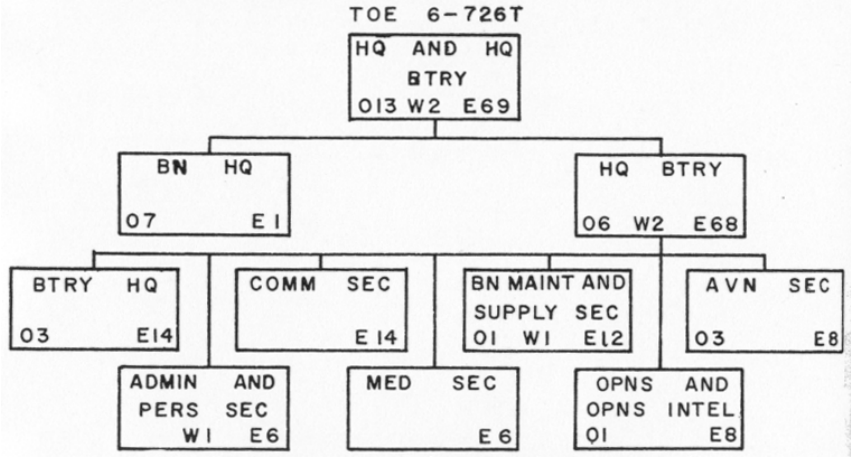


FA Battery, Little John, Air Assault Division

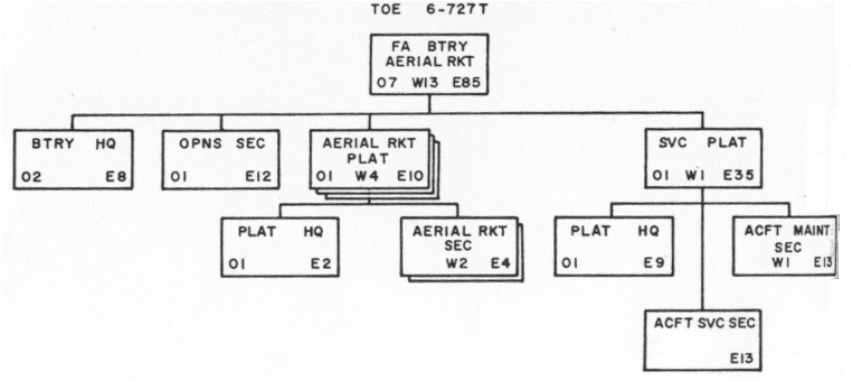
AA DIV ARTY



FA Battalion, Aerial Rocket, Air Assault Division

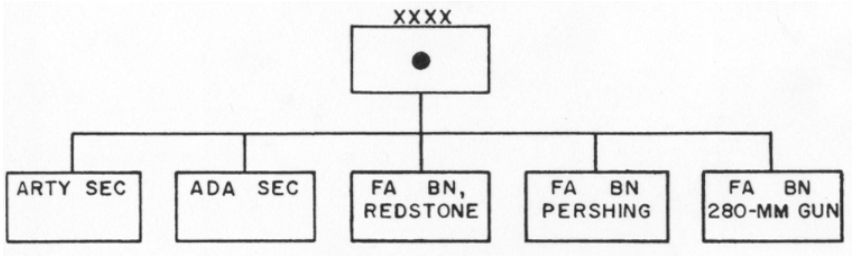


Headquarters and Headquarters Battery, FA Battalion, Aerial Rocket, Air Assault Division

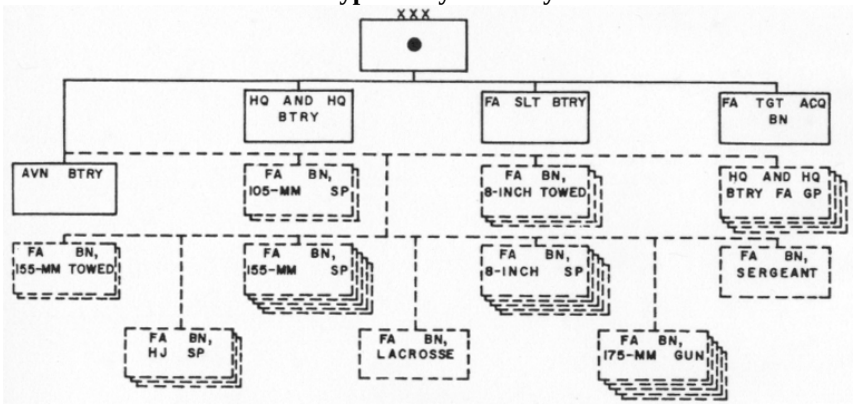


FA Battery, Aerial Rocket, Air Assault Division

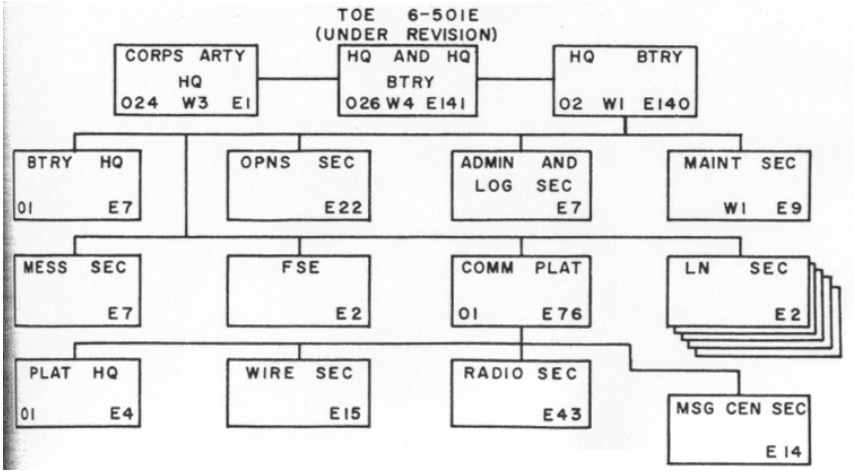
ARMY AND CORPS ARTILLERY



A Type Army Artillery

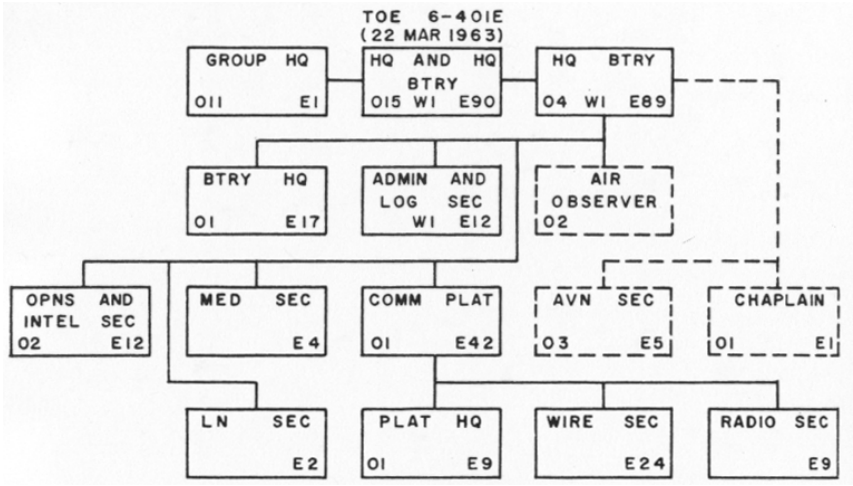


A Type Corps Artillery

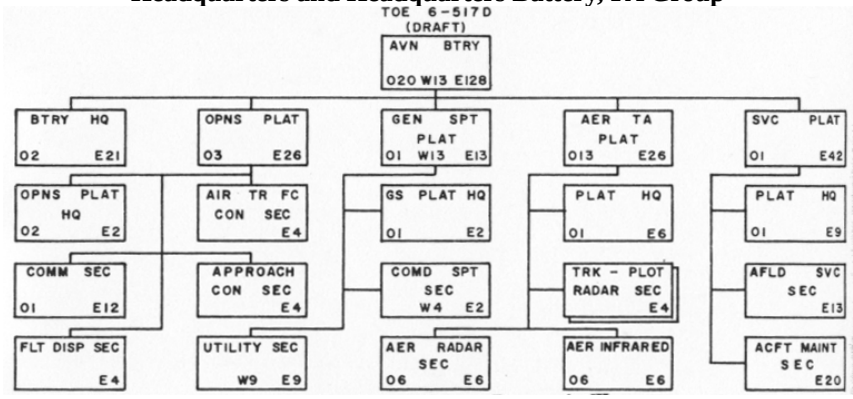


Headquarters and Headquarters Battery,
Corps Artillery or Airborne Corps Artillery

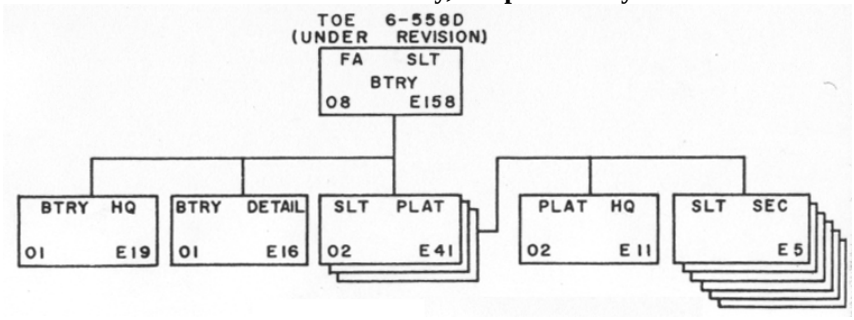
ARMY/CORPS ARTY



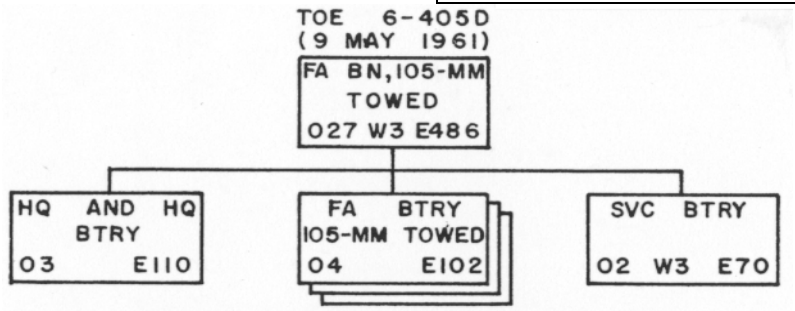
Headquarters and Headquarters Battery, FA Group



