REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
27-02-2012

2. REPORT TYPE
Final

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
Test Operations Procedure (TOP)
01-1-011A Vehicle Test Facilities at Aberdeen Test Center and Yuma Test Center

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHORS

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Automotive Directorate (TEDT-AT-AD)
US Army Aberdeen Test Center
400 Colleran Road
Aberdeen Proving Ground, MD 21005-5059

8. PERFORMING ORGANIZATION REPORT NUMBER
TOP 01-1-011A

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Range Infrastructure Division (CSTE-TM)
US Army Test and Evaluation Command
2202 Aberdeen Boulevard
Aberdeen Proving Ground, MD 21005-5001

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)
Same as item 8

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Statement A. Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES
Defense Technical Information Center (DTIC), AD No.: ADA557002
This TOP supersedes TOP 01-1-011, dated 6 July 1981.

Marginal notations are not used in this revision to identify changes, with respect to the previous issue, due to the extent of the changes.

14. ABSTRACT
This Test Operations Procedure (TOP) describes the vehicle test facilities of Aberdeen Test Center (ATC) at Aberdeen Proving Ground (APG), Maryland and the automotive test courses located at Yuma Test Center (YTC), Arizona.

15. SUBJECT TERMS
ATC YTC automotive test courses paved gravel cross-country

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
Unclassified	Unclassified	Unclassified	SAR	152	19b. TELEPHONE NUMBER *(include area code)*

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39-18

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U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 01-1-011A 27 February 2012
DTIC AD No. ADA557002

VEHICLE TEST FACILITIES AT ABERDEEN TEST CENTER AND YUMA TEST CENTER

*This TOP supersedes TOP 01-1-011, dated 6 July 1981.

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1. SCOPE.

a. This Test Operations Procedure (TOP) describes the vehicle test facilities of the US Army Aberdeen Test Center (ATC) at Aberdeen Proving Ground (APG), Maryland and the automotive test courses located at the US Army Yuma Test Center (YTC) at Yuma Proving Ground (YPG), Arizona (as outlined in Tables 1 and 2). It is designed for use in planning tests of wheeled and tracked vehicles, including vehicular weapon systems. It does not include descriptions of the equipment and instrumentation used to obtain test data. Automotive laboratory instrumentation and field test equipment and instrumentation descriptions are covered in TOP 02-1-002[1]**. The test facilities at ATC meet the needs of the vibration environment categories of Military Standard (MIL-STD)-810G[2], procedure 514.6 Vibration.

TABLE 1. ATC COURSE COMPOSITION/LENGTHS AND FACILITIES

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
				METRIC	ENGLISH
2.1 Churchville Test Area (CTA)	Hilly Cross-Country (Course A)	12	Severe, wooded and rocky terrain	Not Applicable (NA)	NA
	Hilly Cross-Country (Course B)	12	Native soil and stone, grades to 29%	5.8 km	3.6 mi
	Hilly Secondary Road (Course C)	13	Grades to 10%	2.4 km	1.5 mi
	Prepared Dirt Slopes	13	Grades of 10, 15, 20, 25, and 60%, Side slopes of 30 and 40%	37 to 183 m	120 to 600 ft
	Harford Loop	13	Paved, rolling hills	29.8 m	18.5 mi
	Conowingo Loop	14	Paved	74.9 km	46.5 mi
2.2 Environmental Test Facilities	Multi-Purpose Environmental Chamber	14	Temperature range from -57 to 77 ºC (-70 to 170 ºF)	12.2 x 22.9 x 7.3 m	40 x 75 x 24 ft
	Mobility Test Chamber	15	Temperature range from -54 to 74 ºC (-65 to 165 ºF)	9.2 x 18.3 m	30 x 60 ft
	Firing Test Chamber	16	Temperature range from -54 to 74 ºC (-65 to 165 ºF)	12.2 x 12.2 m	40 x 40 ft
	Vibration Facility	16	Electrodynamic Vibration System	177,929 N	40,000 lb
	Climatic Simulation Facilities	17	Wind machine	161 km/hr	100 mph
			Stationary temperature – humidity chamber	2.8 x 2.4 x 1.9 m	9.5 x 7.9 x 6.4 ft
			Portable chambers	1.8 x 1.4 x 1.5 m	6 x 4.7 x 5 ft
			Solar radiation chamber	3 x 3.7 x 1 m	10 x 12 x 3 ft
		17	Electromagnetic Interference Test Facility (EMITF)	28.7 x 18.3 x 8.5 m	94 x 60 x28 ft
2.3 Dynamometer Course	Dynamometer Course	18	Bituminous concrete	1.6 km	1 mi

**Superscript numbers correspond to Appendix B, References.

TABLE 1. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
2.4 Mile Loop	Mile Loop	19	Paved and gravel	1.6 km	1 mi
	Winch Test Facility	19	Concrete base	NA	NA
	Pothole-Crosstie Course	20	Concrete potholes	61 m	200 ft
		20	Wooden crossties in concrete	40 m	132 ft
	1-Inch Bump Course	21	Iron rod in concrete	67 m	220 ft
	Rain Towers	21	Two towers	9.1 m	30 ft
2.5 Mountain Highway	Mountain Highway	21	Paved	64.4 km	40 mi
2.6 Munson Test Area (MTA)	Paved Road	24	Bituminous concrete	681 m	2235 ft
	Improved Gravel Road	25	Compacted gravel	3.2 km	2 mi
	Rolling Hill Course	25	Compacted stone/dust	620 m	2034 ft
	Sand Course	26	Washed beach sand	163 m	503 ft
	Rubble Pile	27	Large boulders, concrete, steel	30.5 m	100 ft
	Corrosion Facility	27	Various corrosive environments	NA	NA
	Abrasive Mud Course	28	Sand loam	73 x 290 m	240 x 950 ft
	Fording Basin	30	Concrete	82 m	270 ft
	Underwater Fording Facility	31	Concrete	96 m	315 ft
	Amphibian Ramp	31	Bituminous concrete	6 x 15 m	21 x 50 ft
	Shallow Water Swimming Area	32	Channel, 3 m deep x 15 m wide (10 x 50 ft)	305 m	1000 ft
	Belgian Block Course	33	Granite blocks in concrete	1.2 km	0.8 mi
	Imbedded Rock Course	34	Granite stones in concrete	244 m	800 ft
	Side Slopes	35	Concrete: 20%	83 m	271 ft
			Concrete: 30%	220 m	723 ft
			Concrete: 40%	91 m	300 ft
	Gradeability Slopes	36	Asphalt: 5%	147 m	483 ft
			Asphalt: 10%	91 m	300 ft
			Asphalt: 15%	78 m	256 ft
			Asphalt: 20%	61 m	199 ft
			Concrete: 30%	45 m	149 ft
			Concrete: 40%	34 m	112 ft
			Concrete: 45%	18 m	59 ft
			Concrete: 50%	30 m	97 ft
			Concrete: 60%	25 m	81 ft
	Simulated Loading Ramps	37	Concrete: 20 °	12 m	40 ft
			Concrete: 15 °	6 m	20 ft
	2-Inch Washboard	39	Concrete	251 m	822 ft
	2- to 4-Inch Radial Washboard	40	Concrete	74 m	243 ft
	3-Inch Spaced Bump	41	Concrete	233 m	764 ft
	6-Inch Washboard	41	Concrete	243 m	798 ft
	Wave Course	42	Concrete	135 m	443 ft
	Vertical Walls	43	Concrete and Wood	NA	NA
	Bridging Device	44	Steel	NA	NA
	Standard Ditch Profile	45	Concrete	7.8 m	25 ft 6 in.

TABLE 1. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
2.6 Munson Test Area (MTA)	Turning Circle	46	Concrete	76 m	250 ft
	Profile IV Course	47	Concrete	142 m	465 ft
	Marsh	48	Low soil strength, heavy vegetation	NA	NA
	Load Vibration Course	48	Concrete, gravel, and paved	2.9 km	1.8 mi
	Fuel Consumption Course	49	Gravel, paved	2.4 km	1.5 mi
	Urban Terrain Course	51	Concrete, gravel, and paved	5.6 km	3.5 mi
	Land Vehicle Maintenance Facility (B338)	53	Shop area of 45,000 square ft	NA	NA
	Half Rounds for Ride Quality	53	Reinforced steel pipe	NA	NA
2.7 Automotive Technology Evaluation Facility (ATEF)	ATEF	53	Paved and gravel	61 m x 7.2 km	200 ft x 5.2 mi
2.8 Perryman Test Area (PTA)	Perryman No. 1	57	Moderate; native loam with quarry spall/gravel	8.4 km	5.2 mi
	Perryman No. 2	57	Moderately rough; native loam with quarry spall	2.9 km	1.8 mi
	Perryman No. 3	58	Rough; native loam	5.3 km	3.3 mi
	Perryman No. 4	59	Severe; native loam with natural marsh	4 km	2.5 mi
	Perryman No. 5	59	Extremely severe; Gabion (No. 6 stone)	152 m	500 ft
	3-Mile Straight-away	60	Bituminous concrete (including turnarounds)	6.1 km	3.8 mi
	Mud Bypass Course	60	Native loam prepared by tilling	213 m	700 ft
	Secondary Road A	61	Unimproved country road, sweeping turns	3.9 km	2.4 mi
	Secondary Road B	61	Unimproved road, level straight-away	5.1 km	3.2 mi
2.9 Phillips Army Airfield (PAAF)	PAAF	61	One runway	2438 x 61 m	8000 x 200 ft
2.10 Lift and Tie-Down Facility	Lift and Tie-Down	63	54 tons (metric) (60 tons) hydraulic load system	NA	NA
2.11 Automotive Laboratory Facilities	Automotive Engineering Test Facility (B436)	63	Shop area of 30,000 square ft	NA	NA
	Tilt Table	64	Steel platform	30.5 x 4.3 m	100 x 14 ft
	Roadway Simulator	66	Support vehicles up to 36,300 kg (80,000 lb)	NA	NA
	Vehicle Durability Simulator	66	Support 2-axle vehicles up to 11,790 kg (26,000 lb)	NA	NA
	Tire Test Rig	67	NA	NA	NA

TABLE 1. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
2.11 Automotive Laboratory Facilities	Shock Absorber Dynamometer	68	NA	NA	NA
	Moment of Inertia Test Facility	69	Support vehicles up to 63 tons (metric) (70 tons)	NA	NA
	Powertrain Dynamometer Facility	70	Engine dynamometers rated at 350 hp and 600 hp	NA	NA
	Wheeled Vehicle Roller Brake Dynamometer	70	Brake forces up to 45 kN (10,000 lb) at axle weights up to 2000 kg (44,000 lb)	NA	NA
	Platform Scales	71	Vehicle weight up to 90,700 kg (200,000 lb)	NA	NA
2.12 Fire Control Test Facilities	Fire Control Test Ranges	71	Ranges for direct fire; moving target; cross-country courses	1.6 km	1 mi
	Tank Armament Test Range (Henry Field)	72	Direct fire range	3 km	1.9 mi
	Evasive Target Firing Range (TW I)	76	Evasive laser beam target	2.4 km	1.5 mi
	Moving Target Simulator	77	Air supported hemisphere	30.5 m radius	100 ft radius
	Multiple Target Firing Range (TW II)	78	Stationary vehicle/stationary target	4 km	2.5 mi
	Ride Quality Courses (Henry Field)	79	Gravel roads	100 to 160 m	330 to 530 ft
2.13 Scalable Net Centric Test Area (SNCTA)	Small Unmanned Ground Vehicle (SUGV) Test Course	79	Various surfaces and obstacles	36.6 x 67 m	120 x 220 ft
	Large Unmanned Ground Vehicle (LUGV) Test Course	80	Various surfaces and obstacles	NA	NA
2.14 Rail Transport Facility	Rail Transport Facility	80	Facility/equipment to ensure compliance with Military Surface Deployment and Distribution Command transportation certification requirements	NA	NA

Notes:
km = kilometer
mi = mile
m = meter
ft = foot
C = Celsius
F = Fahrenheit
N = Newton
lb = pound
hr = hour
mph = miles per hour

in. = inch
hp = horsepower
kN = kilonewton
TW = Trench Warfare

TABLE 2. YTC COURSE COMPOSITION/LENGTHS AND FACILITIES

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
3.1 YTC Durability Test Courses	Patton Level Gravel	82	Compacted gravel	5.6 km	3.5 mi
	Patton Hilly Trails	82	Sand, gravel, rock, grades to 40%	4.2 km	2.6 mi
	Patton Level Trails	83	Level Sand, undulating terrain	10.5 km	6.5 mi
	Patton Hilly Gravel	83	Sand, gravel, rock, grades to 30%	8.0 km	5.0 mi
	Kofa High Speed Gravel	84	Compacted gravel	6.7 km	4.2 mi
	Kofa Level Gravel	84	Compacted gravel	5.0 km	3.0 mi
	Laguna Level Trails, East	85	Sand, gravel	4.5 km	2.8 mi
	Laguna Level Trails, West	86	Sand, gravel	9.0 km	5.6 mi
	Laguna Hilly Trails	86	Sand, gravel, rock, grades	3.3 km	2.1 mi
	Middle East	87	Loamy sand, gravel	33.3 km	20.7 mi
	Rock Ledge	88	Sand, cobbled rock	6.3 km	3.9 mi
	Desert March	89	Sand, gravel	40.8 km	25.4 mi
	Vapor Lock Wash	90	Gravel	4.0 km	2.5 mi
	Highway 95	90	Asphalt	80 km	50 mi
	Bereznuk Track Evaluation	90	Sand, cobbled rock	2.4 km	1.5 mi
	Tire Bruise	91	Sand, cobbled rock	2.1 km	1.3 mi
	Patton Wash	92	Sand, gravel	3.7 km	2.3 mi
	Patton Off Road	93	Sand, cobbled rock	5.0 km	3.1 mi
3.2 YTC Performance Test Courses	Longitudinal Grades	94	Concrete: 5%	37.8 m	124 ft
			Concrete: 10%	45.1 m	148 ft
			Concrete: 20%	91.4 m	300 ft
			Concrete: 30%	72.5 m	238 ft
			Concrete: 40%	47.2 m	155 ft
			Concrete: 60%	32.3 m	106 ft
	Roll On/Roll Off Ship Ramps	95	Metal: 12°	18.3 m	60 ft
			Metal: 15°	14.6 m	48 ft
	Side Slopes	96	Concrete: 10%	150.8 m	495 ft
			Concrete: 15%	151.2 m	496 ft
			Concrete: 20%	150.8 m	495 ft
			Concrete: 30%	121.3 m	398 ft
			Concrete: 40%	72.8 m	239 ft
	Sand Grades	96	Sand: 5%	61 m	200 ft
			Sand: 10%	30 m	100 ft
			Sand: 15%	55 m	180 ft
			Sand: 20%	37 m	120 ft

TABLE 2. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
3.2 YTC Performance Test Courses	Fording Basin	97	Concrete (L x W)	67 x 25 m	220 x 82 ft
	Kofa Dust Course	98	Sand, Dust	3.2 km	2.0 mi
	Cibola Dust Course	99	Sand, Dust	6.3 km	3.9 mi
	Cibola Mud Course	100	Sand, Clay	152.4 m	500 ft
	Dyno Mud Course	100	Sand, Clay, Silt	0.6 km	0.4 km
	Laguna Mud Course	100	Clay	0.6 km	0.4 mi
	Sand Dynamometer	101	Sand	NA	NA
	Ride Dynamics	102	Compacted Gravel	251 to 305 m	825 to 1000 ft
	Fuel Transfer and Test Site Area	102	Concrete Pad	12 m x 37 m	40 ft x 120 ft
	Airfield Delivery Loading Ramp	103	Concrete Pad	96 by 148 m	315 by 485 ft
	Half Rounds and Curb Impact Course	104	Asphalt with interchangeable half round drums	10, 15, 20, 25, 30 cm	4, 6, 8, 10, 12 in.
	C-130 Air Transportability Test Bed	105	C-130 Hulk	NA	NA
	Urban Rubble	106	Concrete boulders	91.5 m	300 ft
	Hot Weather Test Complex	107	Asphalt	7.2 km	4.5 mi
	Laguna High Speed Paved Oval	107	Asphalt	7.2 km	4.5 mi
	Laguna Paved	108	Asphalt	3.2 km	2.0 mi
	GM High Speed Circle Track	109	Asphalt	5.6 km	3.5 mi
	GM Vehicle Dynamics Pad	109	Asphalt	304 x 304 m	1,000 x 1,000 ft
	GM Performance Straight Track	109	Asphalt	4.8 km	3.0 mi
	GM Engineered Ride Road	109	Asphalt and concrete	5.0 km	3.1 mi
	GM Belgian Block and Granite Block	110	Granite	76 m	250 ft
	Potholes Course	110	Steel potholes embedded in gravel	39.9 m	161 ft
	Vertical Steps	110	Concrete steps with replaceable timber edges	30, 46, 61, 76, and 91 cm	12, 18, 24, 30, and 36 in.
	"V" Ditch	111	Concrete: Direct Approach	7.6 m	25 ft
			Concrete: Angled Approach	7.0 m	23 ft
	MOUT Obstacle Course	112	Concrete Curb	4.3 m	14 ft
			Log obstacle	9.1 m	30 ft
			Washboard Terrain	6.1 m	20 ft
			9 in Half Rounds (length)	16.8 m	55 ft
			Steel Staircase (length)	6.1 m	20 ft
	Winch Test Facility	114	Concrete Deadman (max load) 578,000 N (130,000 lb)	NA	NA

TABLE 2. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
3.2 YTC Performance Test Courses	Lift/Tiedown Test Facility	115	Max Longitudinal Force 1,000,000 N (240,000 lb); Max Lateral Force 400,000 N (90,000 lb); Max Vertical Force 266,000 N (60,000 lb)	NA	NA
	Bridging Test Area	117	Sand and Gravel	NA	NA
	Tilt Table	119	Lifting Capacity 136,000 kg (300,000 lb)	3.6 m x 27 m	12 ft x 90 ft
	Boresight Slopes	119	Sand and Gravel	NA	NA
3.3 YTC Off-Site Courses	Imperial Sand Dunes, CA	120	Loose Sand	48.3 x 64.4 km	30 x 40 mi
	Rail Impact	121	Rail	480 m	1,575 ft
	Safari (Interstate 8)	122	Paved Highway, Asphalt	530 km	348 mi
	Safari (Death Valley National Monument)	123	Paved Roads, Asphalt	295 km	183 mi
3.4 YTC Direct Fire Ranges	Combat Systems Direct Fire Range	123	Sand and Gravel	2 x 7 km	3460 acres
	Moving Target Range	125	Caswell Target Max Speed 32 kph (20 mph). Oehler Target Max Speed 18 kph (11 mph)	2500 m	1.6 mi
3.5 YTC Test Facilities	Rain Facility (Rain and Blowing Rain)	126	Chamber (W x L x H)	6.1 x 12.2 x 4.1 m	20 x 40 x 13.5 ft
			Door (W x H)	9.6 x 5.5 m	31.5 x 18 ft
	Blown Air Dust and Sand System (BADSS)	127	Max Speed	96 kmph	60 mph
			Diameter	1.8 m	6 ft
			Material Feed Rate	9 to 18 kg/min	20 to 40 lb/min
	Load Handling System (LHS) Simulators	128	Fabricated steel structure with LHS and hydraulic system	NA	NA
	Environmental Chamber with Weapons Firing Capabilities	129	Dimensions (L x W x H)	13.7 x 8.8 x 4.4 m	45 x 29 x 14.5 ft
			Door (W x H)	5.2 x 4.0 m	17 x 13.2 ft
			Temperature Range -54 to +71 ºC (-65 to +160 ºF) Humidity: 5 to 95 percent RH	NA	NA
	Large Multipurpose Environmental Chamber (LMPEC)	130	Main Chamber (L x W x H)	13.1 x 6.1 x 3 m	43 x 20 x 10 ft
			Antechamber (L x W x H)	1.8 x 1.8 x 2.0 m	6 x 6 x 6.6 ft
			Door (W x H)	5.1 x 3.9 m	17 x 13 ft

TABLE 2. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
3.5 YTC Test Facilities	Large Multipurpose Environmental Chamber (LMPEC)	130	Firing Port (W x H)	1.2 x 2.4 m	4 x 8 ft
			Temperature Range -54 to +71 ºC (-65 to +160 ºF) Humidity: 5 to 95 percent RH	NA	NA
	Climatic Simulation Facility (Vehicle Component Level Tests)	132	Hot/Cold with Humidity Chamber max temperature range: -57 to +82 ºC (-70 to +180 ºF)	NA	NA
			Hot with Humidity Chamber max temperature range: +4 to 82 ºC (+40 to +180 ºF)	NA	NA
			Cold without Humidity Chamber max temperature range: -57 ºC (-70 ºF)	NA	NA
			Hot/Cold without Humidity max temperature range: -54 to +63 ºC (-65 to +145 ºF)	NA	NA
			Altitude Chamber max temperature range: -57 to +74 ºC (-70 to +165 ºF)	NA	NA
			Salt Fog Chamber max temperature range: +35 ºC (+95 ºF)	NA	NA
			Immersion Tank max temperature range: 113 L (4 cu ft)	NA	NA
			Solar Chamber max temperature range: +4 to +82 ºC (+40 to +180 ºF)	NA	NA
	Material Analysis Laboratory	134	Building Size	650 m^2	7,000 ft^2
	Starter Test Stand	137	ST-24 Computerized Starter Tester	NA	NA
	Tire Maintenance Facility	138	Maintenance Facility	NA	NA
	Tire X-ray Facility	138	LumenX 1027B Inspection System	NA	NA
	Hybrid Electric Facility	139	Facility and Load Banks	250 KW max	NA
	Vibration Facility	140	Six electromagnetic vibration systems	NA	NA
	Physical Test Facility	140	Physical measurements, non-destructive measurements, material properties testing, and mass properties testing	NA	NA
	Site 3 Drop Test Facility	140	Item Capacity and Height	453 kg at 9 m	1,000 lb at 30 ft
	12 Meter Drop Test Facility	141	Item Capacity and Height	1,800 kg at 18 m	4,000 lb at 60 ft

TABLE 2. CONT'D

TOP SECTION NO.	TEST COURSE	PAGE NO.	COURSE TYPE	COURSE LENGTH	
3.6 YTC Maintenance Facilities	Operations and Maintenance Division Complex	142	Maintenance Facility with Secure Storage yard	891 m^2	9,600 ft^2
	Main Test Maintenance Facility	142	Maintenance Facility with Lighted Storage yard	8,300 m^2	90,000 ft^2
	Ancillary Test Maintenance Facility	143	Maintenance Facility with Lighted Storage yard	2,483 m^2	26,712 ft^2
	MT Test Maintenance Facility	143	Maintenance Facility	1486 m^2	16,000 ft^2
	Welding and Metal Shop Facility	143	Maintenance Facility	5,417 m^2	58,310 ft^2

b. The test facilities at ATC contain approximately 64 km (40 mi) of automotive test courses on more than 1320 hectares (3300 acres) of land. In addition, there are water areas and firing ranges for vehicle testing. Each automotive test course and facility is designed to meet a particular military vehicle specification and many exceed commercial standards. Information regarding test course severity is located in TOP 01-1-010[3].

c. The test facilities at YTC contain more than 100 miles of test courses. Although YTC spans over 1,300 square miles, the automotive durability and performance courses and test facilities are situated within close proximity of each other within the southern portion of YTC, which allow for tailoring vehicle tests to any specified mission profile.

2. ABERDEEN TEST CENTER COURSES.

2.1 Churchville Test Area (CTA).

a. Purchased in 1942, this area is north of the town of Churchville, and borders the east side of Maryland Highway 136 and the south side of Deer Creek (Figures 1 and 2). It consists of 98.7 hectares (244 acres), located approximately 19 km (12 mi) from APG, and is used for endurance testing of all types of automotive vehicles. It is well suited for determining the durability and reliability of engines and power train systems.

Figure 1. Aerial view of Churchville Test Area.

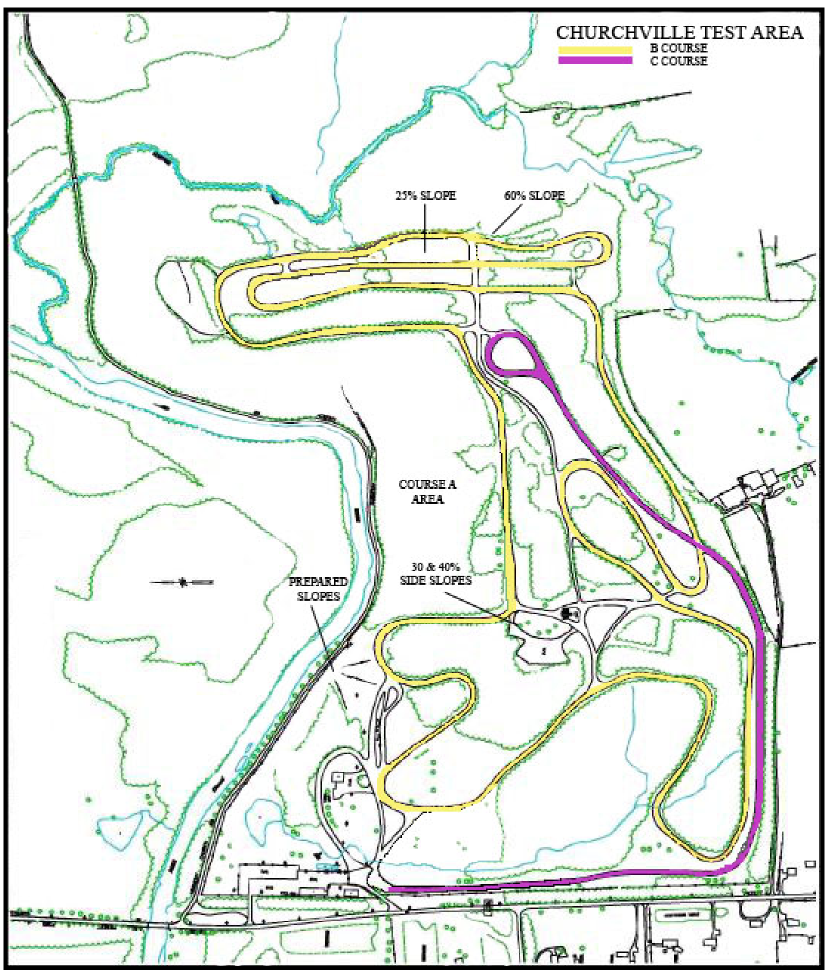

Figure 2. Topographic map of Churchville Test Area.

b. Hilly Cross-Country Courses.

(1) The entire Churchville area is characterized by a series of steep hills with slopes as great as 30 percent, and is heavily wooded in some parts. Test courses are in closed loops over and around the hills.

(2) Course A, more accurately identified as an area, is the most severe of the hilly cross-country courses. It is heavily wooded and includes rocky terrain, ravines, steep grades as great as 30 percent, and side slopes.

(3) Course B (Figure 3 and 4), consists of grades as steep as 29 percent. The terrain is moderate to rough native soil and stone ranging from muddy to dusty, depending on the weather.

Figure 3. Hilly Cross-Country Course B.

Figure 4. Hilly Cross-Country Course B.

(4) Course C is a 2.4-km (1-1/2-mi) secondary road with controlling grades of 10 percent and a turnaround at each end, as shown in Figure 2. The course is well suited for tests of trailers and semi-trailers. Dirt side slopes of 30 and 40 percent are available for mobility and stability challenges. The dirt slope gradients can be reconfigured to suit specific test requirements with advanced planning. The soil type associated with the dirt slopes conforms to the Unified Soil Classification System, type SC.

c. Prepared Dirt Slopes. These slopes are used for controlled tests to evaluate the tractive ability of vehicles. Five longitudinal slopes: (1) 10 percent, 67 meters (220 ft), (2) 15 percent, 76 meters (250 ft), (3) 20 percent, 67 meters (220 ft), (4) 25 percent, 183 meters (600 ft), and (5) 60 percent, 37 meters (120 ft) are particularly useful for measuring mobility performance and for comparison tests of experimental and standard vehicles. Dirt side slopes of 30 and 40 percent are available for mobility and stability challenges. The dirt slope gradients can be reconfigured to suit specific test requirements with advanced planning. The soil type associated with the dirt slopes conforms to the Unified Soil Classification System, type SC.

d. Harford Loop. The Harford Loop is a paved, closed loop course comprised of local highways located north of the CTA. It is 29 km (18.5 mi) in length and is generally described as gentle rolling hills with grades ranging from 2 to 10 percent, and includes three stop signs and one traffic light. It is driven at posted speed limits ranging between 48 and 80 km/hr (30 and 50 mph) to determine vehicle fuel consumption characteristics. A mapping of the course, outlined in blue, is presented in Figure 5.

e. Conowingo Loop. The Conowingo Loop is a paved, closed loop course, 75 km (46.5 mi) in length, comprised of segments of local and federal public highways located north of the CTA of ATC. The course is designed to satisfy requirements of Society of Automotive Engineers (SAE) procedures J1264[4], J1321[5], and J1526[6], which are used to assess medium to heavy duty in-service vehicles. A mapping of the course, outlined in red, is presented in Figure 5.

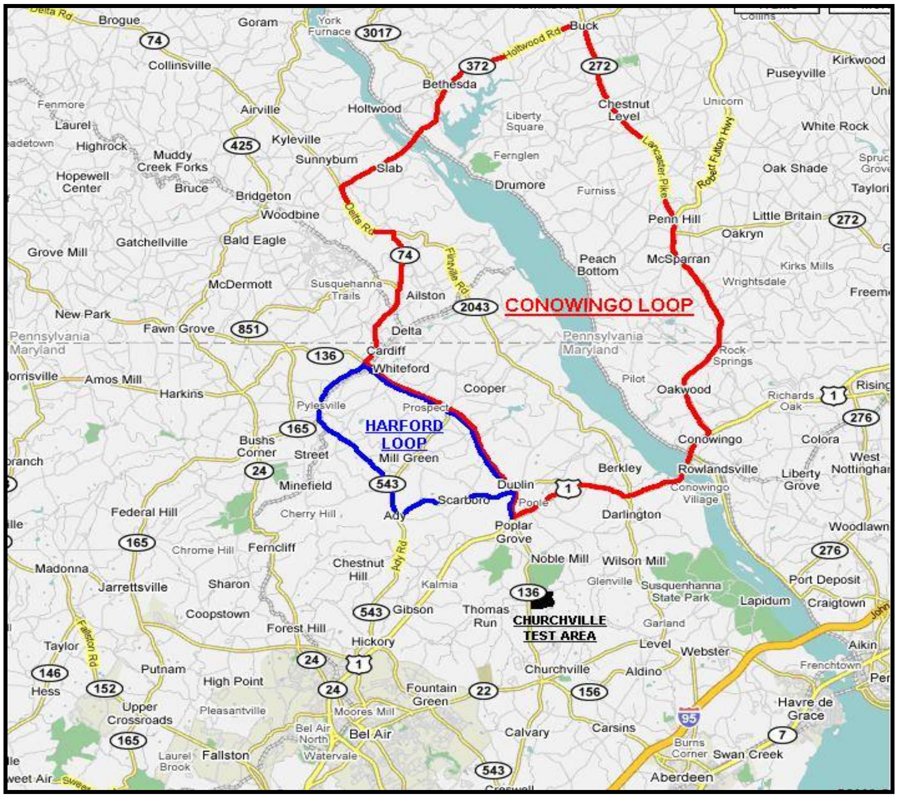

Figure 5. Harford Loop and Conowingo Loop map locations.

2.2 Environmental Testing Facilities.

The facilities described below are used for simulated environmental testing of a variety of equipment at ATC. Some of these chambers are of the proper size and capacity to accommodate automotive vehicles and allow the firing of a variety of weapons.

a. Multi-Purpose Environmental Test Chamber. This spacious multipurpose facility provides temperature, humidity, and icing testing capabilities meeting the requirements of MIL-STD-810G. The chamber is 12.2 meters wide by 22.9 meters long by 7.3 meters high (40 ft wide by 75 ft long by 24 ft high) and is divided into two 12.2- by 11.3-meter (40- by 37-ft) chambers having independent climatic controls. The chamber has a 4.9- by 4.9-meter (16- by 16-ft) door (Figure 6). The temperature range is -57 to 77 ºC (-70 to 170 ºF). An adjacent area is available for data acquisition and control instrumentation.

Figure 6. Multi-purpose Environmental Test Chamber.

b. Mobility Test Chamber. The Mobility Test Chamber (Figure 7) is utilized for non-firing tests at extreme environmental conditions. The facility has two test cells each, approximately 9.2 m wide by 18.3 m long (30 ft wide by 60 ft long). Temperature conditions are variable from -54 ºC (-65 ºF) to 74 ºC (165 ºF) with 141.6 cubic meters per minute (cmm) (5,000 cubic feet per minute (cfm)) conditioned makeup air and exhaust systems. The facility also has a solar array used to simulate extreme solar environments.

Figure 7. Mobility Test Chamber.

c. Firing Test Chamber. The Firing Test Chamber (Figure 8) has large and small caliber firing capability at extreme environmental conditions. Extreme conditions are variable from -54 ºC (-65 ºF) to 74 ºC (165 ºF) with 5,000 cfm conditioned makeup air and exhaust systems.

Figure 8. Firing Test Chamber.

d. Vibration Facility. Three remotely controlled electrodynamic vibration systems capable of testing to MIL-STD-810G are available. These systems are used for shock and vibration testing of vehicle components, equipment, weapons, and ammunition (Figures 9a and 9b). Laboratory vibration schedules are developed from field data. Vibration exciter force capabilities are available up to 178 kN (40,000 pound force) in single axis, three planes. The available temperature range available is from -57 to 77 ºC (-70 to 170 ºF).

Figure 9a. Vibration facility vertical exciter.

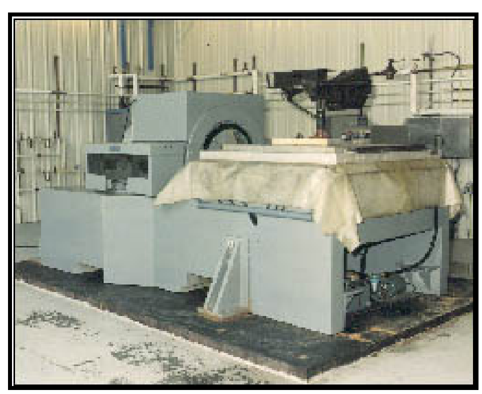

Figure 9b. Vibration facility horizontal exciter.

e. Climatic Simulation Facilities. These facilities (some of which are shown in Figures 10a and 10b) provide climate test support. Three portable wind machines generate up to 161 km/hr (100 mph) winds. In addition, a portable wind-driven rain machine produces 10 cm/hr (4 in./hr) of rain with up to 80 km/hr (50 mph) wind. Two stationary temperature-humidity chambers 2.8 by 2.4 by 1.9 m (9.5 by 7.9 by 6.4 ft) and nine portable units 1.8 by 1.4 by 1.5 m (6.0 by 4.7 by 5.0 ft) having temperature ranges -62 to 93 ºC (-80 to 200 ºF) with humidity up to 100 percent are available. A solar radiation chamber 3 by 3.7 by 1 m (10 by 12 by 3 ft) is also available. Pressurized water up to 345 kilopascals (kPa) (50 pounds per square inch (psi)) can be provided over a 3.7 by 7.3 m (12.0 by 24.0 ft) area. Steam pressure up to 103 kPa (15 psi) and 118 ºC (245 ºF) is available in a 2.1-m diameter by 3.7-m long (7 by 12.0 ft) vessel.

Figure 10a. Solar radiation chamber.

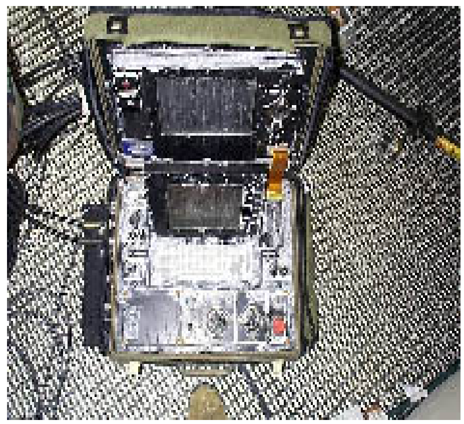

Figure 10b. Salt test.

f. Electromagnetic Interference Test Facility (EMITF). This multiservice test facility is one of the largest of its type. The facility consists of three test chambers, the largest of which measures 28.7 m long by 18.3 m wide by 8.5 m high (94 by 60 by 28 ft), making it large enough for combat vehicles, tactical trucks, large caliber weapons systems, and helicopters (Figure 11). Testing is available through the frequency range of 16 Hertz (Hz) to 40 Gigahertz (GHz), with susceptibility levels up to 200 volts per meter (V/m). Testing can be accomplished in accordance with Military, SAE, Comite International Special de Perturbations Radioectriques (CISPR), and Federal Communications Commission (FCC) standards. The shielded enclosure has magnetic field attenuation of 40 decibels (dB), 14 kHz to 1 Megahertz (MHz), electric field attenuation of 90 dB, 14 kHz to 30 MHz, and plane wave attenuation of 90 dB, 30 MHz to 1000 MHz.

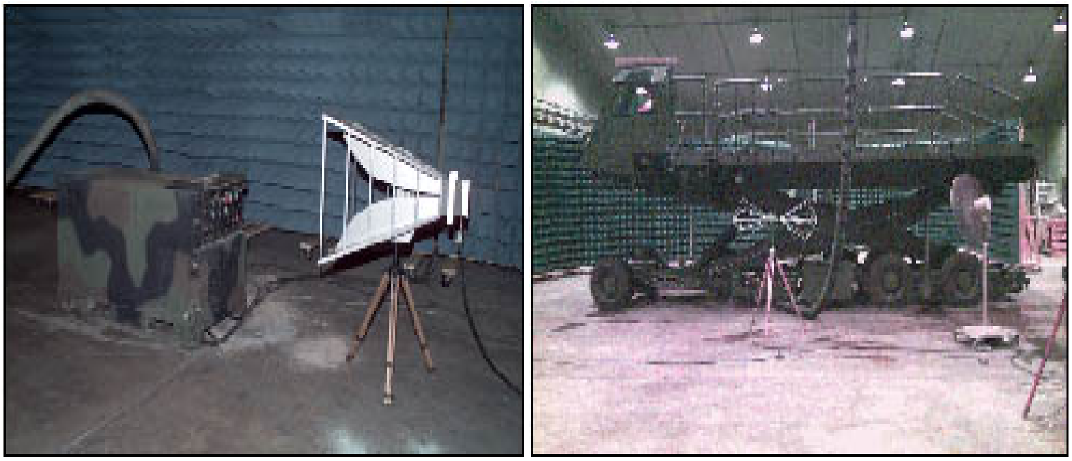

Figure 11. Electromagnetic Interference Test Facility.

2.3 Dynamometer Course.

a. This course, in the Michaelsville area of ATC, is constructed of reinforced concrete, with a hot mixed bituminous surface making it suitable for operations of the heaviest tracked vehicles. The course has a total gradient of less than 0.1 percent in its 1.6-km (1-mi) length, and turnarounds are provided at each end. It is used for closely controlled engineering tests such as drawbar pull (Figure 12), tractive resistance measurements, coast-down, braking, and fuel consumption. These tests are conducted at low to moderate speeds.

Figure 12. Drawbar pull test conducted on Dynamometer Course.

b. A gravel connector between the straight portions of the Perryman No. 1 course and Secondary Road A (Section 2.8) is referred to as the Dirt Dynamometer Course. It provides an approximately 2.4 km (1.5 mi) straight, level, dirt surface to allow dynamometer testing of steel-tracked vehicles which could damage paved surfaces.

2.4 Mile Loop.

a. This oval-shaped facility was originally constructed in 1933 as a level concrete course for continuous high-speed operating tests of vehicles (Figure 13). The Mile Loop consists of two straight sections, each 0.4 km (0.25 mi) long, joined at each end by 0.4-km sections of regular curvature to form an oval totaling 1.6 km (1 mi) in circumference. The curves are slightly banked at a gradient of 4 percent.

Figure 13. Aerial view of the Mile Loop.

b. The course has been modified by covering and maintaining the surface with hot mixed bituminous concrete and by adding a gravel surface parallel to and outside the oval. Located within the Mile Loop are additional facilities, as described below.

(1) Winch Test Facility. This device has a restraining capability of 445 kN (100,000 lb), and is used mainly as an anchor during winch performance and endurance testing.

(2) Pothole-Crosstie Course. This oval facility is situated on a concrete pad within the mile loop, and consists of a series of concrete potholes on one straight side of the oval, a series of wooden crossties on the opposite straight side, and two 10.7-meter (35-ft) radius gravel ends connecting the two straight sections.

(a) The pothole section consists of eight concrete potholes 5 m (17 ft) apart (8 m (25 ft) center to center) (Figure 14). Each pothole is l.8 m (6.0 ft) wide, 2.4 m (8.0 ft) long, and 30.5 cm (12.0 in.) deep, sunk flush with the concrete surface. The sides of each pothole are sloped 45 percent (24.2 degrees) and the ends are sloped 100 percent (45 degrees). The total length of this segment of the course is 61 m (200 ft).