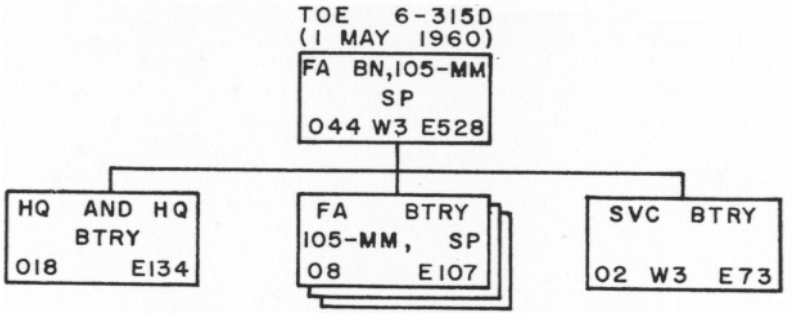
FA Aviation Battery, Corps Artillery



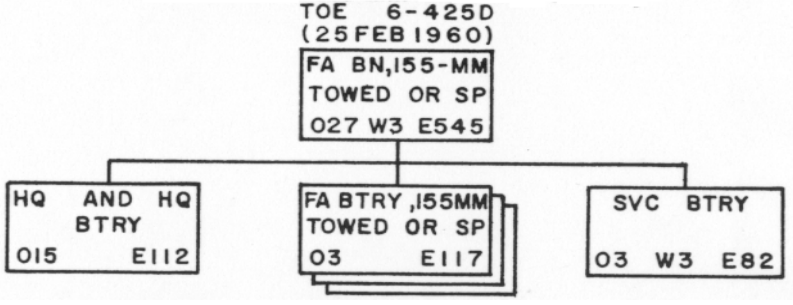
FA Searchlight Battery, Corps Artillery



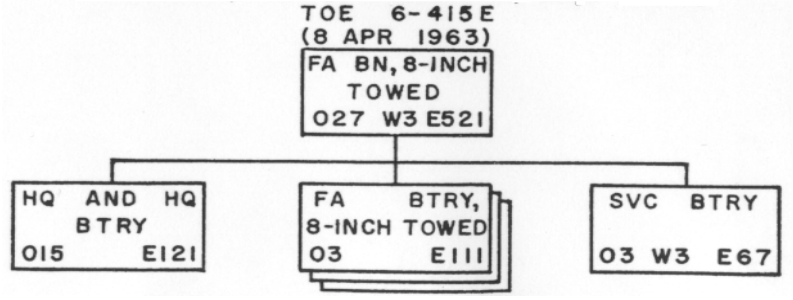
FA Battalion, 105-mm towed, Corps Artillery



FA Battalion, 105-mm SP, Corps Artillery

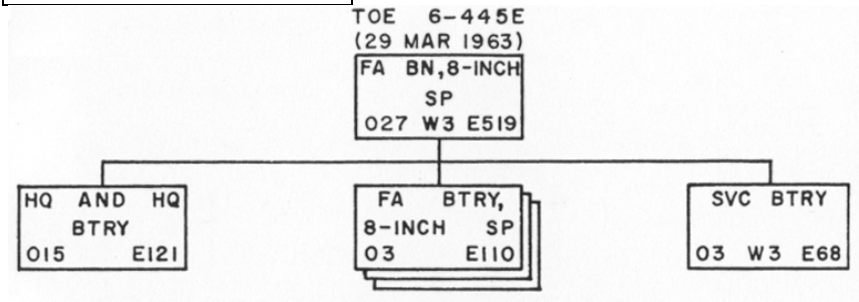


FA Battalion, 155-mm towed or SP, Corps Artillery

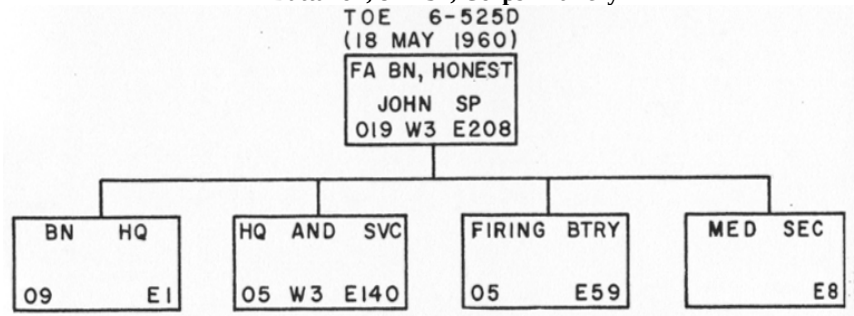


FA Battalion, 8-in towed, Corps Artillery

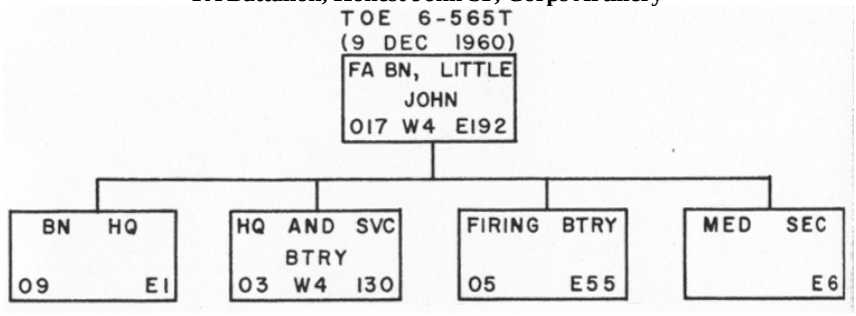
ARMY/CORPS ARTY



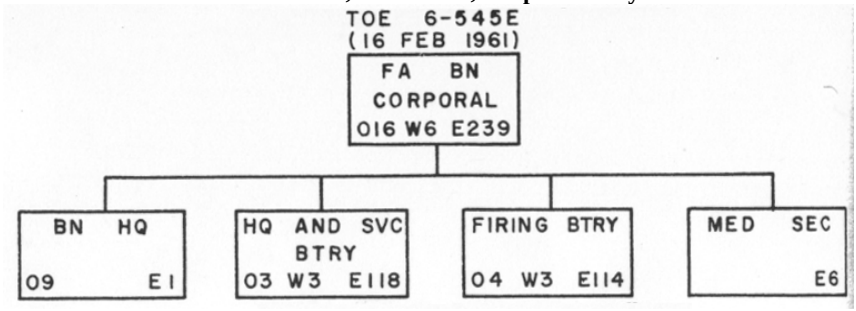
FA Battalion, 8-in SP, Corps Artillery



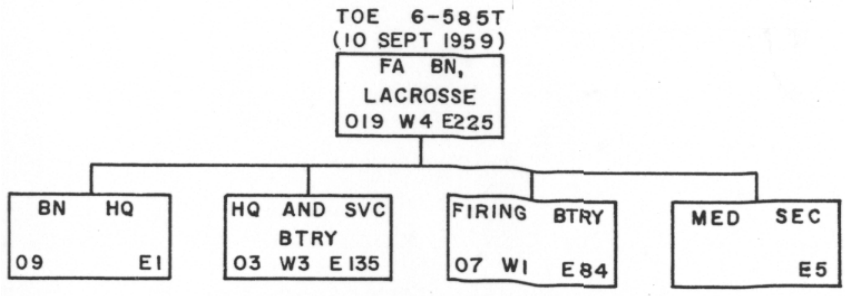
FA Battalion, Honest John SP, Corps Artillery



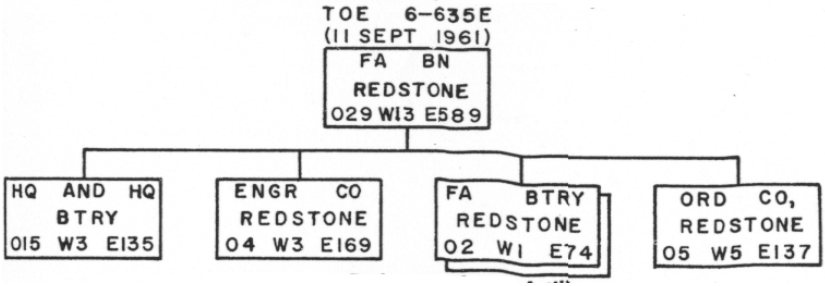
FA Battalion, Little John, Corps Artillery