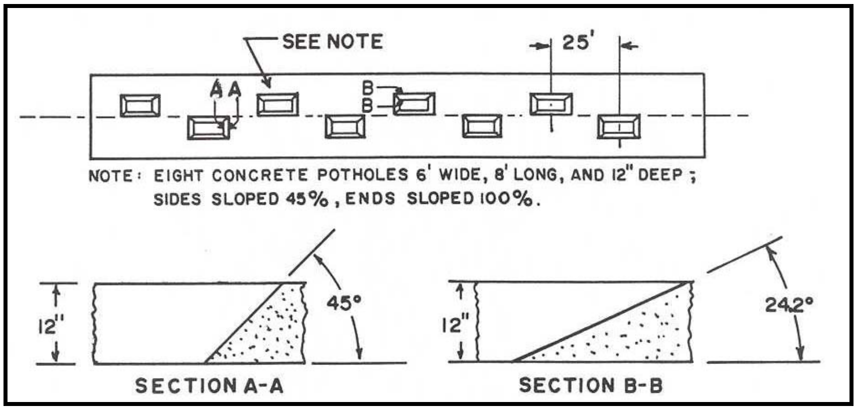

Figure 14. Pothole section of Pothole-Crosstie Course.

(b) The crosstie section of the course consists of 11 crossties, 1.8 m (5.9 ft) long, 15.2 cm (6.0 in.) high, and 15.2 cm (6.0 in.) wide, mounted flush with the concrete surface by means of 7.6 cm (3.0 in.) angle iron. The ties are spaced at 3.7 m (12.0 ft) intervals (center to center) at alternate right and left sides of the course. The total length of this segment is 40.1 m (132 ft). Figure 15 shows a vehicle negotiating the Pothole-Crosstie Course.

Figure 15. Vehicle negotiating Pothole Test Course.

(3) 1-Inch Bump Course. The 2.5-cm (1-in.) bumps are iron rods, 4.3 m (14 ft) long, 5 cm (2 in.) wide and 2.5 cm high, mounted on the flat concrete surface in the center of the pothole-crosstie course. A total of 39 1-inch bumps are spaced at random 1.5- and 1.8-meter (5- and 6-ft) intervals perpendicular to the direction of travel. The course length is 67 m (220 ft).

(4) Rain Towers. The rain towers at ATC offer a dynamic rain course where personnel perform simulated combat activities. The course consists of two 9.1 m (30 ft) high towers that accommodate items up to 9.1 by 15.2 m (30 x 50 ft) in area and up to 7.6 m (25 ft) tall. The rain towers produce simulated free-falling rain of intensities up to 10.2 cm (4 in.) per hour. The rain course accommodates the evaluation of associated shelter support/restraint systems (stakes, guy lines, etc.), generators, environmental control units, and all other wheeled and tracked vehicles. Figure 16 shows the Rain Towers at ATC.

Figure 16. Rain Towers at Mile Loop.

2.5 Mountain Highway.

This is a 64-km (40-mi) mountainous section of US Route 30 in the vicinity of Jennerstown, Pennsylvania. It is used by ATC as a brake test course, and by the brake-manufacturing industry itself, as one of the most severe in the East for brake fade testing. With grades as steep as 11 percent and at various elevations (Figure 17), this section of public highway is admirably suited for testing military wheeled vehicle brakes (test procedures are described in TOP 02-2-608[7]). Standard test conditions are obtained by controlling speed, brake line pressure, and deceleration. Brake temperatures and pressures, and vehicle road speed and stopping distances are measured throughout the test. Figure 18 shows a test vehicle descending a mountain during the mountain brake endurance test.

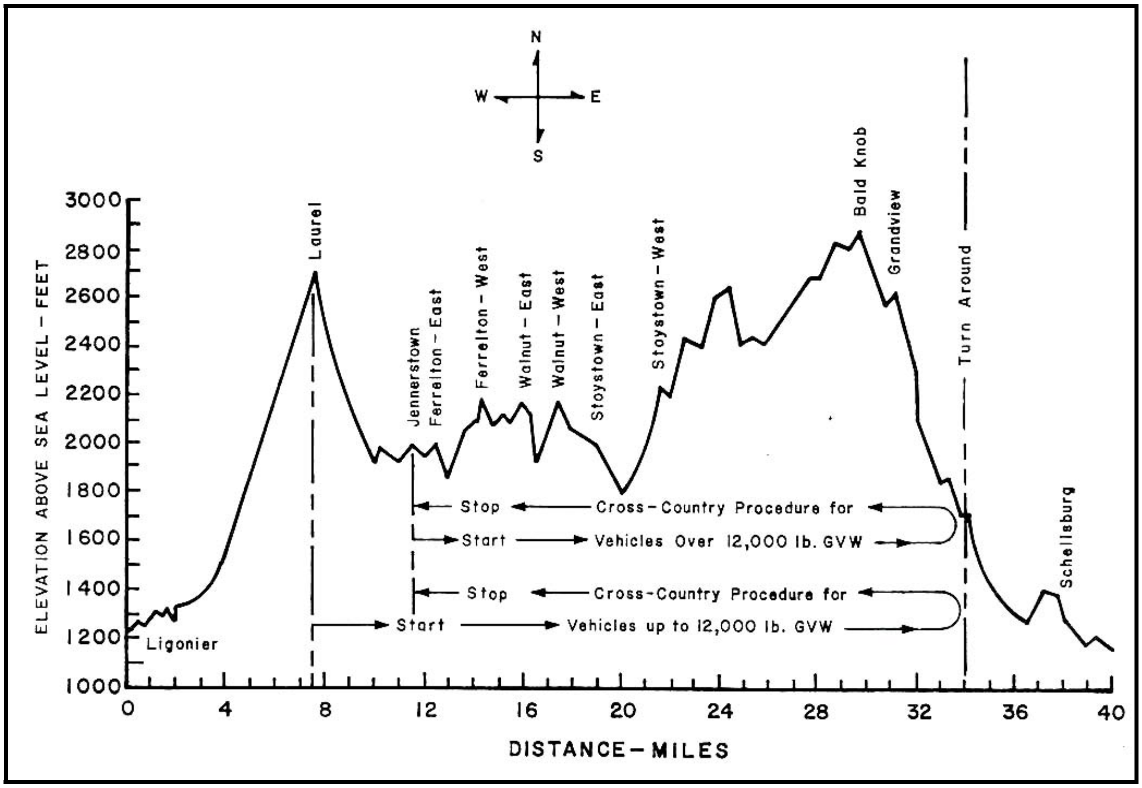

Figure 17. Profile of Mountain Test Course.

Figure 18. Test vehicle and data van / safety escort vehicle descending mountain.

2.6 Munson Test Area (MTA).

a. Located near the eastern boundary of APG and bordering the shores of the Spesutie Island Narrows portion of the Chesapeake Bay, the MTA encompasses about 60 hectares (150 acres) of land. The facility is named in honor of Lieutenant Max Munson who lost his life in 1941 while testing an experimental vehicle.

b. The test courses are designed for making specific measurements and determinations of vehicle performance in the field. All special obstacles and test roads are permanently constructed and maintained according to specifications. The courses and network of connecting roads total 14.5 km (9 mi). Figure 19 shows relative locations of the courses, and Figure 20 is an aerial view.

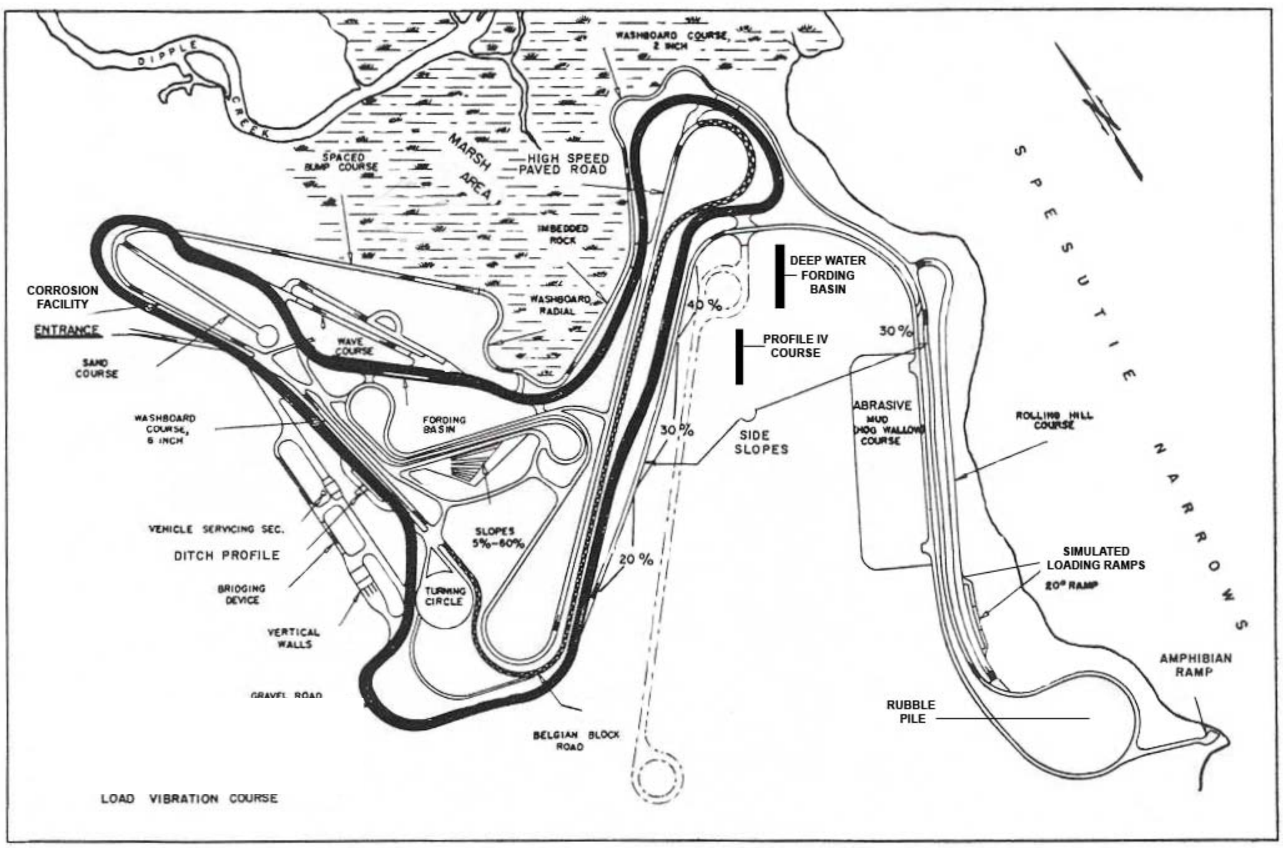

Figure 19. Munson Test Area.

Figure 20. Aerial view of Munson Test Area.

2.6.1 Paved Road.

This is a level road (Figure 21) that permits the operation of most military vehicles at high speed. It provides a sharp contrast in operating conditions when used as part of a loop including the Belgian Block Course.

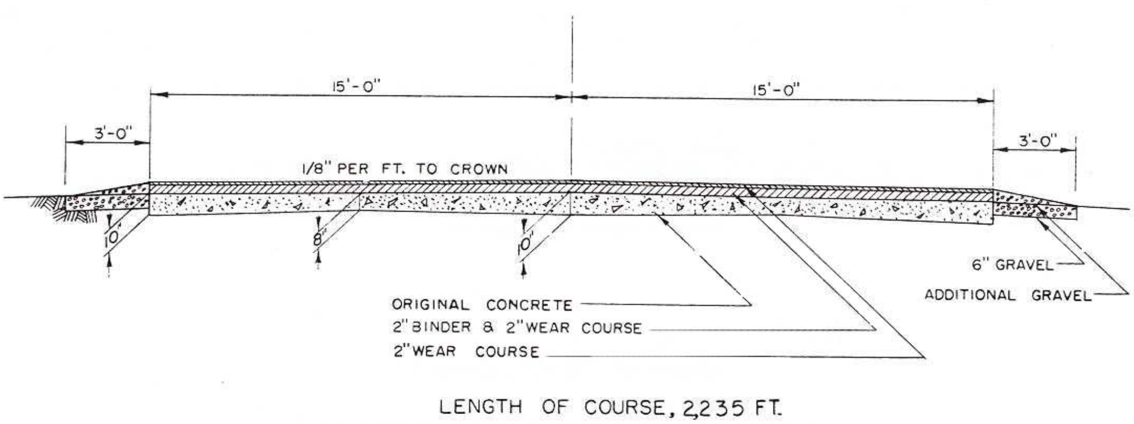

Figure 21. Cross section of Paved Road.

2.6.2 Improved Gravel Road.

This is a loop of about 3.2 km (2 mi) with left and right curves; the surface is compacted gravel maintained by grading (Figure 22). This gravel road (along with other test courses) is used for endurance testing.

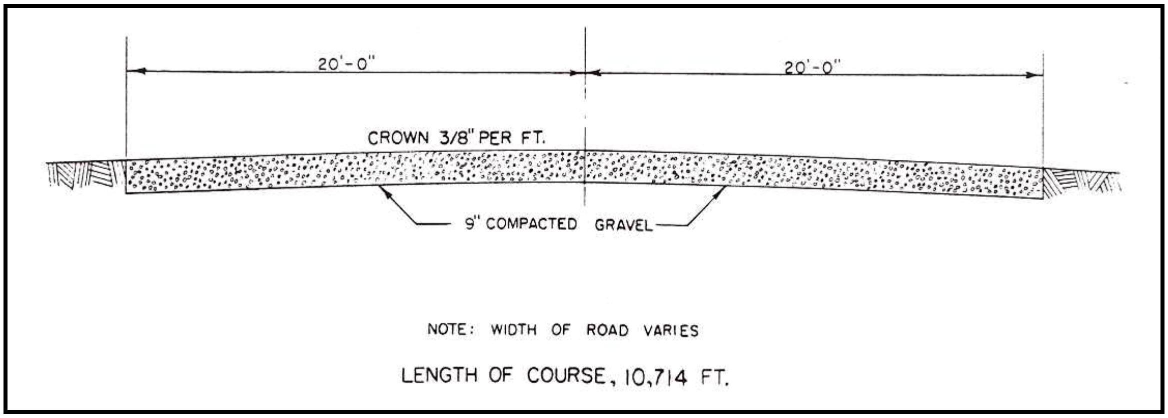

Figure 22. Cross-section of Improved Gravel Road.

2.6.3 Rolling Hill Course.

This was designed to provide short, closely spaced grades. As a vehicle alternates between up- and down-grades on this course (Figure 23), the engine and power train are subjected to rapid variations in loading. The surface consists of crushed stone compacted with stone dust binder.

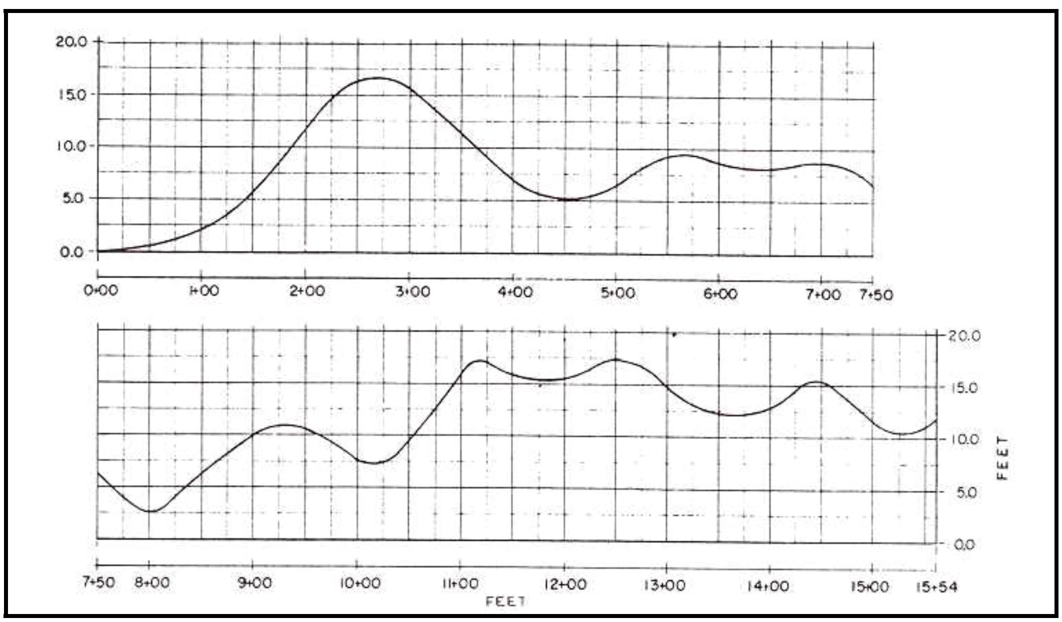

Figure 23. Profile of Rolling Hill Course.

2.6.4 Sand Course.

This course provides a standard for evaluating drawbar pull of wheeled and track-laying vehicles under controlled conditions. The coarse grained sand, conforming to the Unified Soil Classification soil type SP, is contained in a concrete bin that facilitates tilling and drainage, and prevents contamination from the surrounding soil (Figure 24). The straight portion of the course has sufficient length to produce stabilized data for a given load and/or speed condition. The circular bed at the end of the course is useful for evaluating the ability of vehicles to steer in sand, and for determining track-throwing tendencies and the effect of sand accumulation in suspension systems. Figure 25 shows drawbar pull testing conducted on the Sand Course.

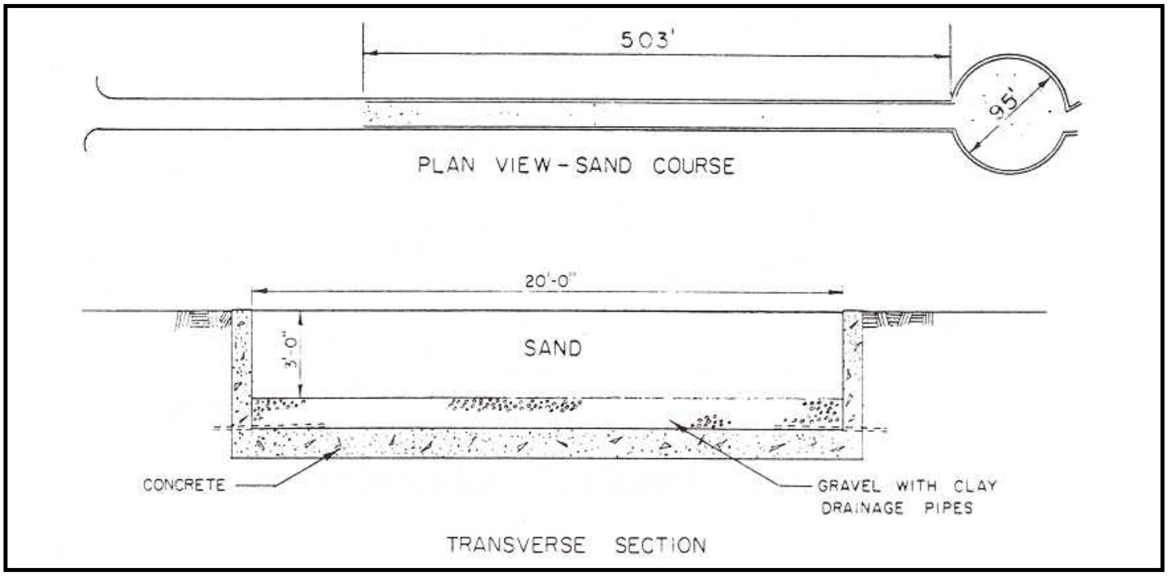

Figure 24. Plan view and transverse section of Sand Course.

Figure 25. Drawbar pull testing in Sand Course.

2.6.5 Rubble Pile.

The Rubble Pile course is approximately 30.5 m (100 ft) in length, consisting of large boulders and pieces of concrete and steel (Figure 26). A test on this course is conducted to determine a vehicle's ability to negotiate this type of obstacle.

Figure 26. Rubble Pile at MTA.

2.6.6 Corrosion Facility.

a. This facility provides aggressive controlled exposure of corrosive conditions to land systems to hasten their weathering process and determine susceptibility to the environments. Fifteen test cycles replicate one year of field corrosion; a 22-year corrosion assessment can be implemented in 200+ days.

b. Each test cycle includes a series of individual corrosive environments (Figure 27): Splash Trough – 22.9 m long x 6.1 m wide (75 ft long x 20 ft wide), solution depth up to 0.1 m (2 in.) subjected to undercarriage; Mist Booth – 18.3 m long x 4.6 m wide x 4.6 m high (60 ft long x 15 ft wide x 15 ft high) up to 3-minute mist applied to top and vertical surfaces; Grit Trough – 22.9 m long x 4.3 m wide (75 ft long x 14 ft wide), slurry depth up to 0.2 m (8 in.) subjected to undercarriage; High Heat / High Humidity Chamber – 12.2 m long x 6.1 m wide x 6.1 m high (40 ft long x 20 ft wide x 20 ft high), up to 74 ºC (165 ºF), 1 to 2 milliliter per hour (mL/hr) condensate; Deep Water Fording Basin – 57.9 m long x 6.7 m wide (190 ft long x 22 ft wide) with adjustable water depth up to 2.1 m (84 in.), and a 3-percent sodium chloride (NaCl) solution which replicates ocean environment. Facilities instrumentation and equipment are used to provide identification, analysis, and documentation of corrosion to the test item.

Figure 27. Accelerated Corrosion Complex.

2.6.7 Abrasive Mud Course.

Also known as the hog wallow, this facility (Figure 28) has an independent piped water supply that provides the means for maintaining muddy conditions, regardless of the season. The soil is sandy, with some clay and silt, making it particularly useful for evaluating the effects of abrasion on seals, brakes, and other components, as well as the effectiveness of seals. The ability to control the moisture content in dry periods makes it possible to adjust the course conditions and soil strength profile (within limits) to suit test requirements of any particular vehicle. The soil conforms to the Unified Soil Classification System soil type SM. The course can be tilled to various depths to a maximum of 0.6 m (2.0 ft). The course is 73 by 290 m (240 by 950 ft). Figure 29 shows a vehicle undergoing crossing velocity testing on the Abrasive Mud Course. Figure 30 shows the Abrasive Mud Course under wet conditions.

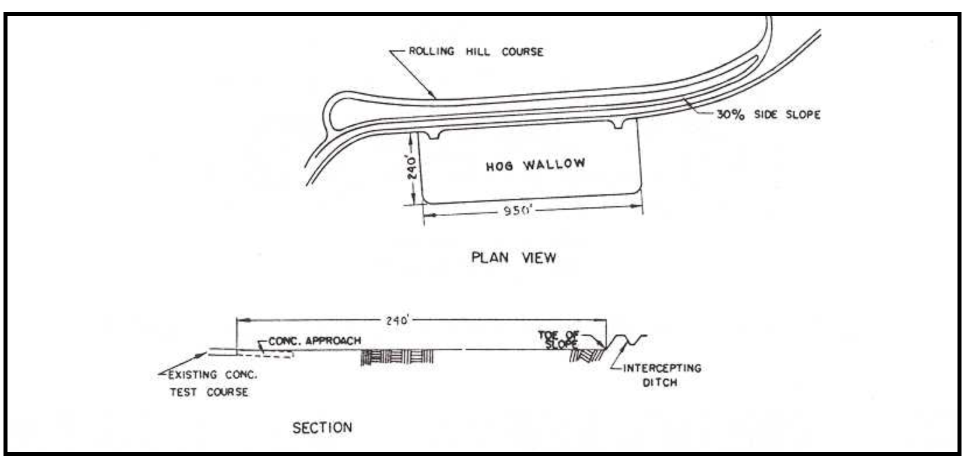

Figure 28. Plan view and section, Abrasive Mud Course.

Figure 29. Crossing velocity test in the hog wallow.

Figure 30. Abrasive Mud Course under wet conditions.

2.6.8 Fording Basin.

Also known as the bathtub, this concrete facility was designed to provide still water at controlled depths to 1.5 m (5.0 ft) (Figures 31 and 32). Ramps at both ends permit gradual immersion if desired. Length and width of the basin are sufficient for running preliminary flotation tests on some amphibious vehicles. The main uses of the basin are for determining fording characteristics of non-floating vehicles and for studying the effects of water on running gear components such as brakes, seals, and universal joints. The length of this course is 82 m (270 ft).

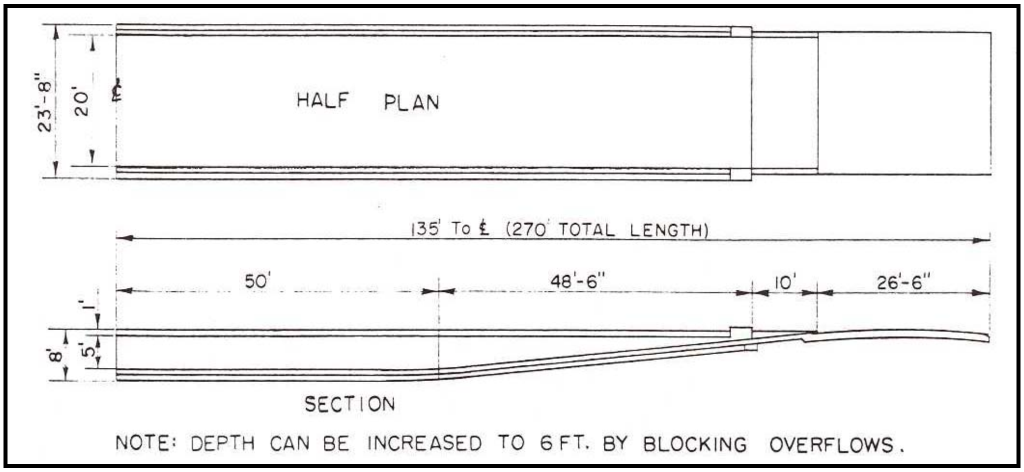

Figure 31. Half plan and section views, Fording Basin.

Figure 32. Fording Basin.

2.6.9 Underwater Fording Facility.

Some vehicles can neutralize water obstacles by submerging. Vehicle effectiveness while submerged is tested in this concrete facility (Figure 33), in which water depths can be adjusted to 6.1 m (20 ft). Performance and safety of operations are evaluated under water and on the 40- and 50-percent entrance and exit slopes. The length of this facility is 96 m (315 ft).

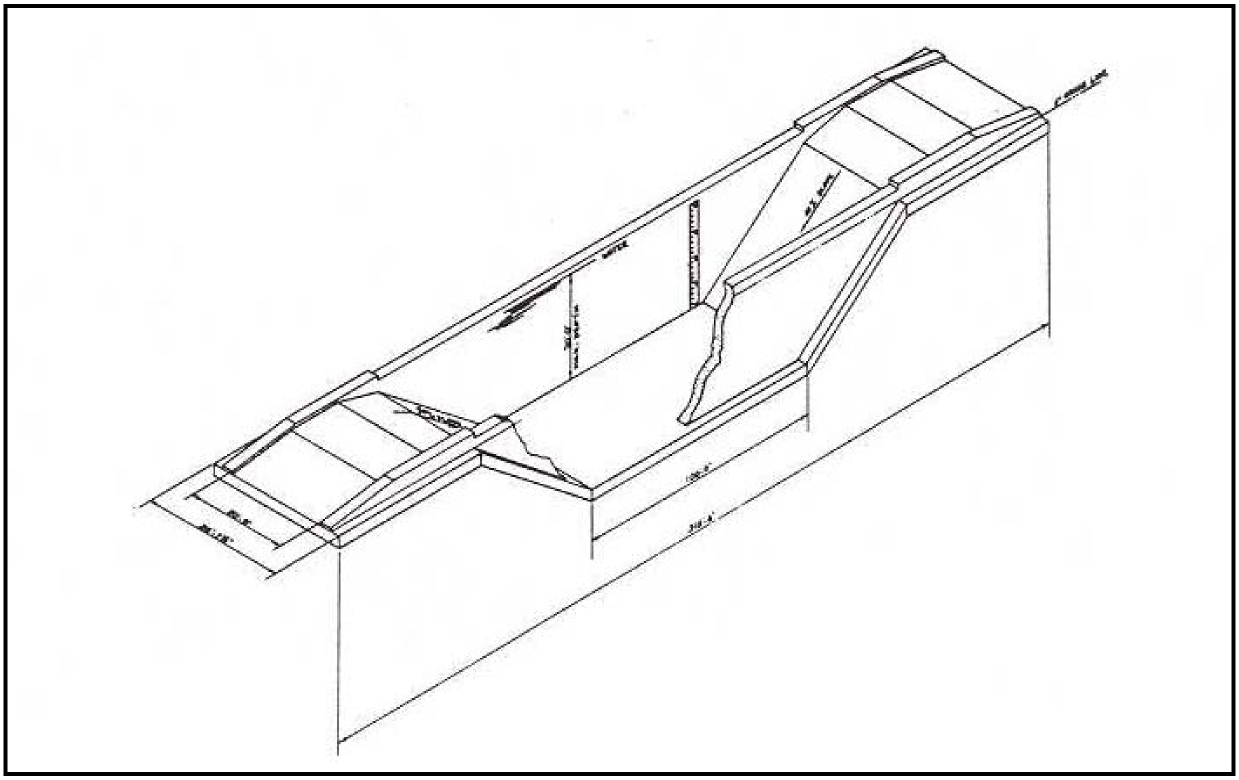

Figure 33. Underwater Fording Facility.

2.6.10 Amphibian Ramp.

This is used for evaluating the ability of vehicles to enter and leave a natural body of water by means of an articulated concrete mat which is composed of concrete blocks and cables. It is anchored in place, and the blocks are filled with aggregate (Figure 34). The moderately sloped ramp extends into the water sufficiently to permit the safe launching of test vehicles whose flotation characteristics are known. The ramp is an ideal location for conducting bollard pull for marine vehicles and amphibians (Figure 35). For water entrance and exit interface tests, earthen slopes are constructed by grading. The ramp is 15 m (50 ft) wide and 6 m (21 ft) long.

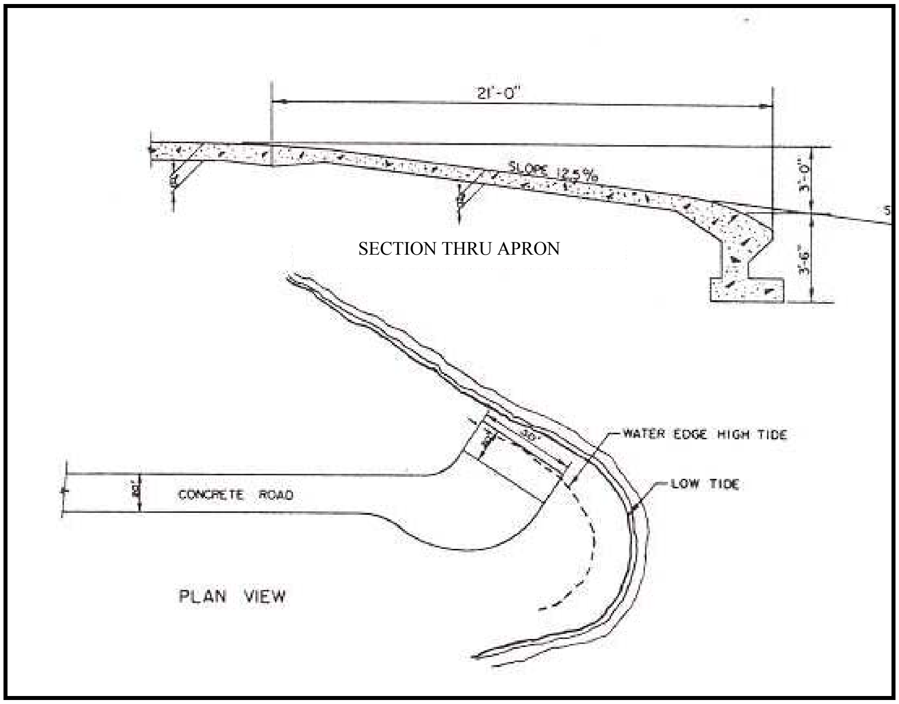

Figure 34. Plan view and section, Amphibian Ramp.

Figure 35. Bollard pull using mobile field dynamometer.

2.6.11 Shallow Water Swimming Area.

The Spesutie Island Narrows has a 305-m (1000-ft) channel typically 3 m (10 ft) deep and 15 m (50 ft) wide suitable for evaluating the swimming and floating capabilities of amphibious vehicles in still water (Figure 36). Fuel consumption and speed tests, as well as tests to evaluate floating bridges and rafts, are conducted here. Entrance to the Spesutie Narrows is by way of the amphibian ramp. The Spesutie Narrows leads to deeper waters of the Chesapeake Bay where additional testing may be conducted if necessary. Rather large vessels, such as landing craft, can gain access to the MTA through the Chesapeake Bay and the Spesutie channel.

Figure 36. Shallow water swimming.

2.6.12 Belgian Block Course.

This facility is paved with unevenly laid granite blocks forming an undulating surface (Figures 37 and 38). It duplicates the rough cobblestone road found in many parts of the world. About 1.2 km (0.75 mi) long, the course is useful as a standard rough road for accelerated tests of wheeled vehicles, and is generally included in cycles of courses used for vibration studies. The motion imparted to a vehicle is a random combination of roll and pitch and high-frequency vibrations imparted by the granite paving blocks.

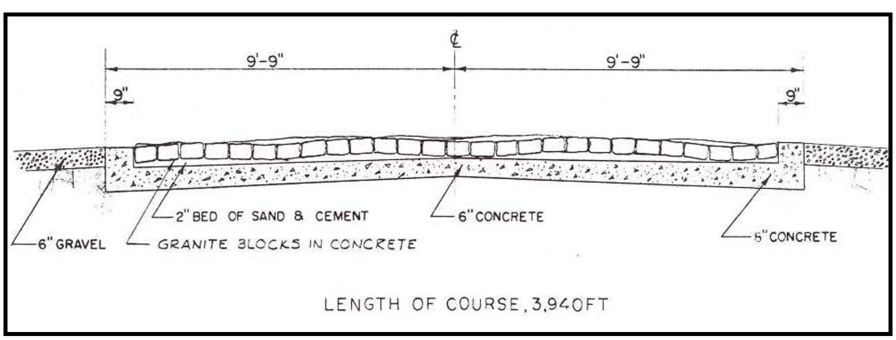

Figure 37. Transverse section, Belgian Block Course.

Figure 38. Belgian Block Course.

2.6.13 Imbedded Rock Course.

This course provides an extremely rough surface for testing wheeled vehicles (Figure 39). It not only has an irregular surface suitable for evaluating suspensions, but is also a severe test for pneumatic tires (Figure 40).

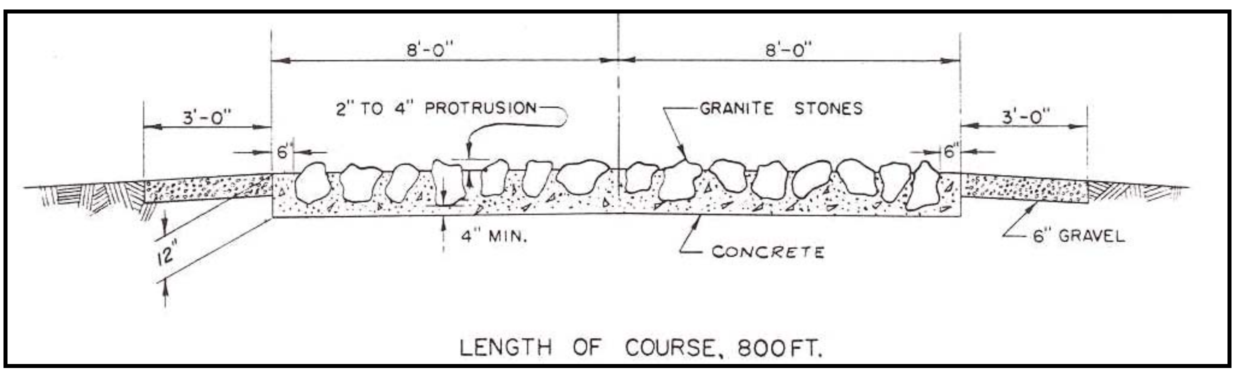

Figure 39. Transverse section of Imbedded Rock Course.

Figure 40. Durability testing using Imbedded Rock Course.

2.6.14 Side Slopes.

Side slopes of 20, 30, and 40 percent are used as standards for testing the stability and controllability of tactical vehicles (Figures 41 and 42). In addition to being used in engineering tests to measure steering efforts and lateral loading effects, the courses are sufficiently long to be incorporated in endurance tests involving other types of operation. A 1.8-m (5.9 ft) level gravel shoulder adjoining the slopes permits operation at gradients less than those of the actual slopes. When required for specific tests, side slopes with other gradients are constructed with a grader. The course lengths are shown in Table 1.

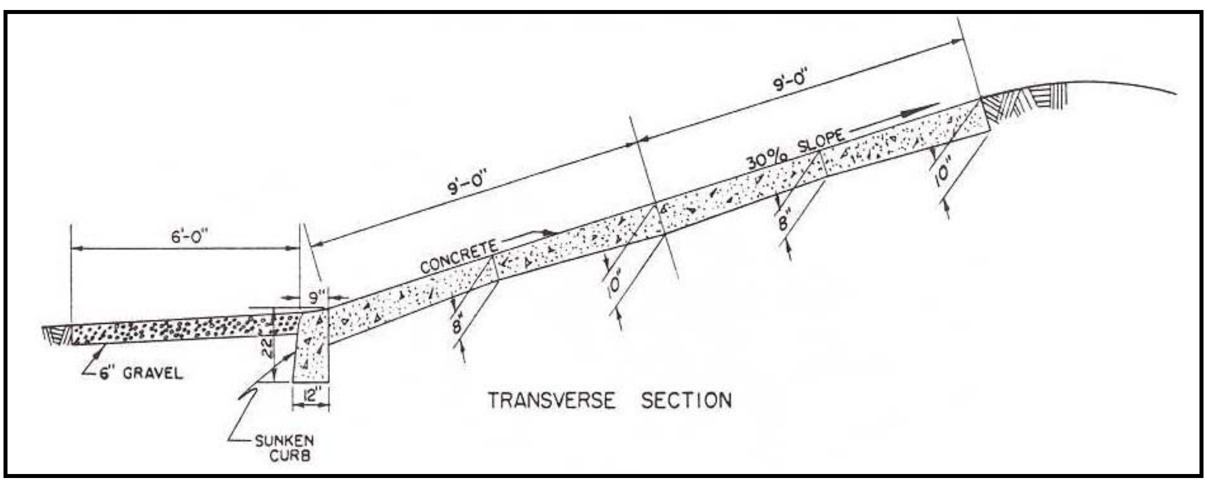

Figure 41. Transverse section of 30-percent side slope.

Figure 42. Vehicle negotiating the 20-percent side slope.

2.6.15 <u>Gradeability (Longitudinal) Slopes</u>.

Gradeability of vehicles is a basic characteristic usually given in design specifications of military vehicles. The MTA Gradeability slopes (Figures 43 and 44) cover a range of 5 to 60 percent. They are used to determine optimum drive ratios and maximum attainable speeds on each slope, as well as brake-holding ability and adequacy of angles of approach and departure. With the test vehicle in ascending and descending attitudes, functions such as lubrication, fuel flow, and carburetor performance are investigated. The effect of imbalance on turret-traversing efforts and functioning of turret drive systems may also be studied on the slopes. The 5-, 10-, 15-, and 20-percent slopes, about 4.3 m (14 ft) wide, are paved with asphalt; the 30-, 40-, 45-, 50-, and 60-percent slopes with concrete. A 7-percent vertical slope is asphalt. The slope lengths are shown in Table 1.

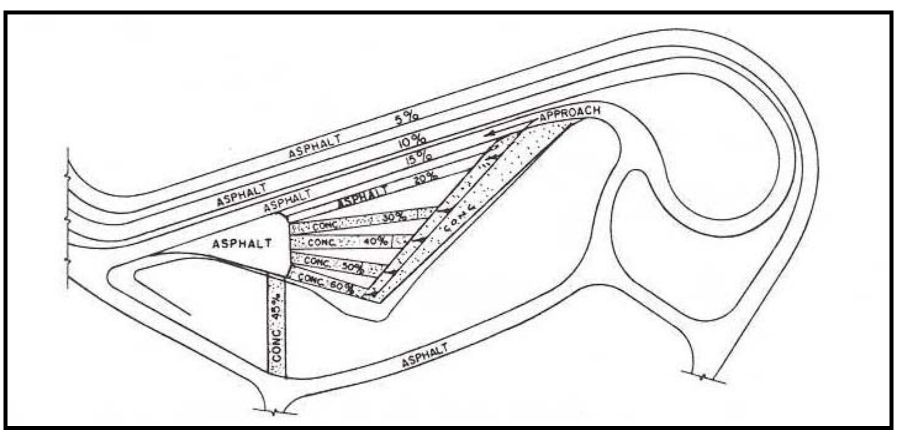

Figure 43. Plan view of Gradeability Slopes.

Figure 44. Vehicle ascending 60-percent gradeability slope.