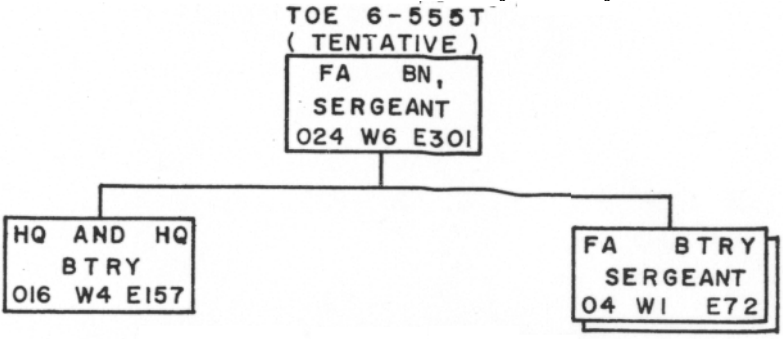
FA Battalion, Corporal, Corps Artillery



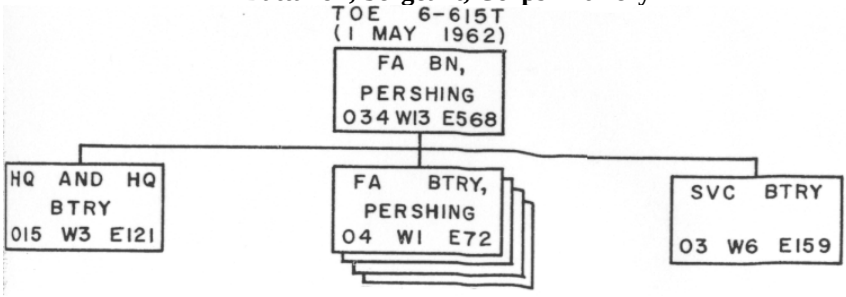
FA Battalion, Lacrosse, Corps Artillery



FA Battalion, Redstone, Army Artillery

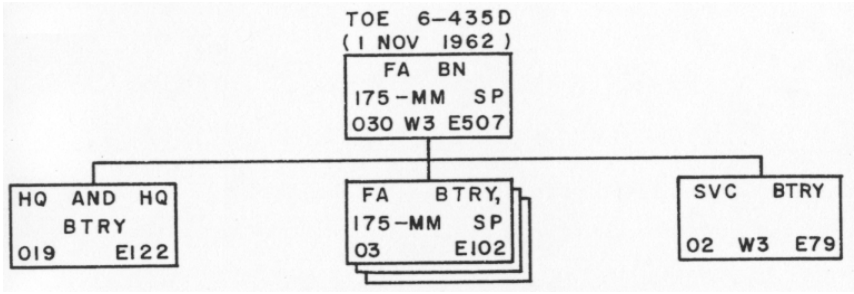


FA Battalion, Sergeant, Corps Artillery

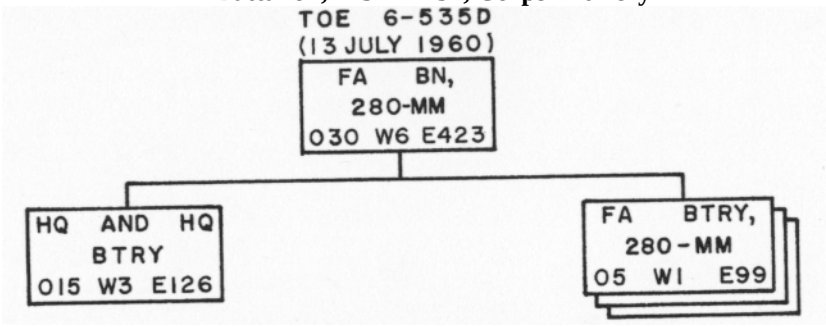


FA Battalion, Pershing, Army Artillery

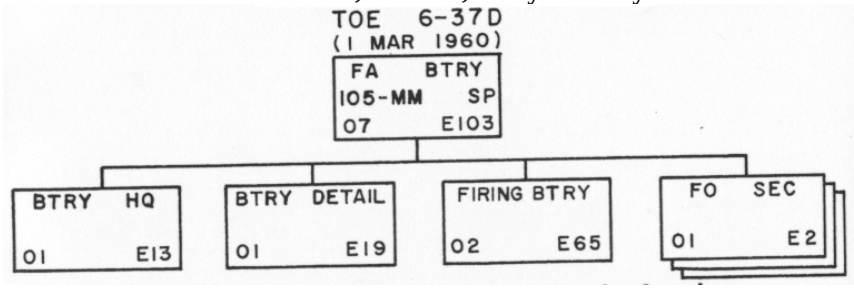
ARMY/CORPS ARTY



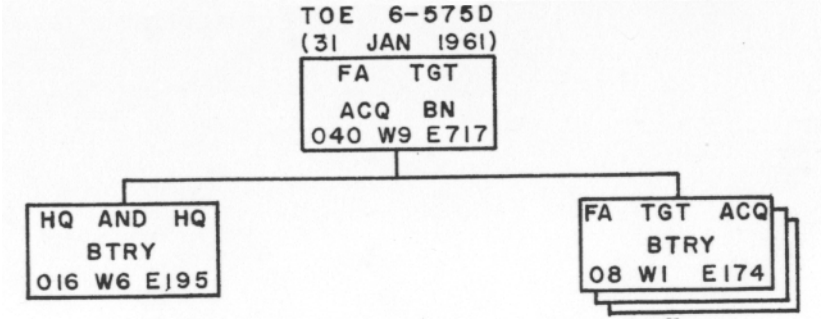
FA Battalion, 175-mm SP, Corps Artillery



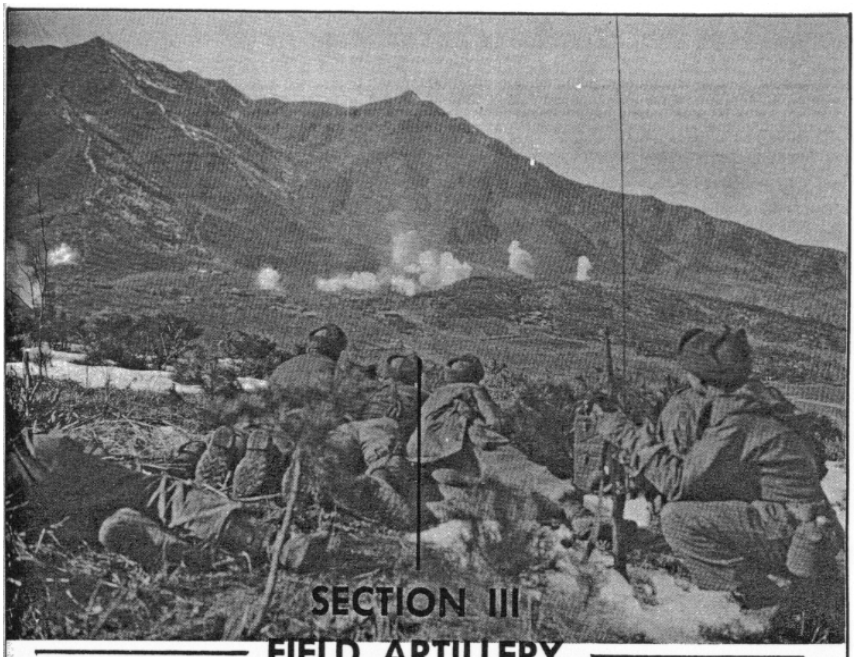
FA Battalion, 280-mm, Army Artillery



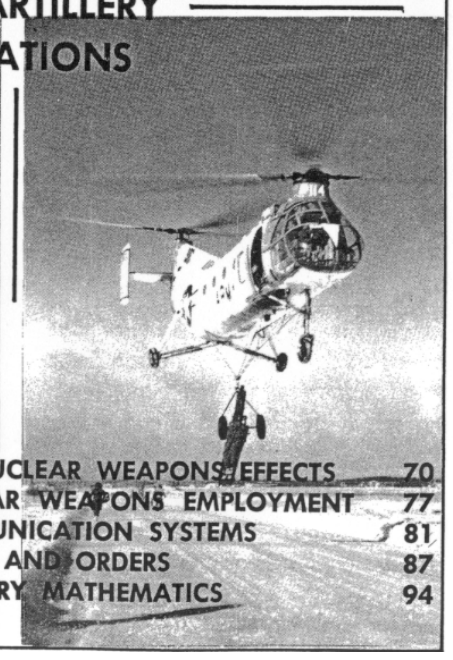
FA Battery, 105-mm SP, Armored Cavalry Squadron



FA Target Acquisition Battalion, Corps Artillery



SECTION III
FIELD ARTILLERY OPERATIONS



NONNUCLEAR WEAPONS EFFECTS

Tables XV-XXVI show the effects of various delivery systems on a certain range of typical target sizes which are within the general capabilities of the particular weapons systems. The tables show the expected fraction of casualties for both troops in the offense and troops in the defense.

The tables are based on the assumption that troops in the offense are standing when the first volley explodes, and prone for all subsequent volleys, the terrain being reasonably level and open. Troops in the defense are assumed to be standing when the first volley explodes, prone when the second volley explodes, and in foxholes without cover for all subsequent volleys. It is important to note that point detonating ammunition is used on the first volley and variable time fuzed ammunition is used for all subsequent volleys. It is also assumed that in the offense the longer dimension of the target is parallel to the line of fire and in the defense the longer dimension of the target is perpendicular to the line of fire.

Two methods of delivery are presented in the tables—observed fire and K-transfer. It should be noted that the terms "observed fire" and "K-transfer" are regarded somewhat categorically. The effects information listed for observed fire is based on the assumption that the center of the fire pattern can be placed on or near the intended target center. The K-transfer information is assumed to be an unobserved fire method, in which a system error is expected.

The expected fraction of casualties, F, is obtained from the formula

$$F = 1 - e^{-\frac{PC_P}{A}}$$

where e is the base of natural logarithms; P is the percentage of rounds expected to fall within the target area; C_p is the summation of the lethal areas of all rounds fired. The lethal area of a given round depends upon the existing target attitude. A is the total area of the target.

If observed fire is employed, there is usually no system error, and P is determined by the probable errors shown in the firing table inherent to the weapon. If the delivery method is K-transfer, another method which involves a system error, then the dispersion is determined by the combination of the two types of error into total probable errors, e_{pr} for range and e_{pd} for deflection.

Table XV

Delivery System: 105-mm How **Btry** Range: Two-Thirds Maximum
Method of Delivery: Observed fire **(1)** Ammunition: High Explosive

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
50m X 100m	.46	.61	.73	.81	.86	Offense**(2)**
	.33	.47	.48	.49	.51	Defense**(3)**
100m X 100m	.26	.38	.48	.56	.60	Offense
	.26	.38	.39	.40	.42	Defense
100m X 200m	.15	.23	.30	.36	.42	Offense
	.14	.21	.22	.23	.24	Defense
200m X 200m	.08	.12	.16	.20	.24	Offense
	.08	.12	.13	.13	.14	Defense

Table XVI

Delivery System: Method of Delivery, Range, and Ammunition
105-mm How **Bn** data are same as in TABLE XV

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.60	.76	.86	.91	.95	Offense**(2)**
	.60	.76	.77	.79	.80	Defense**(3)**
100m X 200m	.40	.54	.65	.74	.80	Offense
	.37	.51	.52	.54	.55	Defense
200m X 200m	.22	.32	.41	.49	.56	Offense
	.22	.32	.34	.35	.36	Defense

(1) It is assumed that the center of the fire pattern is placed on the intended center of the target.

(2) Troops in the Offense indicates that personnel are standing when the first volley hits. Thereafter, personnel are assumed to be prone.

(3) Troops in the Defense indicates that personnel are standing when the first volley hits, prone when the second volley hits, and in foxholes without cover for subsequent volleys.

Table XVII

Delivery System: 155-mm How **Btry** Range: Two-Thirds Maximum
Method of Delivery: Observed Fire**(1)** Ammunition: High Explosive

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.37	.56	.69	.78	.89	Offense**(2)**
	.37	.56	.58	.60	.62	Defense**(3)**
100m X 200m	.24	.39	.50	.60	.68	Offense
	.21	.33	.35	.37	.38	Defense
200m X 200m	.13	.22	.30	.37	.43	Offense
	.13	.22	.23	.24	.25	Defense

Table XVIII

Delivery System: Method of Delivery, Range, and Ammunition
155-mm How **Bn** data are same as TABLE XVII

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.75	.91	.97	.99	.99	Offense**(2)**
	.75	.91	.92	.93	.94	Defense**(3)**
100m X 200m	.57	.77	.88	.94	.97	Offense
	.50	.71	.73	.75	.76	Defense
200m X 200m	.34	.52	.65	.75	.82	Offense
	.34	.52	.54	.56	.58	Defense

(1) It is assumed that the center of the fire pattern is placed on the intended center of the target.

(2) Troops in the Offense indicates that personnel are standing when the first volley hits. Thereafter, personnel are assumed to be prone.

(3) Troops in the Defense indicates that personnel are standing when the first volley hits, prone when the second volley hits, and in foxholes without overhead cover for subsequent volleys.

Table XIX

Delivery System: 8-inch How **Btry** Range: Two-Thirds Maximum
Method of Delivery: Observed Fire**(1)** Ammunition: High Explosive

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.39	.54	.66	.75	.81	Offense**(2)**
	.39	.54	.56	.58	.59	Defense**(3)**
100m X 200m	.24	.35	.45	.53	.60	Offense
	.22	.33	.34	.35	.36	Defense
200m X 200m	.13	.19	.26	.31	.37	Offense
	.13	.19	.20	.21	.22	Defense

Table XX

Delivery System: Method of Delivery, Range, and Ammunition
8-Inch How **Bn** data are same as TABLE XIX

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.77	.91	.96	.98	.99	Offense**(2)**
	.77	.91	.92	.92	.93	Defense**(3)**
100m X 200m	.56	.73	.83	.90	.94	Offense
	.52	.69	.71	.73	.74	Defense
200m X 200m	.34	.48	.59	.68	.75	Offense
	.34	.48	.49	.51	.52	Defense

(1) It is assumed that the center of the fire pattern is placed on the intended center of the target.

(2) Troops in the Offense indicates that personnel are standing when the first volley hits. Thereafter, personnel are assumed to be prone.

(3) Troops in the Defense indicates that personnel are standing when the first volley hits, prone when the second volley hits, and in foxholes without overhead cover for subsequent volleys.

Table XXI

Delivery System: 105-mm How **Btry** Range: Two-Thirds Maximum
Method of Delivery: K-Transfer**(1)** Ammunition: High Explosive

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
50m X 100m	.21	.31	.39	.47	.53	Offense**(2)**
	.11	.17	.18	.18	.19	Defense**(3)**
100m X 100m	.11	.17	.22	.27	.31	Offense
	.11	.17	.17	.18	.19	Defense
100m X 200m	.10	.15	.20	.25	.29	Offense
	.06	.09	.10	.10	.10	Defense
200m X 200m	.05	.08	.11	.13	.16	Offense
	.05	.08	.09	.09	.09	Defense

Table XXII

Delivery System: Method of Delivery, Range, and Ammunition
105-mm How **Bn** data are same as TABLE XXI

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE

Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.28	.42	.52	.61	.68	Offense**(2)**
	.28	.42	.44	.45	.46	Defense**(3)**
100m X 200m	.26	.39	.49	.58	.65	Offense
	.15	.24	.25	.26	.27	Defense
200m X 200m	.14	.22	.29	.35	.40	Offense
	.14	.22	.23	.24	.25	Defense

(1) K-transfer is assumed to be an unobserved fire method which contains a system error.

(2) Troops in the Offense indicates that personnel are standing when the first volley hits. Thereafter, personnel are assumed to be prone.

(3) Troops in the Defense indicates that personnel are standing when the first volley hits, prone when the second volley hits, and in foxholes without overhead cover for subsequent volleys.

Table XXIII

Delivery System: 155-mm How **Btry** Range: Two-Thirds Maximum
Method of Delivery: K-Transfer**(1)** Ammunition: High Explosive

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE						
Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.32	.49	.62	.72	.79	Offense**(2)**
	.32	.49	.52	.53	.55	Defense**(3)**
100m X 200m	.24	.38	.49	.59	.66	Offense
	.18	.29	.30	.32	.33	Defense
200m X 200m	.13	.21	.29	.36	.41	Offense
	.13	.21	.22	.23	.25	Defense

Table XXIV

Delivery System: Method of Delivery, Range, and Ammunition
155-mm How **Bn** data are same as TABLE XXIII

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE						
Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.69	.87	.95	.98	.99	Offense**(2)**
	.69	.87	.89	.90	.91	Defense**(3)**
100m X 200m	.56	.76	.87	.93	.96	Offense
	.44	.64	.66	.68	.70	Defense
200m X 200m	.33	.51	.64	.73	.81	Offense
	.33	.51	.53	.53	.57	Defense

(1) K-transfer is assumed to be an unobserved fire method which contains a system error.

(2) Troops in the Offense indicates that personnel are standing when the first volley hits. Thereafter, personnel are assumed to be prone.

(3) Troops in the Defense indicates that personnel are standing when the first volley hits, prone when the second volley hits, and in foxholes without overhead cover for subsequent volleys.

Table XXV

Delivery System: 8-Inch How **Btry** Range: Two-Thirds Maximum
Method of Delivery: K-Transfer**(1)** Ammunition: High Explosive

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE						
Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.27	.40	.50	.59	.66	Offense**(2)**
	.27	.40	.42	.43	.44	Defense**(3)**
100m X 200m	.19	.29	.37	.45	.51	Offense
	.18	.27	.28	.29	.30	Defense
200m X 200m	.12	.19	.25	.31	.36	Offense
	.12	.19	.20	.21	.21	Defense

Table XXVI

Delivery System: Method of Delivery, Range, and Ammunition
8-Inch How **Bn** data are same as TABLE XXV

EXPECTED FRACTION OF CASUALTIES FOR CONSECUTIVE VOLLEYS OF FIRE						
Target Size	1	2	3	4	5	Troop Attitude
100m X 100m	.62	.78	.88	.93	.96	Offense**(2)**
	.62	.78	.80	.81	.82	Defense**(3)**
100m X 200m	.48	.64	.75	.83	.88	Offense
	.45	.61	.62	.64	.66	Defense
200m X 200m	.33	.47	.58	.66	.73	Offense
	.33	.47	.48	.50	.51	Defense

(1) K-transfer is assumed to be an unobserved fire method which contains a system error.

(2) Troops in the Offense indicates that personnel are standing when the first volley hits. Thereafter, personnel are assumed to be prone.

(3) Troops in the Defense indicates that personnel are standing when the first volley hits, prone when the second volley hits, and in foxholes without overhead cover for subsequent volleys.

NUCLEAR WEAPONS EMPLOYMENT

General

Consolidated herein are general facts considered useful to commanders, staff officers, and firing units involved in the employment of nuclear weapons. No attempt has been made to cover the detailed subject of Target Analysis, since the personnel directly concerned with that function have already received all essential information by school and refresher training and must rely upon the complete treatises contained in appropriate reference manuals, in order to perform their duties properly.

Command Guidance

The magnitude and nature of nuclear weapon effects have a profound influence on ground operations. Therefore, command guidance to the staff before commencement of their planning is vital. The commander devotes at least the same thought and effort to his development of initial staff planning guidance concerning nuclear weapons employment as he does to the employment of maneuver forces and other fires. If there is little time for staff planning, this guidance may consist of a decision by the commander at the very outset. When more time is available, the guidance may include specific courses of action for the staff to consider during the development of staff estimates.

In developing his initial staff planning guidance, the commander considers the requirements of all the general staff. In addition, he provides guidance for the artillery commander and, at field army level, for the air defense artillery commander.

The commander provides such additional guidance as may be required throughout the planning process up to the time nuclear weapons are fired.

It is essential that commanders and staff officers understand the effects of nuclear weapons, the capabilities and limitations of the various delivery systems, the combat service support requirements involved, and the procedures for employing these weapons. However, these officers receive technical advice from the nuclear weapons employment officers (NWEO) in the tactical operations center on matters incident to the use of such weapons.

Initial staff planning guidance normally falls into the following categories; type of targets to be attacked (scheduled or on-call); allocations to subordinate units; and desired nuclear weapon reserve.

The commander's initial staff planning guidance for the use of nuclear weapons varies as to content with the echelon concerned.

a. At division level, this guidance is normally confined to the type targets to be attacked with nuclear weapons and the weapon reserve desired. The division commander may also have occasion to give guidance as to allocation of weapons to a brigade. In the case of DAVY CROCKETT he may desire to allocate to the cavalry squadron or to a small task force. Because of the immediate and profound impact nuclear weapons have on operations at the division echelon, the commander's guidance normally is quite detailed in

the areas mentioned above. He frequently indicates specific weapons that will constitute his nuclear weapon reserve. A division nuclear weapon reserve is retained for attack of targets of opportunity, rather than for future operations.

b. At corps level, initial staff planning guidance is normally provided concerning the type targets to be attacked with nuclear weapons under corps control, a general guide as to weapons allocation to major subordinate commands, and the general nature of the corps nuclear weapon reserve. Because of the scope and area of corps operations, the corps is the lowest echelon that retains a substantial reserve of nuclear weapons for future phases of an operation. Since corps possesses the resources for delivering a decisive blow on the enemy, command guidance includes the nuclear fires desired in connection with the commitment of the corps reserve maneuver force.

c. At field army level, the commander's initial staff planning guidance is more general than at lower echelons. Since field army plans an operation weeks or even months in advance of the D-Day, initial staff planning guidance seldom concerns the attack by field army of specific targets with nuclear weapons. Instead, the field army commander provides guidance that permits the staff to develop tentative allocations of weapons to major subordinate commands for each phase of the army operation, and an appropriate army reserve of nuclear weapons for the entire operation. The army commander also provides guidance in regard to priorities in the employment of nuclear air defense weapons with specific attention to the use of such weapons in a surface-to-surface role. Because of his responsibility in regard to nuclear weapons logistical support, the field army commander provides guidance in this area. This guidance will generally be an expression of desired priorities. Finally, he provides guidance as to his policies (and policies imposed by higher headquarters) concerning limiting requirements (d below). This guidance may include such areas as limitations on fallout, protection of friendly civilians, and avoidance of damage to transportation complexes.

d. Damage criteria and troop safety considerations are SOP matters. Command guidance in these respects is appropriate only when departures from the SOP are desired. The SOP should state the required coverage to destroy a target, and the required target coverage to neutralize a target. Based on the SOP, the nuclear weapons employment officer determines the extent and nature of damage required, and recommends the weapon system best suited for the task. There are three degrees of risk which a commander may accept under differing tactical conditions, i.e., negligible, moderate, or emergency. At a **negligible** risk distance, troops are completely safe with the possible exception of temporary loss of night vision or dazzle. At a **moderate** risk distance anticipated effects levels are tolerable, or at worst a minor nuisance. In rare instances, some individuals may require evacuation. At an **emergency** risk distance, the anticipated effects levels may cause some temporary shock, a few casualties, and may significantly reduce the unit's combat efficiency. Normally, the commander will, as an SOP, desire negligible risk to his own and adjacent forces. The staff, including the nuclear weapons employment officer, automatically take this into account in their analysis and operational

planning. If a risk greater than negligible must be taken, or if friendly troops must be warned of the attack, the employment officer so indicates when he makes his recommendations. Creation of obstacles to friendly movement and other undesirable effects are also matters the staff and the nuclear weapons employment officer are normally quite capable of foreseeing and minimizing without being given specific guidance. These limiting requirements may include one or more of the following:

(1) No significant fallout.