2.6.16 Simulated Loading Ramps.

Tactical vehicles designed for transportation by either aircraft or ramp-equipped landing craft must be capable of entering and leaving the transporting vehicle by means of an inclined surface or ramp. Two concrete simulated loading ramps, one with a 20-degree incline, 12 m (38 ft) long (Figure 45) and the second, with a 15-degree incline, 6-m (20-ft) long (Figure 46), enable vehicles to be tested not only for adequacy of approach and departure angles, but also for adequate ground clearance and freedom from interference at the point of articulation between towing and towed vehicles (Figure 47).

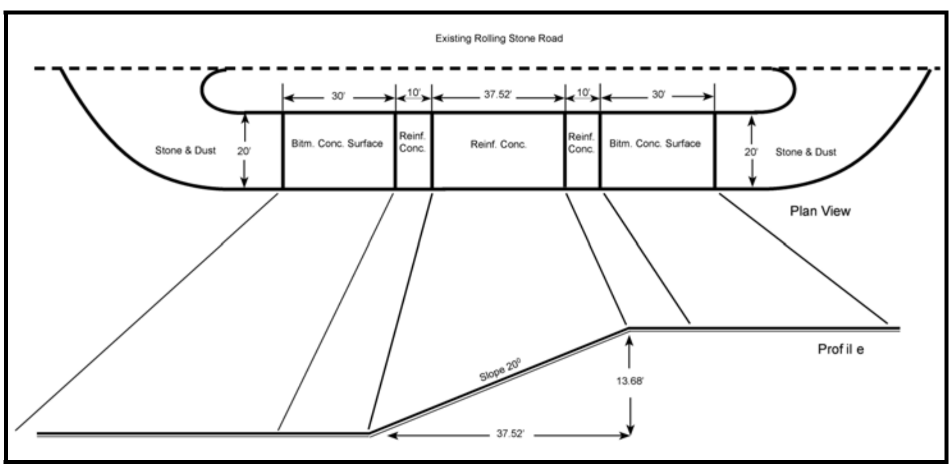

Figure 45. Plan view and section of 20-degree simulated loading ramp.

Figure 46. Vehicle on 15-degree simulated loading ramp.

Figure 47. Vehicle on 20-degree simulated loading ramp.

2.6.17 2-Inch Washboard.

The test course (Figure 48) is comprised of reqular undulations with a wavelength of 0.6-m (2.0-ft) and provides a regular series of periodic humps with special value for testing wheeled vehicle suspensions (Figure 49). It can be used for one phase of endurance tests involving other courses in the area. Shocks imposed on the vehicle are influenced by design factors such as axle spacing and wheel size.

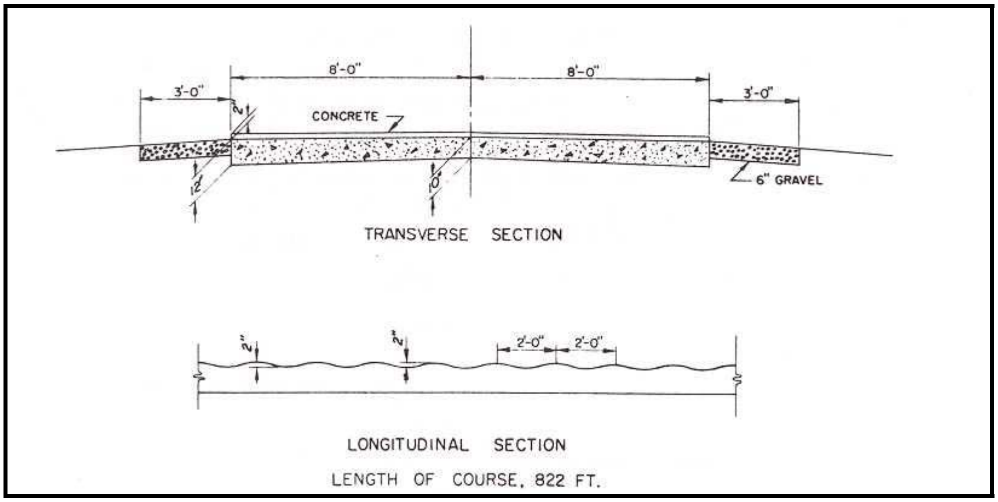

Figure 48. Sections of 2-Inch Washboard.

Figure 49. Testing wheeled vehicle suspension on 2-Inch Washboard Course.

2.6.18 2- to 4-Inch Radial Washboard.

This course is constructed using reverse curves in such a manner that the wheels of a test vehicle are subjected to impacts at varied frequencies for any given speed (Figure 50). The course is useful for evaluating wheel fight and tendencies toward front-wheel shimmy (Figure 51).

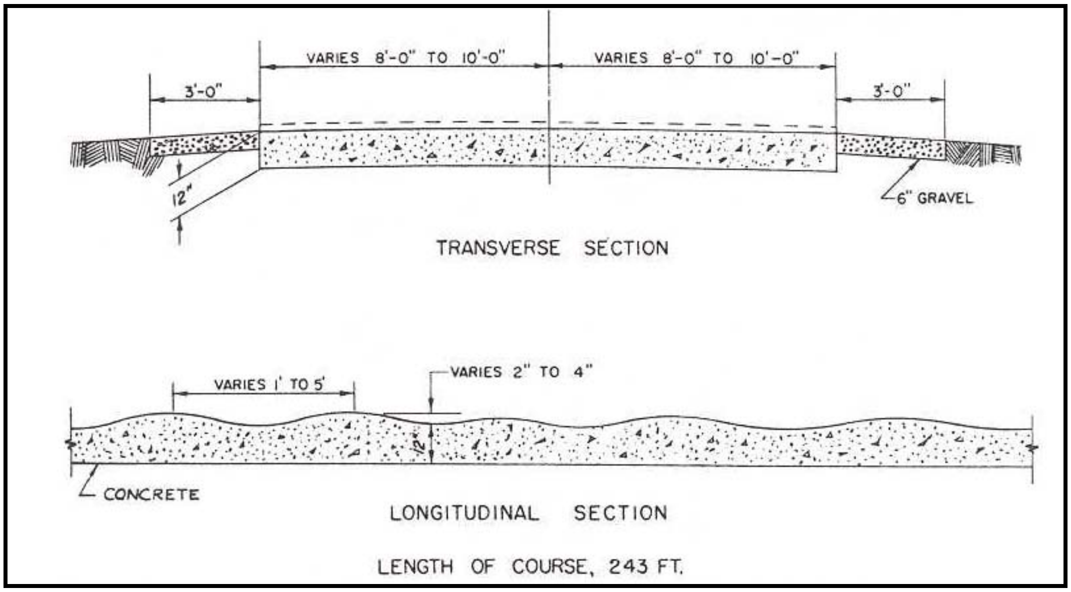

Figure 50. Sections of Radial Washboard.

Figure 51. Vehicle testing on the 2- to 4-Inch Radial Washboard Course.

2.6.19 <u>3-Inch Spaced Bump</u>.

This course gives a vehicle an irregular jolt by means of 7.6-centimeter (cm) (3-in.) rounded sections that cross the road surface at various angles (Figure 52). The spacing allows the suspension to settle down between jolts. This course is used mainly to impose shock and vibration stress on wheeled vehicle suspensions.

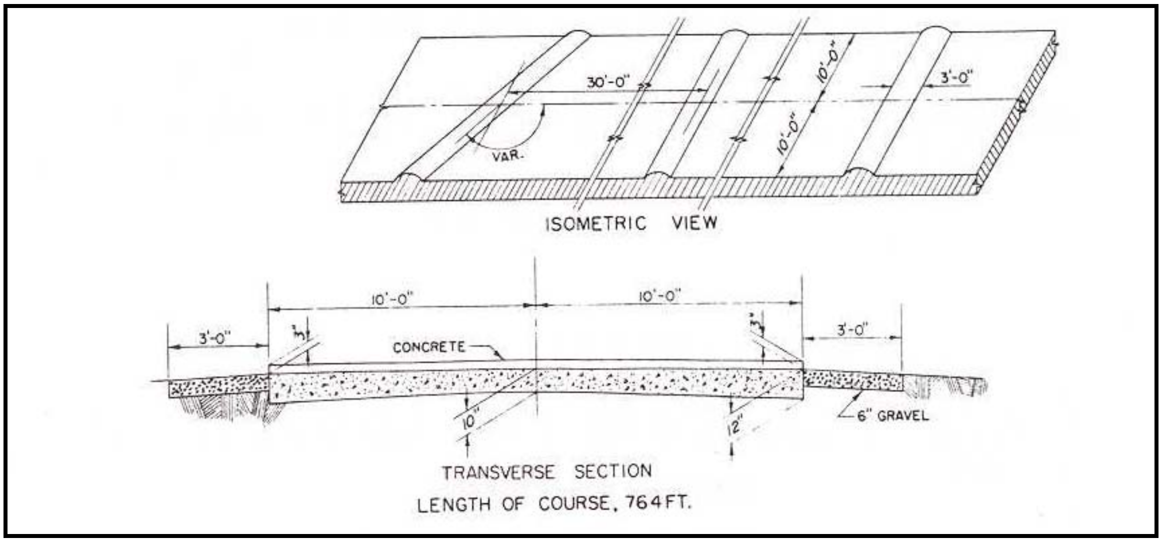

Figure 52. Isometric view and section of 3-Inch Spaced Bump.

2.6.20 <u>6-Inch Washboard</u>.

This course is the most severe of the regular washboard courses, and is designed to evaluate vehicle pitching characteristics (Figure 53). The pitching is induced at various speeds. The relatively large radius of the wave configuration and the 1.8-m (5.9-ft) intervals ensure that the larger wheels and track pitches ordinarily do not bridge the depressions.

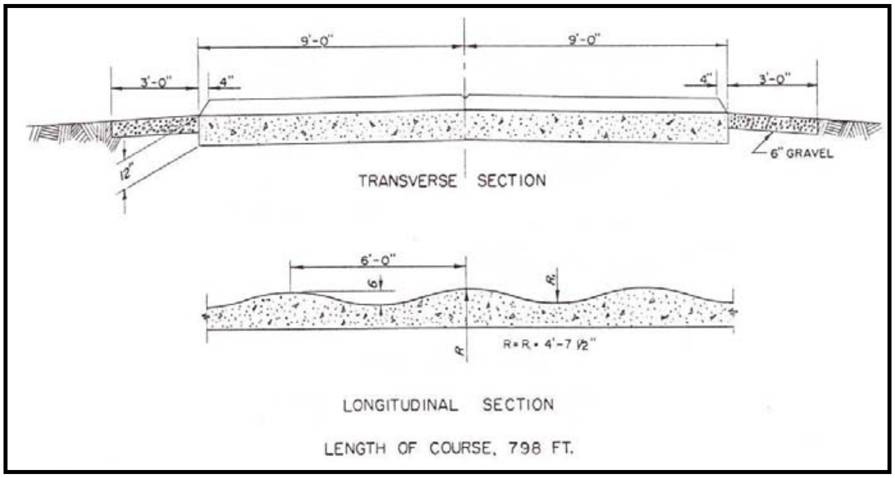

Figure 53. Sections of 6-Inch Washboard.

2.6.21 Wave Course.

Also known as the frame twister, this concrete course (Figures 54 and 55) is designed to deflect the opposite wheels of a vehicle in alternately contrary directions. Articulation of the suspension increases with tread width. The course provides a severe test of differentials and universal joints, as well as suspensions. Distortion of vehicle bodies is checked by operating doors, dump bodies, engine hoods, etc., after stopping the vehicle with the suspension at extremes of vertical travel.

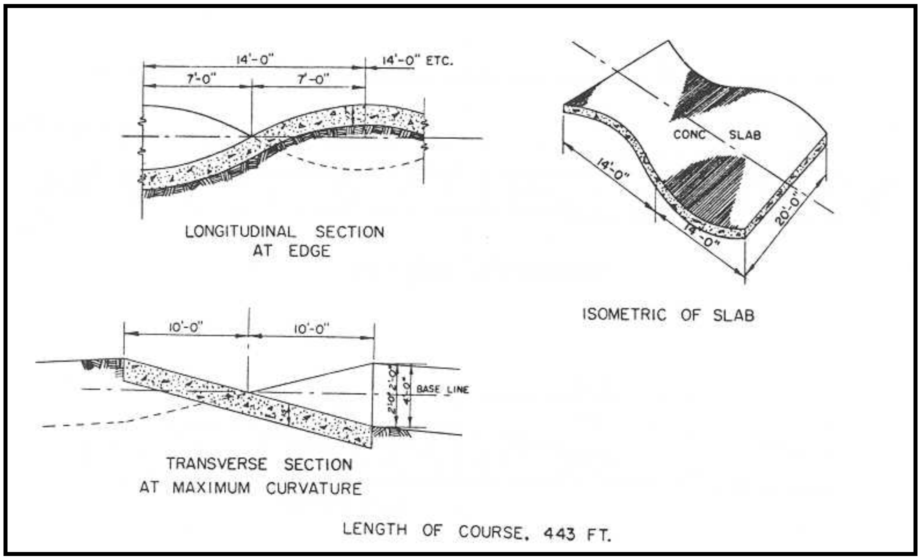

Figure 54. Sections of Wave Course.

Figure 55. Vehicle negotiating the Wave Course.

2.6.22 <u>Vertical Walls</u>.

Wall-climbing ability is a characteristic that is measured for all tactical vehicles. Maximum capability may be limited by projections from the vehicle that extend beyond the wheels or tracks. The vertical wall (Figures 56 and 57) is equipped with replaceable timbers at the top so that the wall may be maintained in a standard condition following damage from tests.

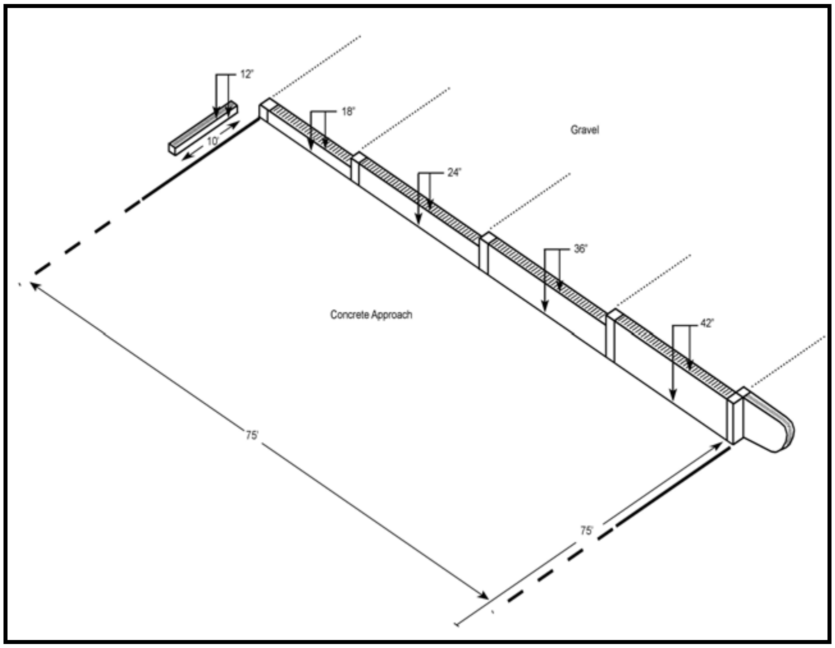

Figure 56. Isometric view of Vertical Walls.

Figure 57. Vehicle ascending the 18-inch vertical wall.

2.6.23 Bridging Device.

The bridging requirement for various types of tracked vehicles is usually specified in the technical characteristics or design specifications. The steel bridging device provides an adjustable gap for measuring the maximum opening that the vehicle can cross unsupported (Figures 58 and 59). The maximum gap is 5.5 m (18 ft).

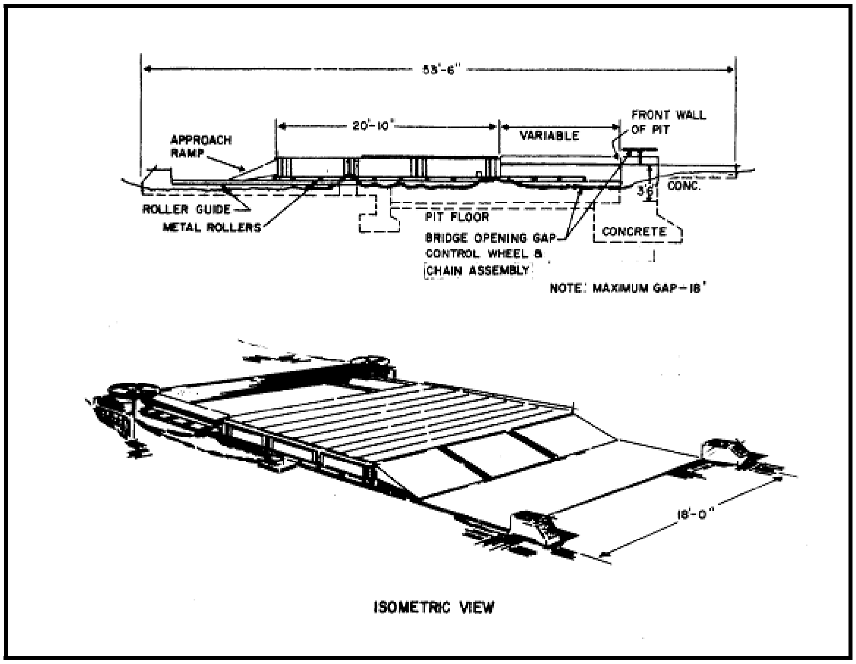

Figure 58. Plan and isometric view of the Bridging Device.

Figure 59. Vehicle negotiating the Bridging Device.

2.6.24 Standard Ditch Profile.

The standard concrete ditch is used to check the adequacy of the angles of approach and departure of tactical vehicles. Tracklayers usually require rubber tracks for sufficient traction for pulling out of the ditch (Figures 60 and 61). The ditch has a 36.5-percent gradient for both ingress and egress.

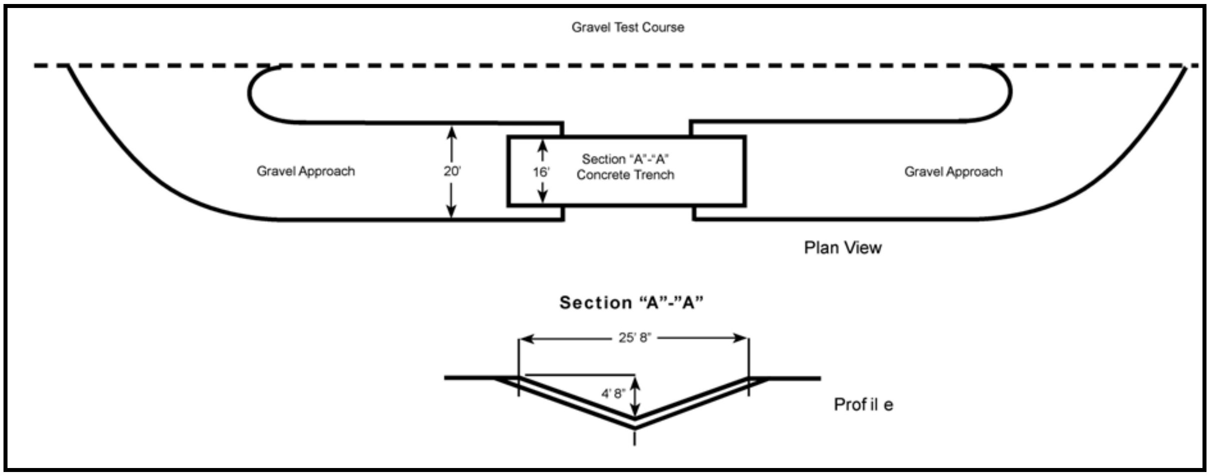

Figure 60. Plan and section view of standard ditch.

Figure 61. Vehicle negotiating the standard ditch.

2.6.25 Turning Circle.

This course is used for measuring vehicle turning diameters on a hard surface (Figure 62). It is large enough, at a diameter of 76 m (250 ft), to permit figure-8 turns by the largest vehicles and for plotting limits of vision (Figure 63). It is also used for other activities requiring a large and essentially flat concrete surface.

Figure 62. Measurement of vehicle turning diameter on the Munson Turning Circle.