(2) No damage to a particular installation or area.

(3) Significant induced contamination will not be placed on a specific area, or the intensity of the induced contamination near ground zero will be held to a minimum.

e. Warnings of Friendly Nuclear Strikes. Advance warning of a nuclear strike is required to insure that friendly forces do not receive casualty-producing weapon effects. The content of nuclear strike warning messages depends upon the echelon of command receiving them, with units of battalion-size or larger receiving a more detailed message than battery- or company-size units.

Fire Orders

Once a fire mission has been approved, fire support agencies are given the necessary orders to cause the weapons to be delivered on the target.

a. Orders to Army delivery units include—

(1) Unit to deliver the weapon.

(2) Firing site, if applicable.

(3) Delivery system/yield.

(4) Height of burst in meters, or in the case of radar-fuzed weapons, height of burst option or radar step number.

(5) When applicable, a fuzing option desired, e.g., contact backup or contact preclusion.

(6) Desired ground zero.

(7) Time of burst.

(8) Resupply instructions, if applicable.

b. If air delivered weapons have been allocated to an Army unit, the message to the ASOC includes—

(1) Yield.

(2) Maximum permissible CEP.

(3) Height of burst in meters, or in the case of radar-fuzed weapons, height of burst option or radar step number.

(4) When applicable, fuzing option desired, e.g., contact backup or contact preclusion.

(5) Desired ground zero.

(6) Time of burst.

(7) Applicable coordination measures. For example:

(a) Special signal procedures such as the marking of the initial point, and abort signals.

(b) Flak suppression measures.

(c) Special air defense coordination procedures.

Early notification to the delivery unit reduces delays in firing. Advance information with which to occupy firing sites, compute firing data, and prepare the nuclear round is desirable. On some occasions, this information is given to the delivery unit prior to the time a decision is made to employ the weapon.

Fire support agencies may be ordered to prepare an alternate nuclear weapon system (either of the same type or of a different type) or to plan nonnuclear fires in the event of failure of the first weapon. This should be done when a less reliable weapon system is employed.

Nuclear Weapons Employment Reference Material

FM 101-31-1, Feb 1963; FM 101-31-2, Feb 1963;

FM 101-31-3, Feb 1963; FM 3-12, Jan 1963; FM 3-210, May 1962;

TM 23-200, Nov 1957, w/C 2, 3 Oct 1960.

The current FM 101-31 used for Nuclear Weapons Employment instruction and DA Pam 39-1, titled Nuclear Weapons Employment were replaced by three manuals or volumes—FM 101-31-1; FM 101-31-2; and FM 101-31-3.

FM 101-31-1 provides specific doctrine concerning those facts of tactical operations which are applicable to active nuclear warfare. It contains the US Army concepts for nuclear weapons employment and the command and staff actions required to carry out those concepts. Appendixes to this volume present detailed technical procedures concerning target analysis.

FM 101-31-2 provides the data necessary for actual target analysis.

FM 101-31-3 provides data concerning a family of hypothetical nuclear weapons. It provides data necessary for target analysis. This volume is designed specifically for use in training of the staff officer particularly the Nuclear Weapons Employment Officer. It is not intended for field exercises or command post exercises by US Forces, but can be so used by non-US Forces. Facility in use of FM 101-31-3 will insure facility in the use of FM 101-31-2.

Short Titles, Legends, and Symbols

The short titles and legends shown in Figure 75 will be used for field artillery amplitude-modulation (AM) and frequency-modulation (FM) nets, and for nets other than artillery only when shown in conjunction with artillery nets.

Letters may be used in combinations, arranged in alphabetical order to indicate dual purpose nets; for example, CF for command/fire direction net, CI for command/intelligence net, etc.

FM nets are shown by a solid line, AM nets by a solid line on which a series of X's are superimposed at convenient intervals. Suffix numbers are added, if more than one net is used for the same purpose; for example, F1, F2, and F3.

Figure 76 depicts various basic symbols for signal installations.

FM NETS	PURPOSE	SHORT TITLE	AM NETS
——— C ———	Command	C	—X—C—X—
——— F ———	Fire Direction	F	—X—F—X—
——— I ———	Intelligence	I	—X—I—X—
——— S ———	Survey	S	—X—S—X—
——— M ———	Meteorological	M	—X—M—X—
— — — — — —	Alternate Net		–X—X—X—X–

Figure 75. Titles and Legends

Wire circuit with telephone set TA-312/PT		Radar Station	
Wire circuit indicating number of pairs available		Telephone switching central not at a command post or HQ	
Multi-channel cable		12 or 24 channel radio relay system	
Not always provided		12 channel radio relay system	
Signal center operated by signal battalion		Radio/wire integration station FM	
Telephone switching central at a command post or HQ		Test point or wirehead operated by signal Bn	

Figure 76. Symbols for signal installations

COMMUNICATIONS SYSTEMS

Division Area Communications Systems

The Division Area Communications System shown in figure 77 is a network of radio relay and carrier links. The establishment of this system is a command responsibility; however, the division signal officer using the equipment and personnel of the Division Signal Battalion supervises the installation and operation of the system.

Circuits between division artillery headquarters and division headquarters are provided by one of the signal companies of the division signal battalion. Whenever possible the division artillery headquarters should extend circuits to other signal facilities within the general area of operation, such as those located at a brigade headquarters, providing an alternate means for routing traffic. Each divisional artillery battalion and battery should install a circuit to the nearest signal facility within the area system as indicated in figures 78 and 79. This will greatly reduce the possibility of losing contact with supported or reinforced units and higher headquarters.

The division area system is connected to the army area system by the Army Signal Group which has the mission of providing personnel and equipment to the division rear and the support command for such purpose. The corps does not operate an area system. The Corps Signal Battalion installs the necessary equipment at the Division Command Posts to permit it to be connected to both division and army area systems.

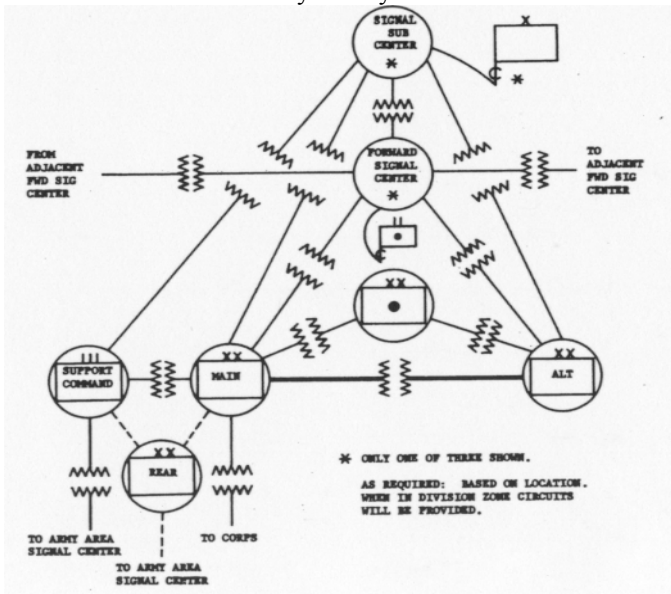
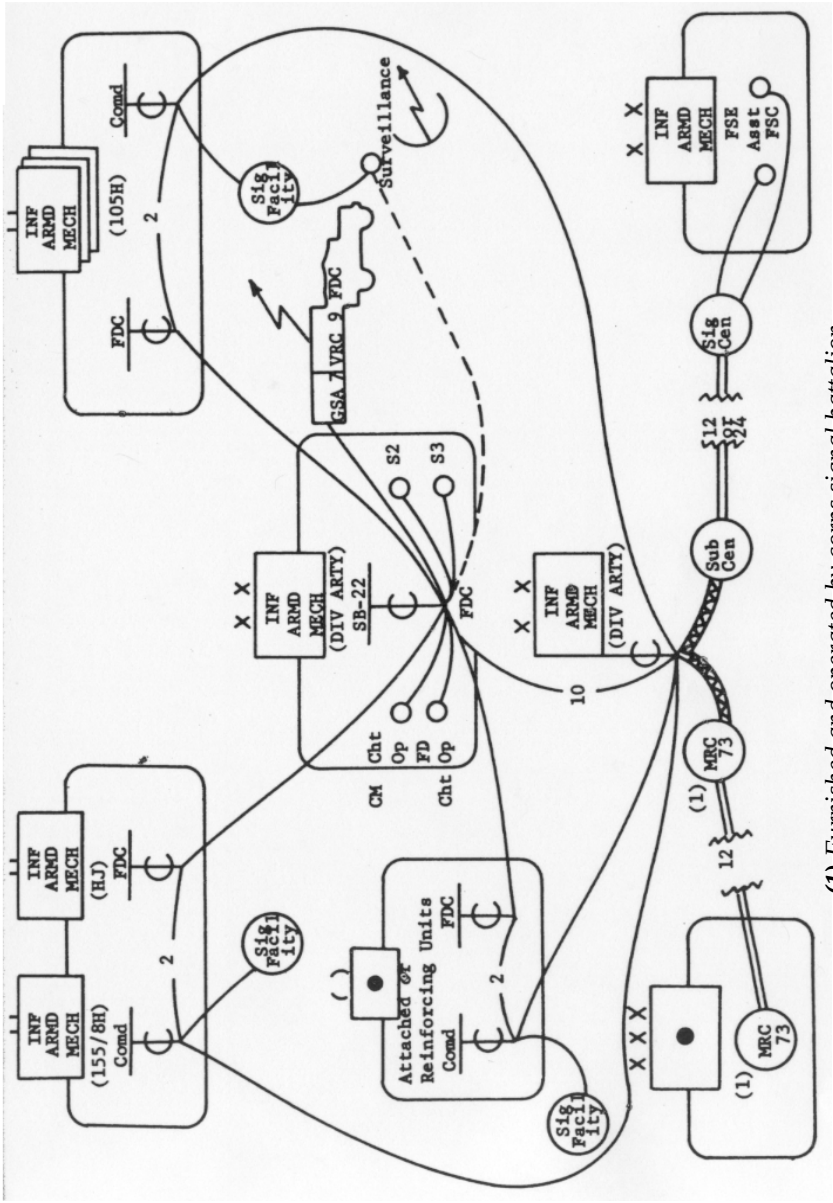


Figure 77. Division Area Communications System

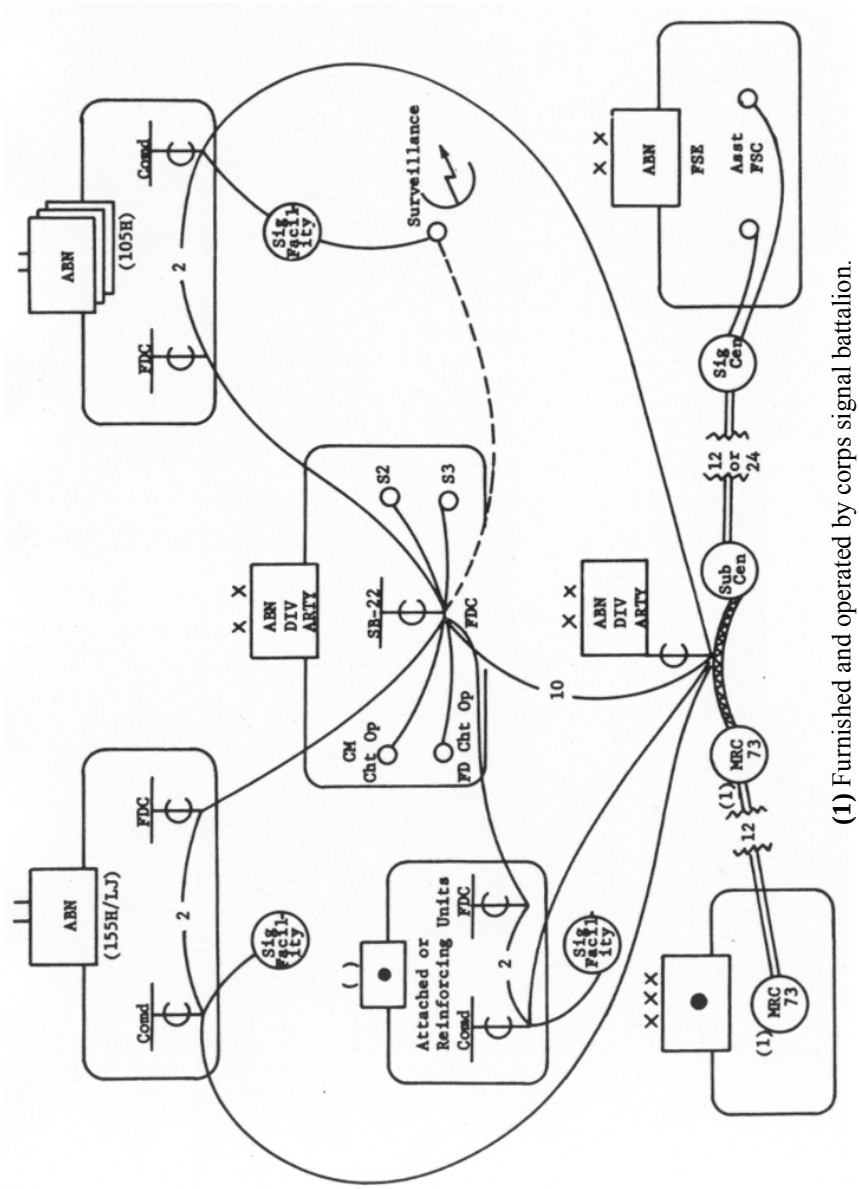
Type Wire System for Infantry, Armored or Mechanized Division Artillery



(1) *Furnished and operated by corps signal battalion.*

Figure 78. Type Wire System for Infantry, Armored or Mechanized Division Artillery.

Type Wire System for Airborne Division Artillery



(1) Furnished and operated by corps signal battalion.