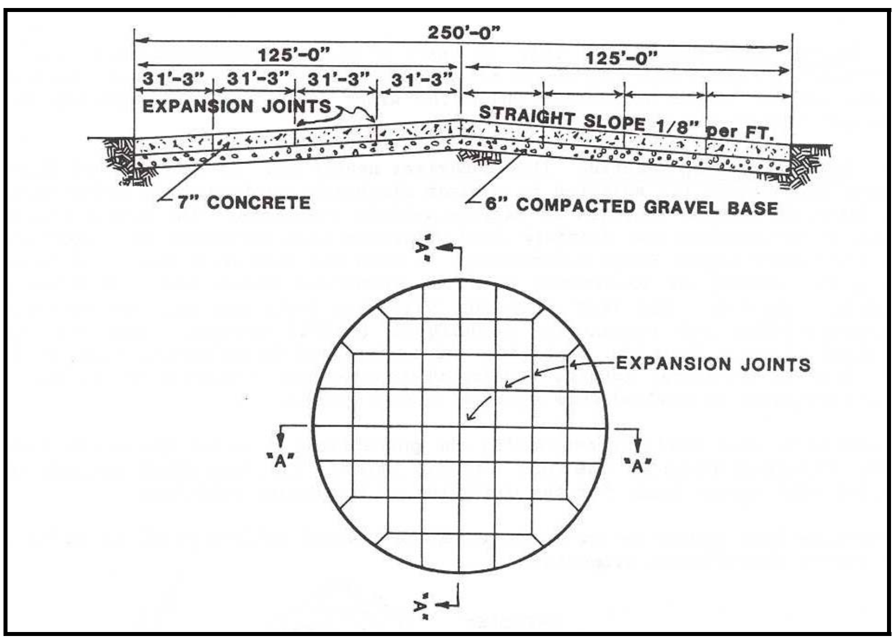

Figure 63. Section and plan view of Turning Circle.

2.6.26 Profile IV Course.

The Profile IV Course consists of a series of eleven different types of bumps (some of which are repeated) distributed over a 142 m (465 ft) long concrete course. The height (displacement) of each of the bumps was computed for each inch of longitudinal travel. The course layout is shown in Figure 64. An M1 tank traversing the MTA Profile IV Course is shown in Figure 65.

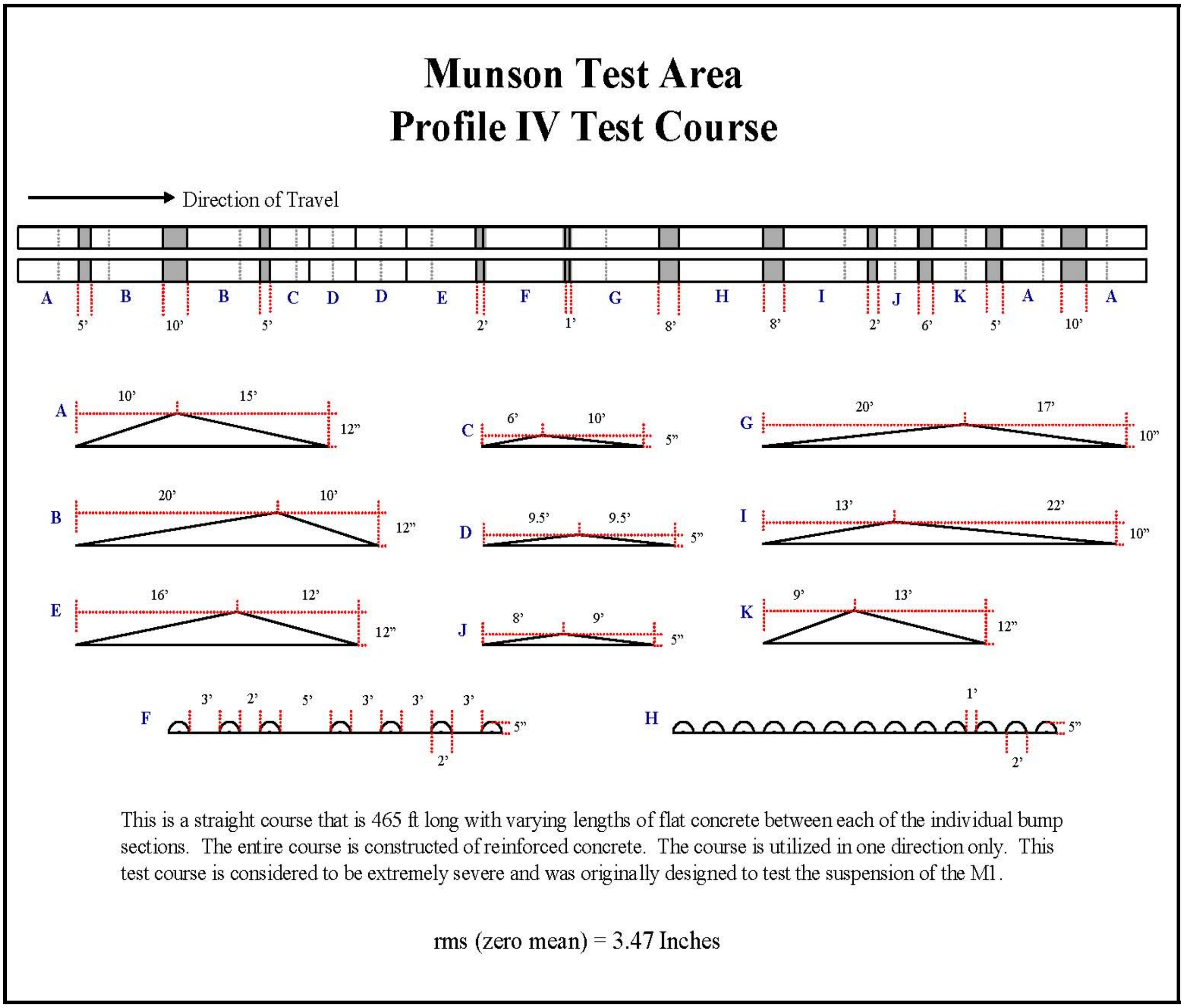

Figure 64. MTA Profile IV Test Course layout.

Figure 65. Abrams tank traversing the MTA Profile IV Test Course.

2.6.27 Marsh.

a. Between the Munson area and Dipple Creek is a marsh with marginal soil strength that represents adverse conditions for mobility testing. The marsh has a heavy growth of vegetation, much of which is periodically flooded by tidal action. The area is ideally suited for single pass vehicle cone index tests and is a significant mobility challenge for conventional and marginal terrain vehicles. The soil type is classified as conforming to the Unified Soil Classification System (USCS) soil type CH.

b. Around the edge of the marsh, a water filled simulated jungle trail has been cut in a woody area by vehicular traffic. It passes through heavy vegetation consisting of vines, swamp grass, and matted roots.

2.6.28 Load Vibration Course.

a. This comprises nearly 2.9 km (1.8 mi) of MTA courses (Figure 17) selected to subject electronic equipment and other sensitive loads in wheeled vehicles to various vehicle reactions. The course is arranged to accommodate the standard load vibration test developed in cooperation with the former Signal Corps Laboratories at Fort Monmouth, New Jersey as a means for determining the ability of electronic units to withstand shock and vibration in specified vehicles. The course layout of the Standard Load Vibration test is outlined in Figure 66.

b. The course is also used for evaluating the portability of other special military loads, including those of the Navy and Air Force.

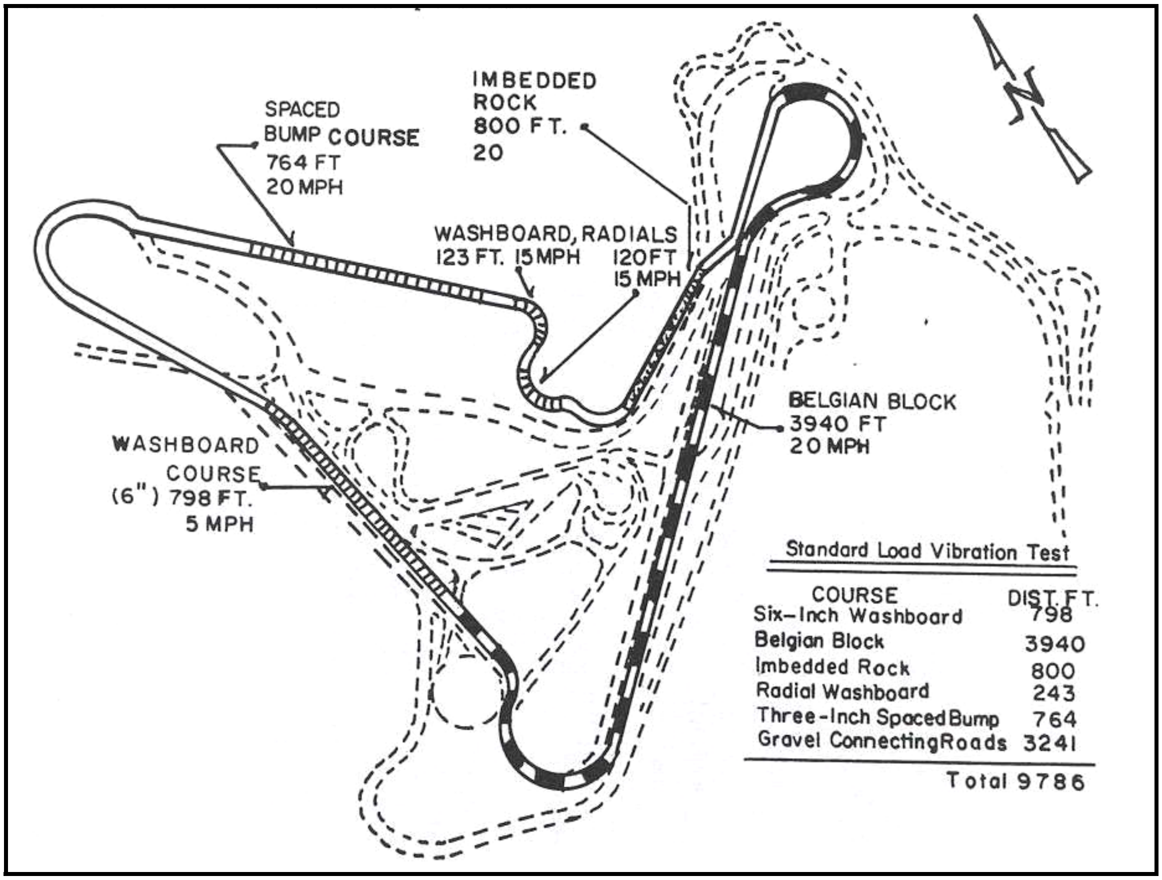

Figure 66. Load Vibration Course.

2.6.29 Fuel Consumption Course.

This course is a loop of gravel and paved road surfaces with longitudinal grades totaling 2.4 km (1.5 mi). The course is used for a specific standard test (TOP 02-2-603[8]), in which the vehicle is operated around the loop a specific number of times in both clockwise and counterclockwise directions (Figure 67). Fuel consumption data are recorded and used for evaluating vehicle design, vehicle comparison, and determining the fuel consumption rate that might be expected under field conditions. The course layout of the Fuel Consumption Course is described in Table 3.

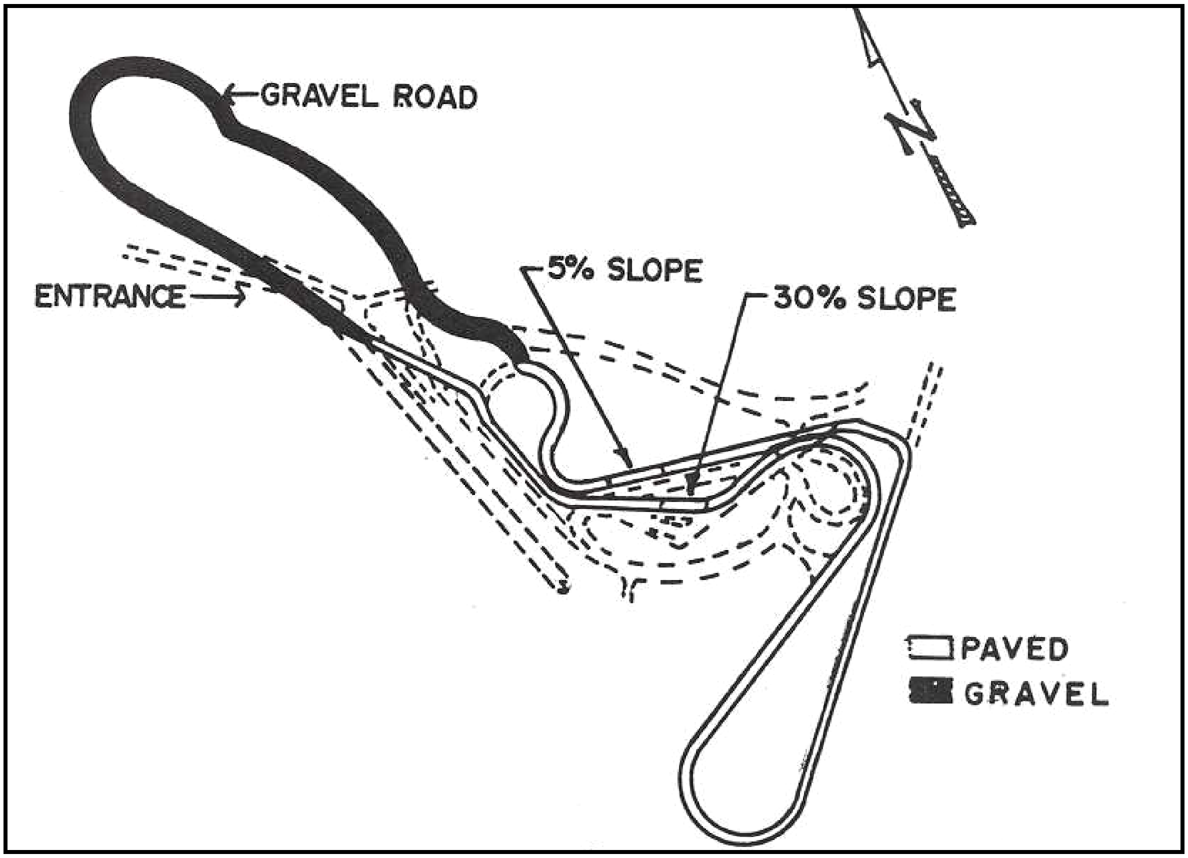

Figure 67. Fuel Consumption Course.

TABLE 3. FUEL CONSUMPTION COURSE

SURFACE	GRADE, %	OPERATING DISTANCE[a]			
		CLOCKWISE		COUNTERCLOCKWISE	
		meter	feet	meter	feet
Gravel	Less than 1	828	2718	828	2718
Bituminous concrete	Less than 1	1198	3930	1198	3930
	1 to 5	142 up	467 up	142 down	467 down
	5	147 down	483 down	147 up	483 up
	15	78 down	256 down	78 up	256 up
Concrete	30	45 up	149 up	45 down	149 down
Total		2439	8003	2439	8003

Note a: Included are short lengths of approach roads in addition to the centerline dimensions of individual test course.

2.6.30 Urban Terrain Course.

This course is a loop of graded gravel- and concrete-paved roads totaling 5.6 km (3.5 mi) (Figure 68). The concrete-paved road is 3.6 km (2.2 mi) or 65 percent of the total profile. The test vehicle is operated in clockwise and counterclockwise directions, with stop and go, maneuverability, and obstacle negotiation challenges. The layout of the Urban Terrain Course is described in Table 4.

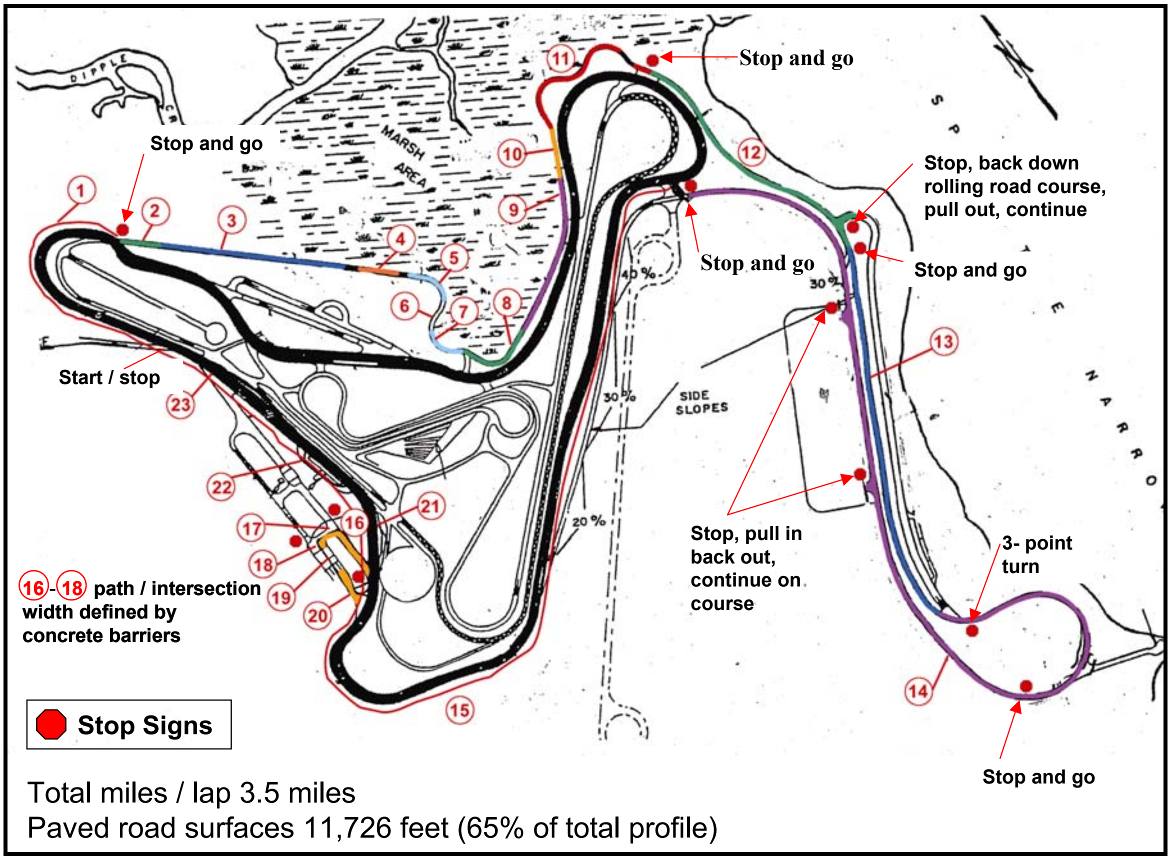

Figure 68. Urban Terrain Course

TABLE 4. URBAN TERRAIN COURSE

COURSE SEGMENT	CONSTRUCTION	ATTRIBUTE/VEHICLE CHALLENGE	LENGTH, feet[a]	CUMULATIVE TOTAL, feet
1	Compacted gravel	Acceleration, steering, braking	1056	1056
2	Bituminous concrete	Corduroy road surface (approach to spaced bumps)	***360***	1416
3	Concrete 3-inch spaced bump	Vibration, suspension exercise	***750***	2166

TABLE 4. CONT'D

COURSE SEGMENT	CONSTRUCTION	ATTRIBUTE/VEHICLE CHALLENGE	LENGTH, feet[a]	CUMULATIVE TOTAL, feet
4	Rough concrete	Mild vibration	***240***	2406
5	Concrete radial washboard	Vibration, steering and suspension exercise	***120***	2526
6	Smooth concrete	Allows suspension to settle	***115***	2641
7	Concrete radial washboard	Vibration, steering and suspension exercise	***120***	2761
8	Concrete serpentine path	Steering	***485***	3246
9	Imbedded rock	Tire performance, steering, vibration	***800***	4046
10	Brushed smooth concrete	Allows suspension to settle	***100***	4146
11	Concrete 2-inch washboard	Suspension, steering, vibration	***822***	4968
12	Bituminous concrete	Moderate speed, sweeping turns, slight grade	***1320***	6288
13	Rough concrete sideslope 30%	Stability, steering performance, lateral loading of suspension, tires, etc	***1690***	7978
14	Bituminous concrete loop (poorly maintained primary road)	Moderate speed, steering, acceleration, braking	***4594***	12,572
15	Compacted gravel	Moderate speed, steering, acceleration, braking	3325	15,897
16	Loose gravel	Maneuverability (low speed w/90^o steer required)	260	16,157
17	Deteriorated concrete/gravel	Maneuverability (low speed w/90^o steer required)	***80***	16,237
18	Rough concrete	Maneuverability (low speed w/90^o steer required)	***130***	16,367
19	18-inch vertical step	Obstacle negotiation/maneuverability, tire performance		
20	Loose gravel (return to Munson gravel)	Hard steer (>135^o) to return to Munson gravel	335	16,702
21	Compacted gravel	Acceleration, steering	355	17,057
22	Gravel and concrete (V-ditch)	Obstacle negotiation/maneuverability, tire performance, power	270	17,327
23	Compacted gravel to starting point	Acceleration, braking	650	17,977

Note a: Bold italic font denotes concrete road surfaces totaling 11,726 ft (65% of total profile).

2.6.31 Land Vehicle Maintenance Facility (B338).

a. This facility (Figure 69) is comprised of 4,180 square meters (45,000 square feet) of interior bay space that includes 13 maintenance bays, an electric/battery shop, an engine test cell, and a closed-loop steam cleaning facility.

b. The shop facility provides maintenance/diagnostic analysis to direct support/general support level for prototype, standard/production, and foreign systems and rebuild capability for electrical components/systems, hull/chassis assemblies, and power train components.

Figure 69. Land Vehicle Maintenance Facility.

2.6.32 Half Rounds (MTA).

These obstacles are reinforced steel pipes of 10, 15, 20, 25, and 30 cm (4, 6, 8, 10, and 12 in.) radii) affixed to a level, gravel course. They are used to address the shock portion of ride quality testing.

2.7 Automotive Technology Evaluation Facility (ATEF).

The ATEF (Figure 70) is a phased project, specifically engineered as a concentric multi-surface, paved and gravel high-speed test track. The flat, 7.2 km (4.5 miles) long and 61 m wide (200 ft) wide tri-oval includes generous safety run-off areas and wireless monitoring of every test vehicle for real-time data capture. The military specific road bed will support vehicle weights in excess of 109 tons metric (120 tons). ATEF enables the Department of Defense (DoD) to effectively, efficiently, and safely conduct high-performance, endurance, and reliability testing on all wheeled and tracked vehicles, of both manned and un-manned ground platforms. By inherent design, this track doubles the amount of possible test miles without increasing required test time.

Figure 70. Automotive Technology Evaluation Facility.

2.8 Perryman Test Area (PTA).

a. The PTA adjoins the northwestern boundary of APG, and includes about 800 hectares (2000 acres) approximately 8 km (5 mi) from post headquarters (Figure 71). Originally devoted to farming, the area is now used mainly for cross-country testing of vehicles for durability and reliability. Facilities for other tests are also in the area. A detailed mapping of the various courses located at the PTA is shown in Figure 72.

Figure 71. Aerial view of Perryman Test Area.

Figure 72. Detailed map of test courses located at PTA.

b. Although surface variations due to weather are a desirable feature of most PTA courses, course geometry is assessed periodically by a test course profilometer that provides appropriate data to maintain the courses to the same severity. Details of the procedure are provided in TOP 01-1-010. Test course area supervisors also make daily inspections and maintain an on-site log of climatic and course conditions.

2.8.1 Perryman Off-Road Courses.

Five off-road loop courses graduated in severity are within the PTA.

a. Perryman No. 1 is moderate with a substantial roadbed composed primarily of quarry spall and bank gravel (Figure 73). The loop includes sharp and sweeping curves, and the surface ranges from smooth to rough (roughness being due to potholes, washboard, and rutting). Potholes and other sharp depressions are usually limited to a depth of 15 cm (6 in.) by filling with crushed stone. During wet weather, the whole course is characterized by light mud which affects wheeled vehicles mainly by splash. The course is 8.4 km (5.2 mi) long. The average root mean square (rms) roughness is 0.89 cm (0.35 in.).

Figure 73. Perryman No. 1 roadbed characteristics.

b. Perryman No. 2 is laid out in a loop of moderately irregular terrain. The native soil includes Sassafras loam, a silty loam with 17.3-percent clay content, and Sassafras silt loam, a silty loam with less than 15-percent clay. Surfaces range from smooth to rough, and there are sweeping turns. Under wet conditions, the course is extremely muddy (Figure 74); when dry, it is extremely dusty (Figure 75). One area of the course used for testing earthmoving equipment includes earthen side slopes, a cut-and-fill area, and a figure-8 course. The course is 2.9 km (1.8 mi) long. The average rms roughness is 2.3 cm (0.9 in.).

Figure 74. Perryman No. 2 under muddy conditions.

Figure 75. Perryman No. 2 under dusty conditions.

c. Perryman No. 3 is rougher still, and is composed of native soil similar to that of Perryman No. 2. Mud ranges from light (with free water) to cohesive. Although dust is severe when the course is dry, there is always mud in some areas (Figure 76). Much of the course is rough due to many years of testing tank-type vehicles. The course is 5.3 km (3.3 mi) long. The average rms roughness is 7.3 cm (2.9 in.).

Figure 76. Vehicle negotiating Perryman No. 3.

d. Perryman No. 4 is a tract of extremely rough terrain including marshy areas with swamp-type vegetation (Figure 77). The drier areas are characterized by a succession of depressions that develop after intensive operation of heavy tracked vehicles. The difference in the slopes is attributed to the fact that vehicles have generally been run in one direction. The soil of the course is native soil as described under Perryman No. 2. The course is 4 km (2.5 mi) long.

Figure 77. Vehicle negotiating Perryman No. 4.

e. Perryman No. 5 is constructed of Gabion (No. 6 stone) and is approximately 152 m (500 ft) long (Figure 78). This course is designed to be extremely severe; the average rms roughness is 9.7 cm (3.8 in.).

Figure 78. View of Perryman No. 5 Course.

2.8.2 3-Mile Straight-away.

This is a 6.1-km (3.8-mi) level straight-away with banked turnaround loops at each end for tests requiring uninterrupted operation such as cooling tests. This course is made of bituminous concrete (including turnarounds). A 305 m long by 15 m wide (1000 ft x 50 ft) section of bituminous concrete is located midway between the turnarounds and is suited for conducting brake testing, and evasive handling maneuvers. A portion of the travel lane is treated with a sealer that when wetted down provides a low coefficient of friction road surface used for testing traction control and anti-lock brake features.

2.8.3 Mud Bypass Course.

This is a 213-m (700-ft) bypass off of Perryman No. 1. It is most useful in periods of dry weather for exposing vehicles to muddy conditions to evaluate seals, brakes, or other mud-sensitive components during endurance operations. The course is prepared by tilling and pumping water onto it from a local dedicated well (Figure 79).

Figure 79. Mud Bypass Course with sprinklers operating.

2.8.4 Secondary Road A.

Secondary Road A is a closed loop course 3.9 km (2.4 mi) in length with long, sharp, sweeping turns typical of unimproved country roads. The course surface is about 10.7 m (35 ft) wide, maintained by grading and filling with native soil. The average rms roughness is 0.84 cm (0.33 in.).

2.8.5 Secondary Road B.

Secondary Road B is a 5.1 km (3.2 mi) long, level straight course composed of native soil. The average rms roughness is 0.66 cm (0.26 in.).

2.9 Phillips Army Airfield (PAAF).

a. The airfield (Figure 80) utilizes a hard surface runway that measures 2,438 by 61 m (8,000 by 200 ft). Automotive testing accomplished on this runway includes: steering and handling tests such as lane changes and J turns, brake testing in all weight classes and at high speeds, and mobile field dynamometer testing.

Figure 80. Phillips Army Airfield.

b. The 122 by 244 m (400 x 800 ft) bomb ramp is used to execute skid pad (circular steer) and some lower speed step steer maneuvers. Virtually every wheeled vehicle platform requires some sort of handling and braking test using these facilities. Figure 81 shows a circular steering test being executed using the bomb ramp facility.

Figure 81. Handling test on the bomb ramp of PAAF.

2.10 Lift and Tie-Down Facility.

This facility is used to test the lifting and tie-down capability of military vehicles in accordance with MIL-STD-913A[9] and MIL-STD-209K[10]. The facility has a 50-ton metric (55-ton) overhead chain hoist with a remotely controlled 54-ton metric (60-ton) hydraulic load application system (Figure 82). In addition, it has two hydraulically operated bridge cranes of 45- and 136-ton metric (50- and 150-ton) capacities.

Figure 82. Lift and Tie-Down Facility.

2.11 Automotive Laboratory Facilities.

2.11.1 Automotive Engineering Test Facility (B436).

a. This facility (Figure 83) supports engineering tests addressing performance and reliability, availability and maintainability (RAM) evaluations for the areas of Automotive, Fire Control and Live-Fire/Vulnerability, Road Shock and Vibration, Transportability, and Environmental Conditions.

b. Provided are the resources to design, plan, and conduct testing that include nearly $50 million of state-of-the-art instrumentation, over 2,800 square meters (30,000 square feet) of laboratory and shop space, on-site instrumentation and hardware fabrication facilities, and the acquisition, processing, analysis and reporting of test data.

Figure 83. Automotive Engineering Test Facility

c. Also provided are specialized off-site data transfer capabilities that include fiber optic and bi-directional microwave telemetry links that provide high speed data transfer and real-time test control, and secure, single source data access from any location in the world via the internet.

2.11.2 Tilt Table Facility.

The tilt table facility is located adjacent to the Automotive Instrumentation Facility, Building 436. This steel table is used to determine the propensity of a test vehicle to roll over when operating on a side slope or during steady-state cornering. Six hydraulic cylinders are employed to raise and lower the table. The table platform is accessible from each end and at its center (Figure 84). The tilt table is 4.3 m (14 ft) wide at each end with a center width area of 7.6 m (25 ft) for additional maneuverability for rough terrain forklift testing. The overall table length is 30.5 m (100 ft), with a lift capacity of 127 tons metric per 6.1 m (140 tons per 20 ft) of length, for a total theoretical capacity of 635 tons metric (700 tons). The table's maximum tilt angle is 40 degrees (83.9 percent). Tilt table testing is performed in accordance with SAE J2180[11]. The test vehicle is typically tilted about its roll axis until the uphill tires lift off the platform, at which point safety cables restrain the vehicle from an actual rollover (Figure 85).

Figure 84. Tilt Table Facility.

Figure 85. Tilt table testing to determine roll over threshold.

2.11.3 Roadway Simulator.

This facility provides a dynamic hardware-in-the-loop simulation for conducting engineering level automotive performance tests under strictly defined and controlled conditions. It supports vehicles ranging from 2,270-kg (5,000-lb) 2-axle light trucks to 36,300-kg (80,000-lb) tractor trailers (Figure 86). It was designed to perform vehicle dynamics, power train performance, and shock and vibration testing in a laboratory environment. The test vehicle is adaptively constrained in the longitudinal, lateral, and yaw directions through its center of gravity, and is free to move in the vertical, roll and pitch directions. A robotic autopilot drives the truck on a series of treadmills, while vehicle body forces are measured in the constrained degrees of freedom. The motion of the treadmills is coordinated to provide a coherent roadway over various terrain profiles.

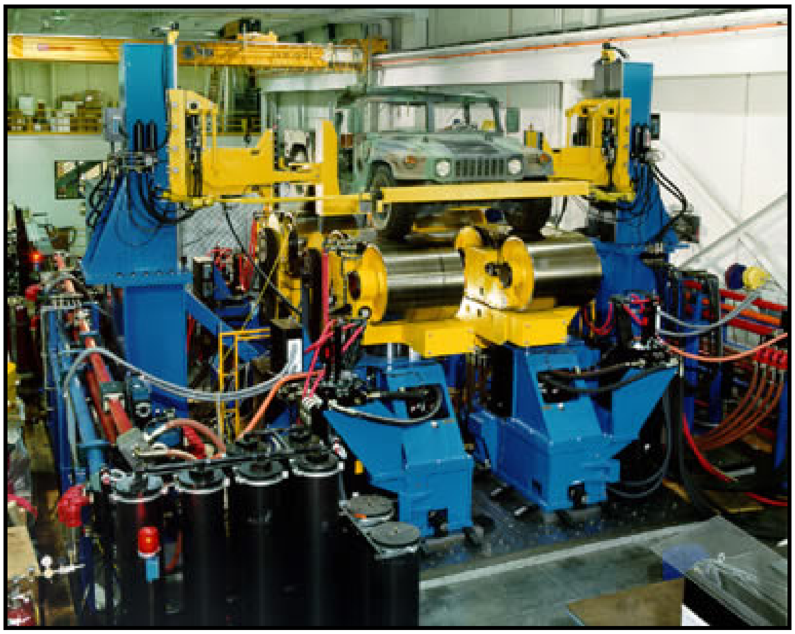

Figure 86. Roadway Simulator.

2.11.4 Vehicle Durability Simulator (VDS).

a. The VDS consists of a 6-degrees-of-freedom spindle-coupled MTS 329LT test rig*** (Figure 87). The facility provides laboratory-based simulation of off- and on-road shock and vibration testing. Structural components and subsystems on 2-axle trucks up to 11,800 kg (26,000 lbs) can be tested 24-hours per day with precise control of the test scenario. Drive files are produced using the remote parameter control (RPC) process, using force and/or acceleration feedback. The simulator can also be used as a kinematics and compliance measurement system to support vehicle modeling initiatives.

***The use of brand names does not constitute endorsement by the Army or any other agency of the Federal Government, nor does it imply that it is best suited for its intended application.

Figure 87. Vehicle Durability Simulator.

b. The strengths of the VDS are:

(1) Accelerated durability testing of automotive systems, subsystems, and components (suspensions, computers, wiring, plumbing, and chassis).

(2) Troubleshooting and diagnosing component fatigue failures.

(3) Vehicle model development.

2.11.5 Tire Test Rig.

This facility (Figure 88) is used for measuring tire performance parameters at various axle loads, slip conditions, tire pressures, and speeds. The rig consists of a MTS Systems Flat-Trac© rolling ground plane positioned beneath a structural beam and spindle. The tire is mounted to the spindle with an MTS Systems SWIFT wheel force transducer that measures the three forces and three moments applied to the tire. The tire can be cambered up to 8 degrees, and vertical loads can exceed 6,800 kg (15,000 lbs), depending on the camber condition. Ground speeds can reach 260 km/hr (160 mph), and slip angle can exceed 15 degrees. Typical tests include lateral force measurement (versus vertical load and slip), vertical stiffness (static and dynamic), and tire durability assessments. Advantages of the ATC tire test rig include the ability to test at high axle weights and large tire diameters frequently encountered with military vehicles. High slip rates are also achievable.

Figure 88. Tire Test Rig.

2.11.6 Shock Absorber Dynamometer.

The Shock Absorber Dynamometer (Figure 89) is used to characterize damper and spring performance that simulates off-road conditions of performance and durability testing at loads up to 890 kN (200,000 lb) and rates up to 3.8 m/s (150 inch/second). The shocks are driven using a hydraulic actuator, with a bell crank for speeds exceeding 2.0 m/s (80 inch/second). Drive cycles can be simulated for durability and cooling tests, within a 50-Hz frequency range.

Figure 89. Shock Absorber Dynamometer.

2.11.7 Moment of Inertia (MOI) Test Facility.

The Moment of Inertia Facility provides the means to measure inertia tensor and center of mass properties on the full spectrum of tactical and combat vehicles and vehicle components, up to 70+ ton vehicles (Figure 90). The facility uses modular platforms appropriately sized for different classes of vehicles. The MOI fixtures measure the inertia and mass properties by swinging the vehicle in the yaw, roll, and pitch directions and recording the period of oscillation of the pendulum. The fixtures are located indoors to eliminate measurement error associated with the presence of wind. The facility is adjacent to the Roadway Simulator (RWS) and

Vehicle Durability Simulator (VDS) Facilities, providing continuity with the modeling and simulation resources at those facilities.

Figure 90. Vehicles subjected to inertia tensor and center of mass testing.

2.11.8 Powertrain Dynamometer Facility.

The Powertrain Dynamometer Facility provides flexible dynamometer style suites that enable full or partial drivelines to be tuned, optimized, characterized and tested. The site consists of two engine dynamometers and a separate test cell with electrical power processing capability. The engine dynamometers, rated at 350 Hp and 600 Hp, have the capability to absorb and/or deliver power making them invaluable for drive cycle development and for prove-out of driveline concepts. The power processing components are computer controlled bi-directional alternating current and direct current load banks. These units are transformer coupled to the utility grid and are able to supply power to electric drive components as well as absorb power to allow testing of hybrid drivelines or components of hybrid drivelines. The test cells have upgraded fire suppression systems, overhead cranes and bed plates.

2.11.9 Wheeled Vehicle Roller Brake Dynamometer.

The roller brake dynamometer is capable of dynamically testing brakes and anti-lock brake systems (ABS). It can also test automatic traction control and electronic stability control (ESC) components and functions that are controlled by the ABS electronic control unit (ECU). Testing of the brakes, ABS, automatic traction control, and ESC are performed in an automated, closed loop manner. The ABS test checks the function of individual wheel speed sensors, ABS valves, automatic traction control valves, ABS and automatic traction control warning lights and wiring harnesses. Tests also confirm proper communication between the ABS ECU and the engine ECU. The brake dynamometer is capable of measuring and recording brake forces of up to 45 kN (10,000 lbs.) per wheel and weights at each axle of up to 2,000 kg (44,000 lbs.) with an accuracy of within 2.5 % on both measurements.

2.11.10 Platform Scale.

The 90,700 kg (200,000 lb.) capacity platform scale measures 9.1 m in length and 4.6 m wide (30 x 15 ft). There are 30.4-m (100-ft) level concrete approach and departure lanes provided so that accurate weight distributions can be conducted. Figure 91 shows vehicles undergoing weight measurements on the platform scale.


Figure 91. Vehicles on platform scales.

2.11.11 Wheel Scales.

Wheel scales with a capacity of 9070 kg (20,000 lb.) and a resolution of 1 kg (2 lb.) are located at the same site as the platform scale.

2.12 Fire Control Test Facilities.

The testing and evaluation of tank armament is conducted on unique firing ranges at the Gunpowder Neck (Figure 92) and Trench Warfare (TW) areas. Tracking data are generated by two gated TV systems with input from a video camera boresighted with the tank gun (to collect lead angle and tracking data), and another video camera in the sight (to collect gunner tracking data). These systems are video digitizers that output constantly updated error signals equal to the target's azimuth and elevation deflections in the field-of-view of the video cameras. The error signal output may be merged with other parametric data recorded directly to computer memory. Video recorders provide video documentation of the gate TV tracking data and monitors allow the test director real time monitoring of the video data.

Figure 92. Aerial view of Henry Field at Gunpowder Neck.

2.12.1 Tank Armament Test Range (Henry Field).

a. This is a direct fire; multi-range test area used for evaluating tank armament systems under moving and stationary tank and target scenarios and is located at the Henry Field area of Gunpowder Neck (Figure 93). The direct-fire ranges are arranged with width-angle safety fans with line-of-sight targets as far away as 3 km (1.9 mi). For specialized long-range firing, a range of 5 km (3.1 mi) (partly over water) is available. Special firing slopes (15-percent up, 30-percent down, and various combination slopes up to 20 percent) permit firing at maximum gun elevation and depression, as well as over a variety of vehicle attitudes. Supporting facilities include a four-bay maintenance shop with adjoining offices and briefing room, range control/instrumentation shelters, ammunition magazines, meteorological instrumentation, and communications and other equipment.

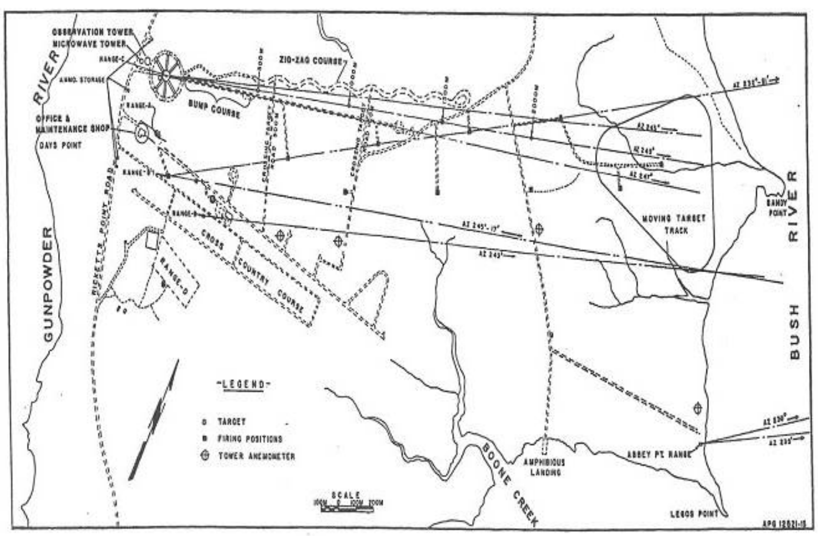

Figure 93. Henry Field, Gunpowder Neck.

b. Various terrain courses that include gravel, bump, zig-zag, and natural earth are available for comparative performance testing of tank turret-stabilized fire control systems. A cross-country course of about 1.6 km (1.0 mi) long is in the area for determining durability characteristics of gunnery systems during vehicle operation. Two standardized configurations of the Bump Course are: (1) Elevation Stabilization Bump Course (Figure 94), and (2) RRC-9 Bump Course (Figure 95). These courses use two types of bumps: (1) Type A Bump (Figure 96), and (2) Type B Bump (Figure 97).