Figure 79. Type Wire System for Airborne Division Artillery

Radio Systems for Infantry, Armored or Mechanized Division Artillery

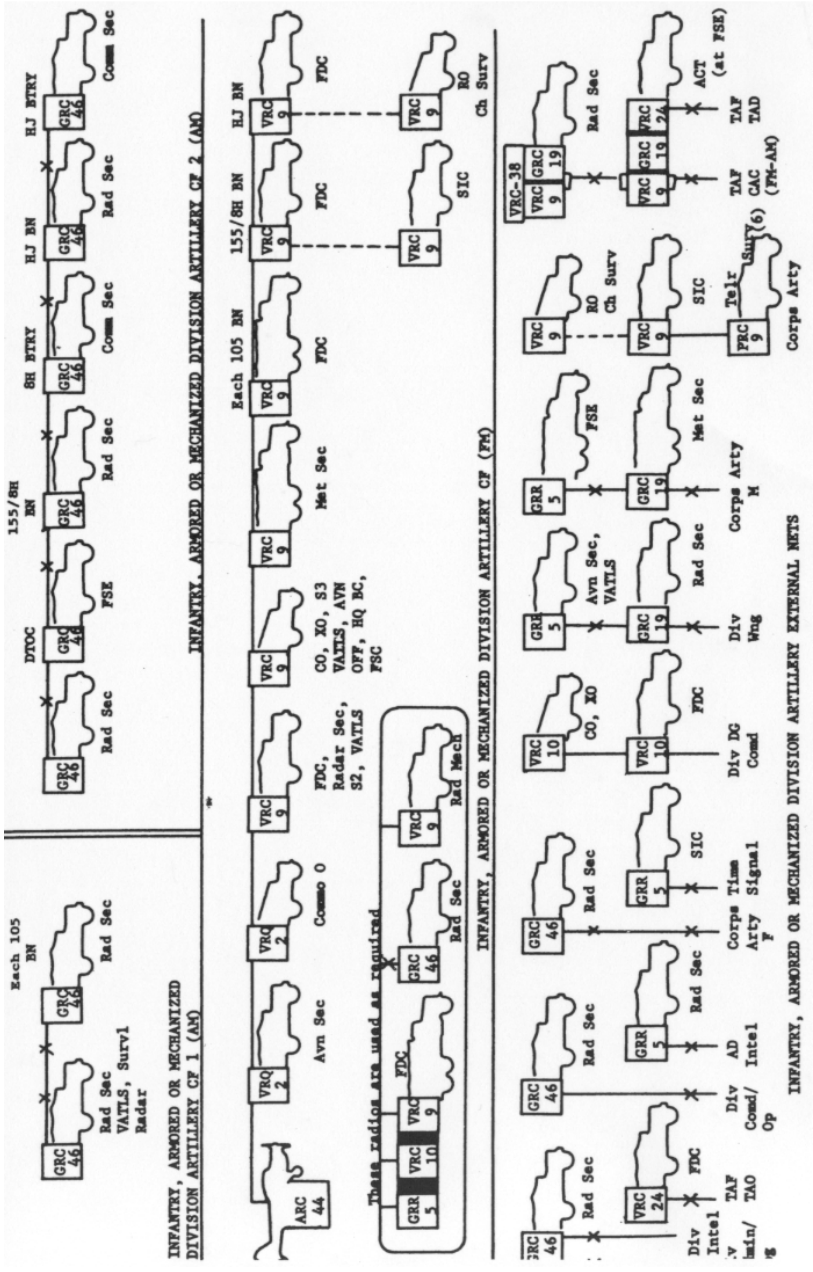


Figure 80. Radio Systems for Infantry, Armored or Mechanized Division Artillery

Radio Systems for Airborne Division Artillery

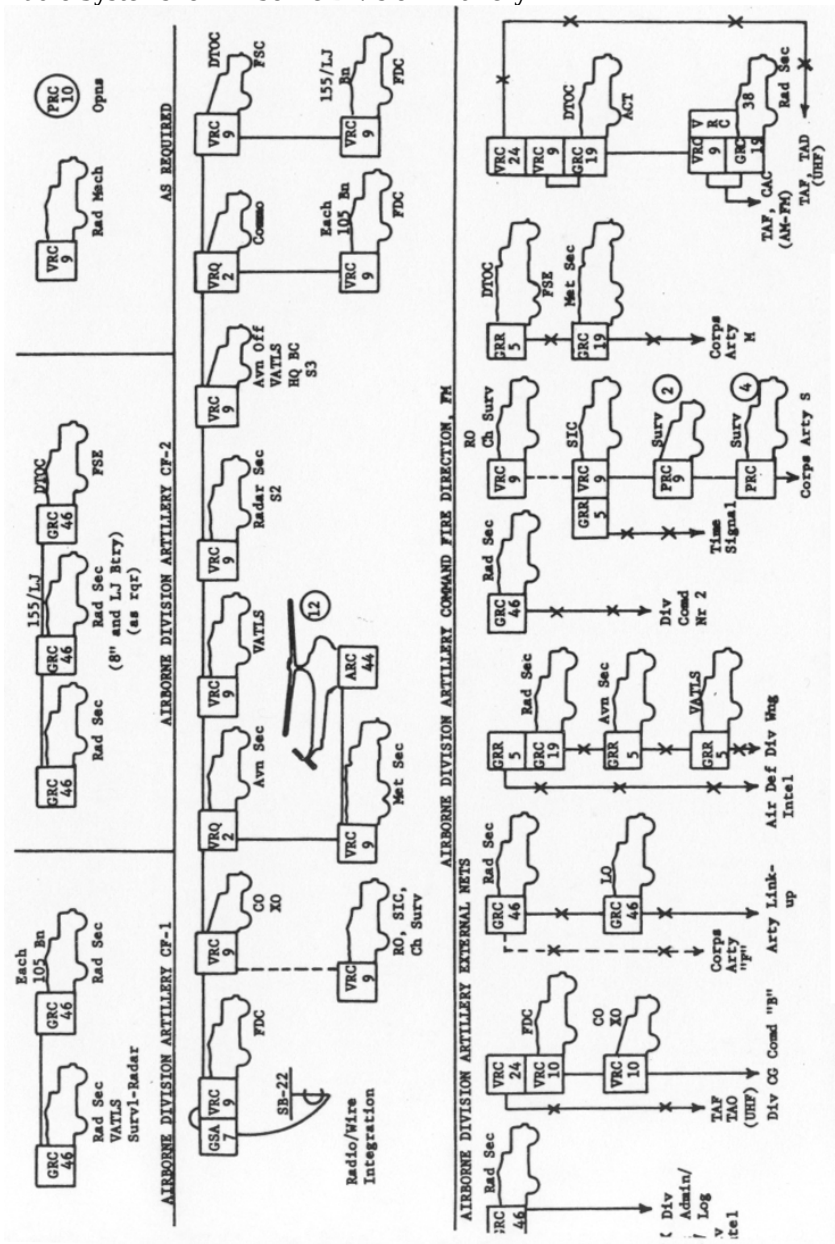


Figure 81. Radio Systems for Airborne Division Artillery

General

Pages 87-93 provide figures and printed material summarizing the manner in which various field artillery estimates, orders and requests are prepared and issued. Elements of each format should be covered in the sequence shown, with omissions permissible as indicated.

Estimate of the situation

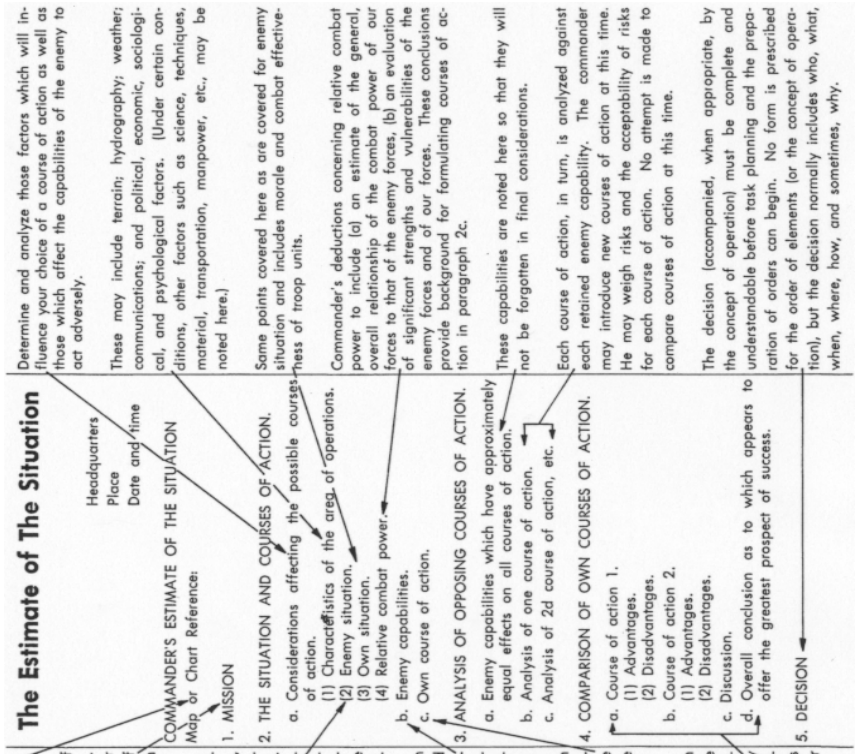


Figure 82. The Estimate of the Situation

Operations Order

The phrase "No change from verbal orders" or "No change from verbal orders except paragraph ——" would appear here if verbal orders have been issued concerning this operation. In the absence of verbal orders, the space is left blank.

Copy Number ———
Issuing Unit
Place of issue (may be in code)
Date-time group of signature (time order is effective unless otherwise designated in para 3)
Message reference number

Operation Order ——————————————————

(Type and serial number) **(Note 1)**

Reference: List any map, chart, or other document required to understand the order. Reference to a map will include the country or geographical area and/or map series number, edition (if required), scale, and map sheet name or number.

Time Zone: (The zone applicable to the operation; if not required for clarity, omit).

Task Organization: Where the organization for combat of the command is long or complicated, list here the task subdivisions or tactical components comprising the command with the names and ranks of the commanders if appropriate. This listing constitutes attachment unless qualified by such terms as "SPT" or "DS" indicating a support or direct support role for the unit commander. When the task organization is not shown, this information is included in paragraph 3 or in an annex.

1. SITUATION. Information of the overall situation essential to understand the current situation. This paragraph is divided into three subparagraphs as follows.

a. Enemy Forces. Factual information concerning the enemy. Often a reference to a published intelligence document, overlay, or annex will be sufficient. **(Note 2.)**

b. Friendly Forces. Information concerning higher, adjacent, supporting, or reinforcing units. Information should be limited to that which the subordinate commanders need to know to accomplish their assigned missions.

c. Attachments and Detachments. List the units attached to or detached from the headquarters issuing the order together with the effective time. If these units are indicated in the task organization, an appropriate reference is entered. In the case of a unit which has been attached for some period of time, the term "remains attached" may be used.

2. MISSION. A clear concise statement of the task to be accomplished by the command and its purpose. This normally requires the inclusion of the WHO, WHAT, WHEN, and WHY of the commander's decision. The WHERE of the decision may be included if needed for clarity. The HOW (unit(s) making the main attack, and other amplifications), more properly belong in paragraph

Operations Order (cont.)

3a, "Concept of operation." The mission is stated in full, even if shown on the operation overlay. There are no subparagraphs in paragraph 2.

3. EXECUTION.

a. In the first subparagraph give the concept of operation. This is a statement of the commander's visualization of the conduct of the overall operation. The concept clarifies the purpose of the operation and is stated in sufficient detail to ensure appropriate action by subordinates in the absence of additional specific instructions. The concept usually includes the development and phasing of the operation, use of nuclear fires, unit making the main attack (in those operations where appropriate), the formation to be employed (the HOW), whether or not a preparation is to be fired, and the duration prior to H-hour.

b. In subsequent separate lettered subparagraphs give the specific tasks to be accomplished by each element of the command charged with the execution of tactical missions. These elements are listed in the order:

(1) Combined arms commands in numerical or alphabetical order.

(2) Infantry elements.

(3) Armor elements.

(4) Artillery.

(5) Combat support elements (e.g., armored carrier units, engineer units, as applicable).

(6) Reserves.

c. If a task organization is not used, the organization for combat is shown under those units to and from which attachments and detachments are made. Units attached for operational control may also be indicated.

d. Combat arms units are listed in numerical sequence by parent regimental (or div) number.

e. The artillery subparagraph is divided into two numbered subparagraphs; the first covers field artillery, the second air defense artillery. As a minimum the artillery subparagraph indicates the artillery organization for combat (when not already indicated in a task organization).

f. Combat support elements are listed in alphabetical sequence by branch. Normal service missions are not included. It is not necessary to list all the units in the command nor is it required to give instructions for the total employment of a particular unit. For example, instructions to an engineer unit concern only the tactical support portion of the unit's mission.

g. Instructions to the reserve appear in the next to the last subparagraph of paragraph 3 entitled "Reserve." In the case of a unit totally in reserve at the time the order becomes effective this is the only subparagraph where such a unit will appear. Units not in reserve at the time of the order but designated as reserve at some future time are listed with a qualifying phrase as to when or under what conditions the unit will be in reserve. The listing of two or more units in this subparagraph does not in itself indicate an attachment.

Operations Order (cont.)

h. The last subparagraph of paragraph 3 is entitled "Coordinating instructions," and contains details of coordination and control applicable to two or more elements of the command. Troop safety measures appropriate to the nuclear battlefield may be shown here. Restrictions on use of nuclear weapons may be included. If instructions relative to a preparation are not included in the concept of operation they are shown here.

4. ADMINISTRATION AND LOGISTICS. A statement of pertinent administrative instructions and the way combat service support is to be provided for the operation to include the allocation of critical supply of items such as nuclear weapons. If an administrative order is in effect, or is being issued separately, or if an administrative annex is being issued make reference thereto. Paragraph 4 contains such subparagraphs as are required and follows the sequence of the administrative order.

5. COMMAND AND SIGNAL. Instructions relative to command and the operation of signal communications. This paragraph may have as many subparagraphs as are required. Normally three subheadings are listed: Signal, Command, and Axis of Command Post displacement. (Normally the main echelon of the headquarters unless otherwise specified.) Signal Instructions may refer to an annex, but as a minimum, should list the index and issue number of the signal operations instructions (SOI) which is in effect. Command instructions include command post location of subordinate and higher units. Designation of alternate command post and succession of command will be entered in this subparagraph if not adequately covered in SOP or annex. The axis of CP displacement consists of one or more future locations.

Acknowledgement instructions. These are a part of the ending and must be included here. Normally the single word "acknowledge" is sufficient. This indicates that the receiver will, by use of the message reference number in the heading, acknowledge that he has received and understands the order.

_____

(Commander) **(Note 3)**

NOTES: 1. The type of operation order (e.g., Army, Navy, Air Force, or Joint) is usually indicated in combined or joint operations. Within a single Service the type of operation order is normally omitted. When required, a code title may also be included. Operation orders of a command are numbered successively in each calendar year.

2. Reference to an annex may be made at any time it is desired to call the reader's attention to the annex. One such reference is all that is required.

3. The name and grade of the commander appear on all copies of the order. The original copy (No. 1) must be **signed** by the commander or a specifically authorized representative. This is the historical copy which remains in the files of the headquarters. If the commander or chief of staff signs a master copy, the use of which permits automatic reproduction of the document with his signature thereon, no further authentication is required. If this signature is not reproduced, authentication by the preparing general staff officer is required on all subsequent copies.

Initial Fire Request

Element	When omitted	Precision registration using surveyed chart	Area mission using polar plot	Destruction mission using shift from known point	Area mission using prearranged data	Area mission firing high-angle fire
(1) Identification of observer	Never	THUNDER 9, THIS IS THUNDER 31	STALLION 9, THIS IS STALLION 31	COMPOUND 9, THIS IS COMPOUND 31	KANVAROD 9, THIS IS KANVAROD 31	RAMROD 9, THIS IS RAMROD 31
(2) Warning	Never	FIRE MISSION	FIRE MISSION	FIRE MISSION	FIRE MISSION	FIRE MISSION
(3) Location of target	Never	REGISTRATION POINT 2, AZIMUTH 4710	AZIMUTH 5260, DOWN 30, DISTANCE 3200	FROM REGISTRATION POINT 1, AZIMUTH 2640, RIGHT 500, UP 25, DROP 800	CONCENTRATION AB302, AZIMUTH 5040	COORDINATES 762134, AZIMUTH 4750
(4) Nature of target	In precision registration.	Omitted	20 INFANTRY IN THE OPEN	BUNKER	5 TANKS & COMPANY OF INFANTRY IN THE OPEN	MACHINEGUN FIRING
(5) Classification of fire	When target is deep.	Omitted	Omitted	Omitted	Omitted	CLOSE 500
(6) Type of adjustment:						
(1) Type of fire	Area fire	REGISTRATION	Omitted	DESTRUCTION	Omitted	Omitted
(2) Trajectory	Low-angle fire	Omitted	Omitted	Omitted	Omitted	HIGH ANGLE
(3) Method of fire	In precision fire. When center one round is desired. In FFE mission.	Omitted	SALVO LEFT	Omitted	Omitted	Omitted
(4) Distribution	When parallel sheaf is desired. In precision fire.	Omitted	Omitted	Omitted	Omitted	CONVERGED SHEAF
(5) Volume FFE	When applicable.	Omitted	Omitted	Omitted	REQUEST BATTALION	Omitted
(7) Type of projectile	When shell HE is desired.	Omitted	Omitted	Omitted	SHELL HE AND WP	Omitted
(8) Fuze action	When fuze quick is desired. When HC smoke or illuminating shell is requested.	Omitted	FUZE TIME	Omitted	Omitted	FUZE VT
(9) Control	Never	WILL ADJUST	WILL ADJUST	WILL ADJUST	FIRE FOR EFFECT	WILL ADJUST

Figure 83. Initial Fire Request.

Battalion Fire Order

Element	When Announced	Example
(1) Battery(ies) to fire	Always	BATTALION
(2) Adjusting battery	When applicable	BRAVO
(3) Method of fire of adjusting battery	When different from observer's request	SALVO LEFT
(4) Basis for corrections	When applicable	USE REGISTRATION POINT 2
(5) Distribution	When applicable	SHEAF, 50 METERS
(6) Projectile	When different from observer's request	SHELL WP
(7) Ammunition lot and Charge	When applicable	LOT XY, CHARGE 5
(8) Fuze	When different from observer's request	FUZE TIME
(9) Number of volleys	Always in area fire; never in precision fire	5 VOLLEYS
(10) Range spread or zone	When different from observer's request	ONE C APART
(11) Time of opening	When different from observer's request	AT MY COMMAND
(12) Concentration number	Always	CONCENTRATION ALFA KILO 413

Figure 84. Battalion Fire Order

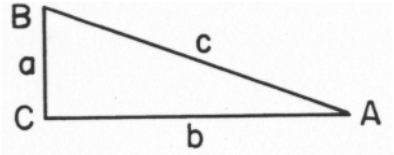
Fire Commands

Sequence		When Announced	
Element	Example	Initial Fire Command	Subsequent fire Command
(1) Pieces to follow commands	BATTERY ADJUST	Always	Never
(2) Special instructions	SPECIAL CORRECTIONS or USE GUNNER'S QUADRANT	When applicable	When applicable
(3) Projectile	SHELL HE	Always	When changed
(4) Ammunition lot	LOT XY	When applicable	When changed
(5) Charge	CHARGE 5	Always (except in fixed ammunition)	When changed
(6) Fuze	FUZE TIME	Always	When changed
(7) Pieces to fire	CENTER	Always	When either is changed
(8) Method of fire	CENTER 1 ROUND BATTERY 3 ROUNDS IN EFFECT	Always	When either is changed
(9) Direction	DEFLECTION 2639	Always	When changed
(10) Fuze setting	TIME 18.0	When applicable	When changed
(11) Quadrant elevation	QUADRANT 293	Always	Always

Figure 85. Sequence of fire commands to the firing battery.

Trigonometric Functions

In any right triangle, the ratio of one side to either of the other two sides depends directly on the size of the angle. As long as the angle remains the same, the sides, no matter how long, will maintain the same ratio. The trigonometric functions are as shown in figure 86.



$$\text{sine (sin) A} = \frac{\text{side opposite}}{\text{hypotenuse}} = \frac{a}{c} \qquad \text{tangent (tan) A} = \frac{\text{side opposite}}{\text{side adjacent}} = \frac{a}{b}$$

$$\text{cosine (cos) A} = \frac{\text{side adjacent}}{\text{hypotenuse}} = \frac{b}{c} \qquad \text{cotangent (cot) A} = \frac{\text{side adjacent}}{\text{side opposite}} = \frac{b}{a}$$

Figure 86. Trigonometric Functions

The Law of Sines

If any side and the angle opposite that side and any other side or angle are known in any triangle, the triangle can be solved by using the law of sines below.

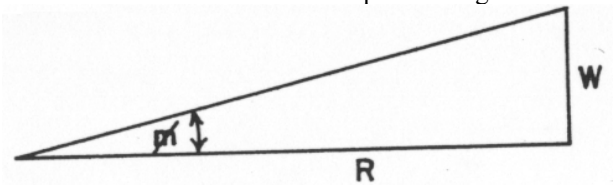
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

Mil Relation

A mil is that angle which, at a distance of 1,000 units, will subtend a width of one unit.

The mil relation is frequently used in field artillery computations for approximations of ranges and widths. For example, the forward observer uses the relation, in conjunction with the mil scale on his binoculars, to adjust artillery fires. Since the distance so measured represents a width across two equal radii rather than a perpendicular to the observer-target line, the mil relation becomes inaccurate for large deviations, and rough sine factors (normally used with angles 600 mils or greater) should be used. The mil relation is depicted in figure 87.

$$mils = \frac{W}{R}$$



mils = angular measurement in mils between two points.
W = the lateral distance in yards or meters between the points.
R = the mean distance to the points in thousands of yards or meters.

Figure 87. Mil Relation

Rough Sine Factors

Angle In Mils	Rough Sine Factors	Angle In Mils	Rough Sine Factors
100	0.1	900	0.8
200	0.2	1,000	0.8
300	0.3	1,100	0.9
400	0.4	1,200	0.9
500	0.5	1,300	1.0
600	0.6	1,400	1.0
700	0.6	1,500	1.0
800	0.7	1,600	1.0

Laying the Battery

a. By Azimuth

(1) Subtract the announced azimuth from the declination constant, adding 6,400 mils to the declination constant, if necessary. Example:

Declination constant	200 mils
	+6400 mils
	6600 mils
Minus announced azimuth	—5250 mils
Deflection to set on aiming circle	1350 mils

(2) With the single 0 of the aiming circle nearest you and the 0-3200 line pointing generally in the direction of the announced azimuth, turn the **upper** motion of the aiming circle clockwise, until its index is opposite the deflection determined in (1) above.

(3) Using the **lower** motion, center the magnetic needle.

(4) Using the **upper** motion, lay the battery reciprocally so that each tube is parallel to the 0-3200 line of the aiming circle.

b. By Orienting Angle.

(1) Point the 0-3200 line of the aiming circle in the general direction of fire.

(2) Using the **upper** motion, set off the desired orienting angle on the scales of the aiming circle.

(3) Using the **lower** motion, sight on the end of the orienting line.

(4) Using the **upper** motion, lay the battery reciprocally so that each tube is parallel to the 0-3200 line of the aiming circle.

TABLE XXVII. CONVERSION FACTORS

	Multiply → To Obtain	By By	← To Obtain Divide
Distance			
	Inches	.083	Feet
		2.540	Centimeters
	Feet	30.48	Centimeters
		0.3048	Meters
	Yards	3.0	Feet
		91.44	Centimeters
		0.9144	Meters
	Statute Miles	5,280.0	Feet
		1,760.0	Yards
		1.609 x 100,000	Centimeters
		1.609	Kilometers
	Nautical Miles	1.1508	Statute Miles
		1.852	Kilometers
	Centimeters	0.01	Meters
	Meters	39.37	Inches
	Kilometers	3,281.0	Feet
		1,093.6	Yards
		100,000.0	Centimeters
		1,000.0	Meters
	Knots	1.1508	Miles Per Hour
Angular			
	Mils	0.0563	Degrees
	Degrees	17.78	Mils
		60.0	Minutes
		3,600.0	Seconds
Weight			
	Ounces	0.0625	Pounds
	Kilograms	2.205	Pounds
	Tons (long)	2240.0	Pounds
	Tons (short)	2000.0	Pounds
Volume			
	Cubic Inches	5.787 x 0.0001	Cubic Feet
		2.143 x 0.00001	Cubic Yards
		16.39	Cubic Centimeters
		1.639 x 0.00001	Cubic Meters
		0.03463	Pints (liquid)
		0.01732	Quarts (liquid)
		1.639 x 0.01	Liters
	Cubic Feet	0.03704	Cubic Yards
		2.832 x 10,000	Cubic Centimeters
		0.02832	Cubic Meters
		59.84	Pints (liquid)
		29.92	Quarts (liquid)
		7.481	Gallons
		28.32	Liters
	Cubic Yards	7.646 x 100,000	Cubic Centimeters
		0.7646	Cubic Meters
		1616.0	Pints (liquid)
		807.9	Quarts (liquid)
		202.0	Gallons
		764.6	Liters
	Cubic Centimeters	0.000001	Cubic Meters
		2.113 x 0.001	Pints (liquid)
		1.057 x 0.001	Quarts (liquid)
		2.642 x 0.0001	Gallons
		0.001	Liters
	Cubic Meters	2113.0	Pints (liquid)
		1057.0	Quarts (liquid)
		264.2	Gallons
		1000.0	Liters
	Gallons (US)	8.0	Pints (liquid)
		4.0	Quarts (liquid)
		3.785	Liters
		1.204	Imperial gallons