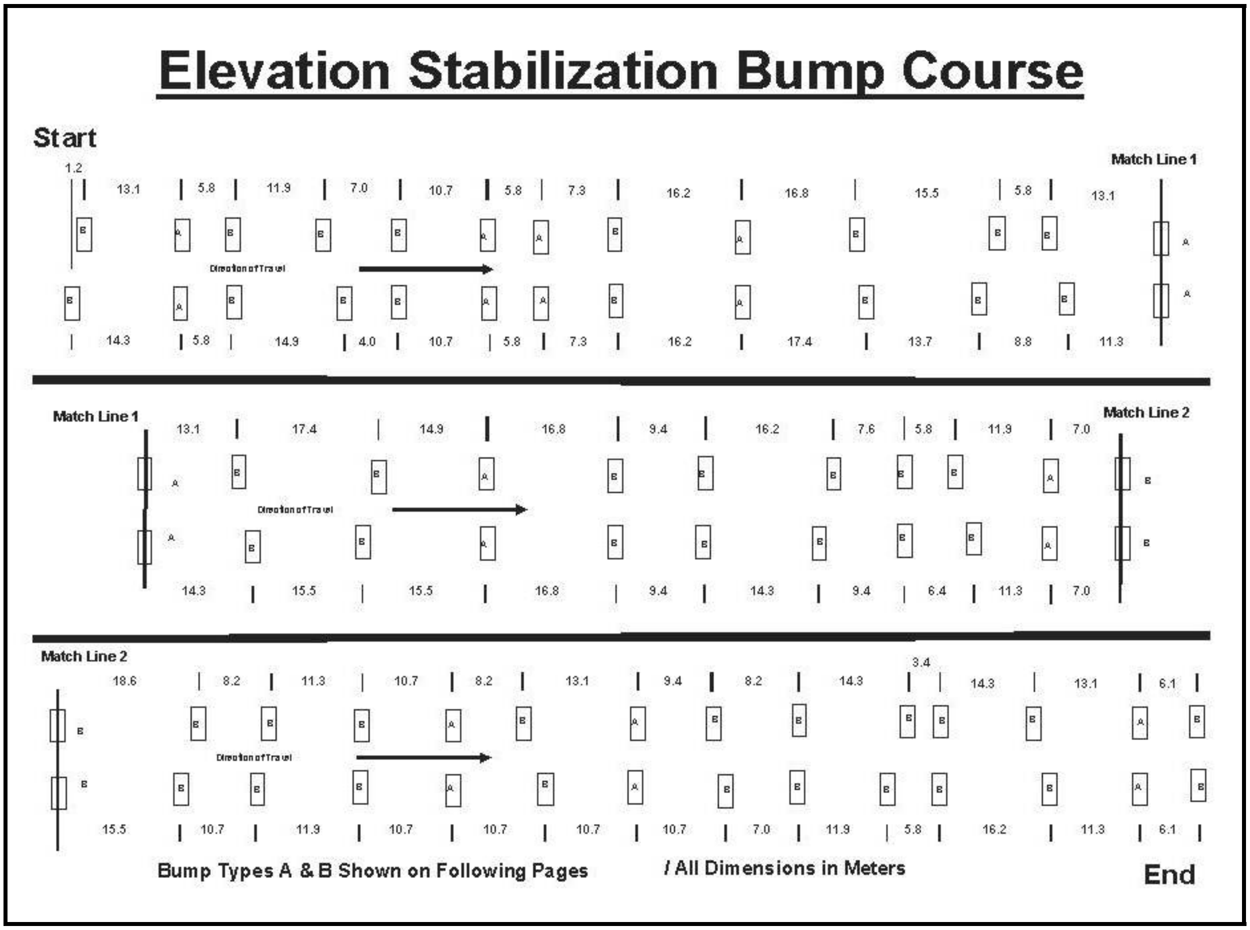

Figure 94. Elevation Stabilization Bump Course.

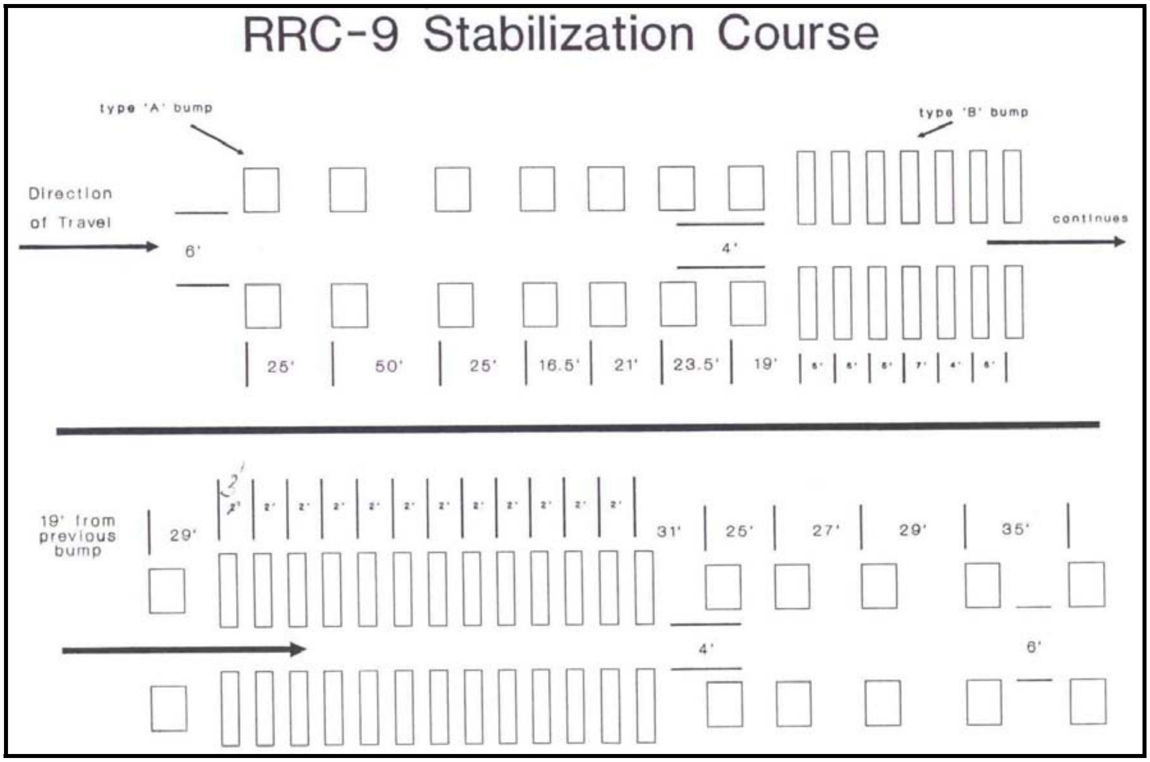

Figure 95. RRC-9 Stabilization Course.

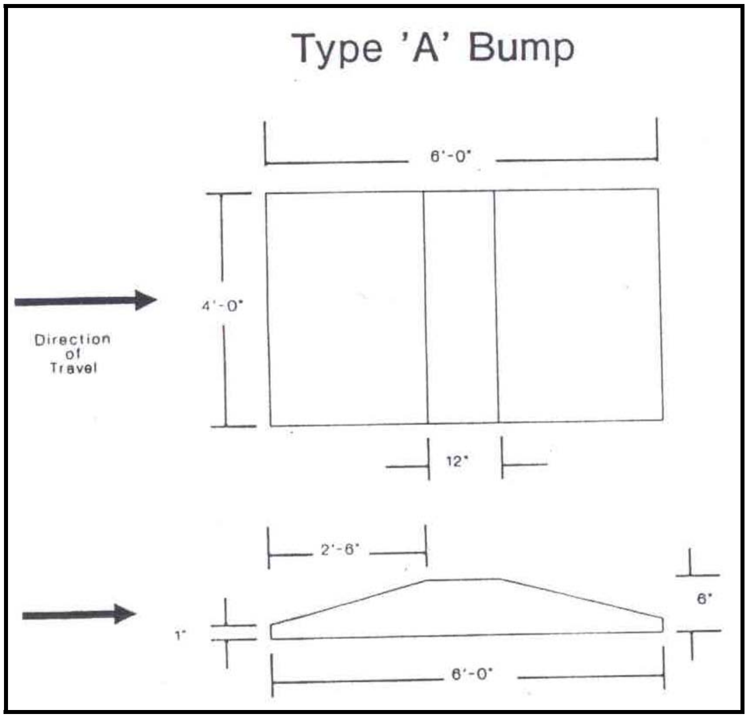

Figure 96. Type A Bump.

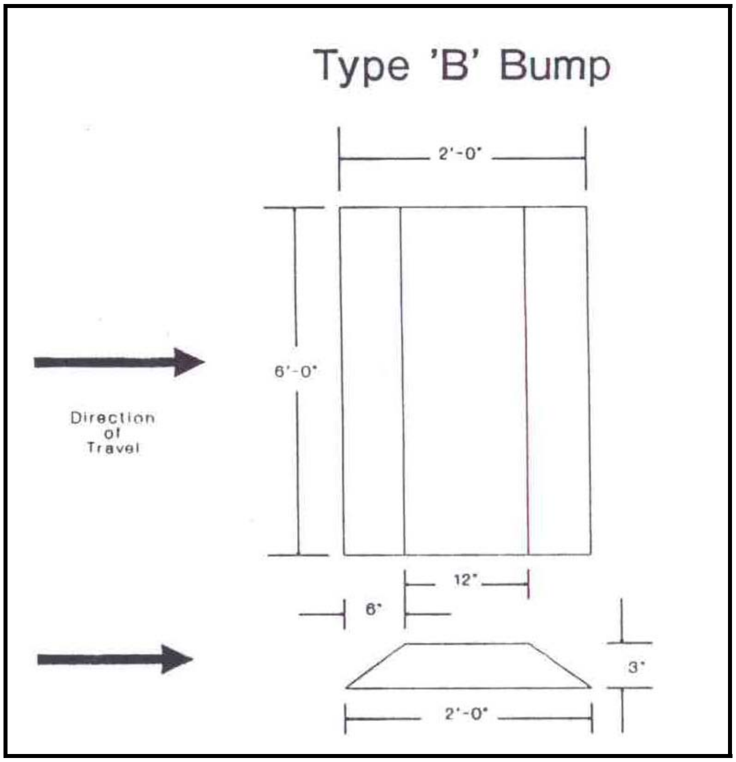

Figure 97. Type B Bump.

c. A 6- by 6-meter (20- by 20-ft) moving target facility has speeds as great as 56 km/hr (35 mph). With a vehicle at stationary position, traversing the gravel bump or the zig-zag course, remote controls and a 2-km (1.25-mi) triangular railroad layout are used to alter the speed and orientation of the moving target to the line of fire. The moving target is used to measure accuracy of fire for tank turrets, including those equipped with hyper-velocity guns or guided missiles.

d. There are four ride quality courses located within the Henry-Field Area. These straight courses are composed of gravel, and range in length from 100 to 160 m (330 to 530 ft). The US Army Waterways Experiment Station (WES) developed these courses solely for the purpose of ride quality testing. The surface roughness for each course varies from approximately 3.0 to 7.6 cm rms (1.2 to 3 inches rms), depending on the test course.

e. In addition, the Henry Field ranges are equipped with video scoring instrumentation to remotely record target impacts. Down-range wind speed and direction, as well as other meteorological data, are obtained by means of a fully automated meteorological station. Other telemetry and data-processing instrumentation are available to record and reduce data obtained from monitoring on-board vehicular equipment such as gun sight optics, ballistics computer output, rangefinder readings, and main gun aimpoint.

f. Testing capabilities at the principal ranges of Henry Field are summarized in Table 5.

TABLE 5. HENRY FIELD TANK GUNNERY RANGE TEST CAPABILITY

MAXIMUM DISTANCE FOR DIRECT FIRE (METERS 0 TO)	FACILITIES	TYPE OF TEST
3000	Targets and bombproofs; slopes for firing in 15% reverse, 30% forward position, or other vehicle attitudes to 20%.	Miscellaneous.
2000	Moving (vehicle-mounted) target area.	Tracking of vehicle mounted targets.
5000	Targets partly across water.	High velocity, long range.
3000	Remotely controlled moving target 0 to 56 km/hr (0 to 35 mph) controllable to ±3.2 km/hr (±2 mph).	Accuracy firing on moving targets, including light armor plate structures.
3000	Stabilizer course (zig-zag, gravel, straight, black-top, chronograph, jump targets, cant slopes, bump; automated meteorological station including down-range wind profile).	Effectiveness of stabilizers, functioning of traversing mechanisms.
500 and 1100	Crossing target roads.	Tracking and laying tests.
3000	Targets and bombproofs.	Width-angle accuracy firing.
457	Sand butts.	Machinegun and mine tests, vulnerability of vehicles.

2.12.2 Evasive Target Firing Range (TW I).

a. The Trench Warfare I (TW I) range (Figure 98) is a direct fire range for assessing tank fire control systems under stationary and moving test item/target scenarios. Maximum distance for stationary targets is 3 km (1.9 mi). A laser beam-simulated moving target is located at 2.4 km (1.5 mi) range. This computer-controlled evasive laser beam target is projected on a replaceable, reflective surface. Gravel, bump, zig-zag, and natural earth courses are available for fire-on-the-move exercises. A thermal target capability is also available. Automated data acquisition capabilities for target scoring, projectile velocity, meteorological, thru-site and weapon pointing video, data bus activity and system performance are provided. A physical moving target 2400m from the firing pad is also installed. This rail-mounted target, moving laterally at variable speeds, provides the capability of moving-vehicle, moving-target engagements.

Figure 98. Evasive Target Firing Range (TW I).

b. The TW I range is also used for longer distance non-firing target surveillance and observation exercises to evaluate combat vehicle night sights. Its large open area with undulating terrain can accommodate targets as far as 4000 m from the viewing vehicle.

2.12.3 Moving Target Simulator (MTS).

The Moving Target Simulator (MTS) facility provides a laboratory environment for assessing weapon control systems such as laying, tracking, and fire control system accuracy/performance tests to determine hit probability (Figure 99). It uses a 30.5-m (100-ft) radius air-supported hemisphere. Inside the hemisphere a computer-controlled laser beam generates repeatable stationary vehicle versus moving target test scenarios. The laser projected moving target is projected on the interior of the hemisphere. The computer-generated stationary, moving and evasive ground and aerial targets are produced by the laser beam steering system. Instrumentation acquires data such as video scoring, weapon and thru-sight video, data bus activity, weapon system/component performance and target position.

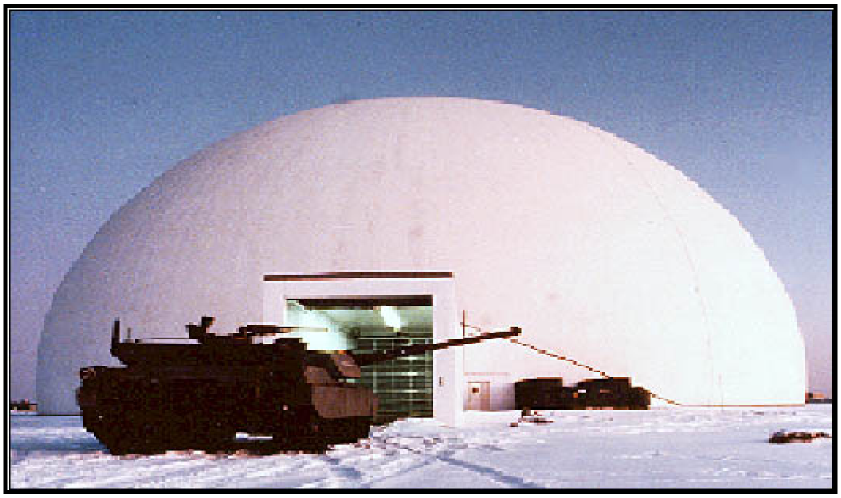

Figure 99. Moving Target Simulator.

2.12.4 Multiple Target Firing Range (TW II).

This highly instrumented, stationary vehicle/stationary target direct-firing range is designed to determine interactions of the fire control system, weapon, ammunition, and weapon mount (Figure 100). Two lines of fire are available to accommodate depleted uranium and live high-explosive projectiles. Multiple targets are available to 4 km (2.5 mi). A continuous velocity profile is provided by Doppler radar. Real-time measurement of jump, projectile miss distance, boresight retention, trajectory mismatch, aim error, weapon system implementation error, and hit probability can be determined. Instrumentation includes weapon and thru-sight video, target scoring, projectile velocity, data bus acquisition, weapon system/component measurements, and meteorological data.

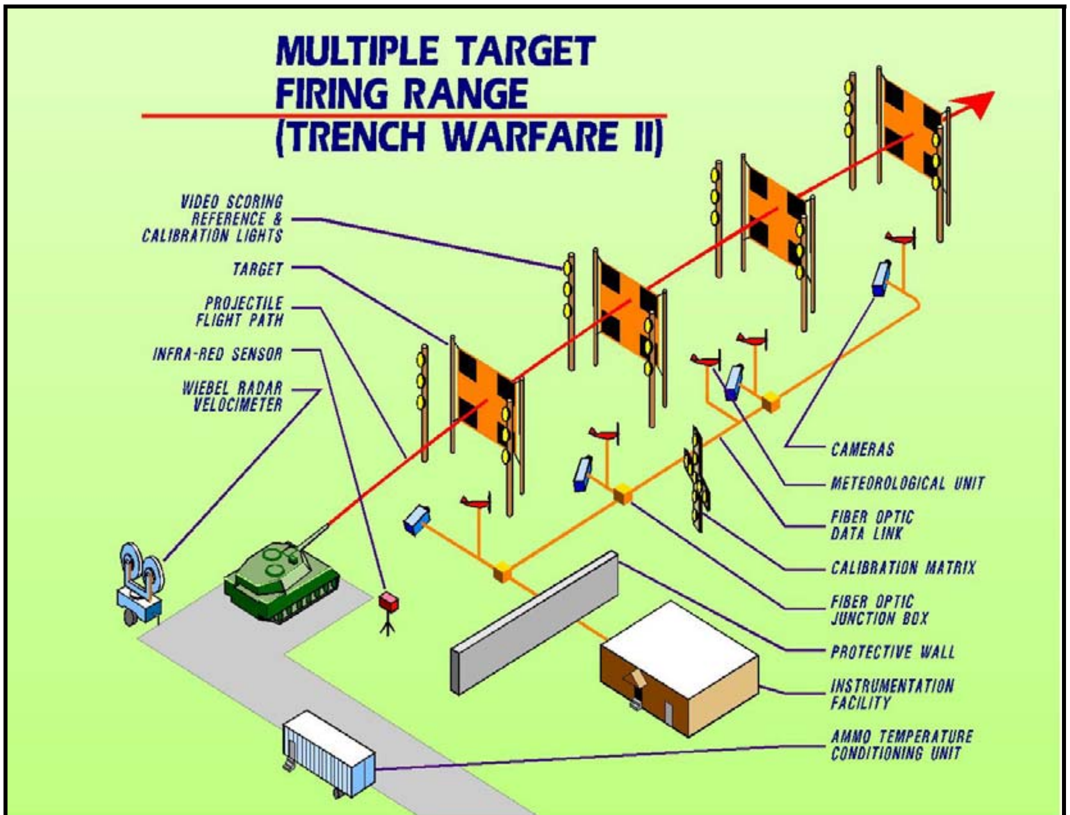

Figure 100. Multiple Target Firing Range (TW II).

2.12.5 Ride Quality Courses No. 1 through 4, Henry Field Area.

These four straight courses are composed of gravel, and range in length from 100 to 160 m (330 to 530 ft). The WES developed these courses solely for the purpose of ride quality testing. The surface roughness varies from approximately 3.0 to 7.6 cm rms (1.2 to 3 in. rms), depending on the test course selected.

2.13 Scalable Net Centric Test Area (SNCTA).

The SNCTA consists of two test courses, the Small Unmanned Ground Vehicle (SUGV) test course and the Large Unmanned Ground Vehicle (LUGV) test course. All elements of the SNCSA are being designed to provide real-world challenges to the sensor and safety systems being engineered into unmanned ground vehicles (UGVs).

2.13.1 Small Unmanned Ground Vehicle (SUGV) Test Course.

The SUGV Test Course has several test stations that allow an operator to evaluate a broad range of vehicle capabilities. A top view sketch of the course is shown in Figure 101a, and photographs of the course are shown in Figure 101b. The test course is nominally 37 m x 67 m (120 ft x 220 ft). Two test loops, each measuring 2 m (5 ft) wide, enclose a 24 m x 46 m (80 ft x 150 ft) open land grass area, which is the location of the course operator. Adjacent to the course is a wooded area marked off to provide a small course used to test vehicle mobility through grass, leaves, and low undergrowth.

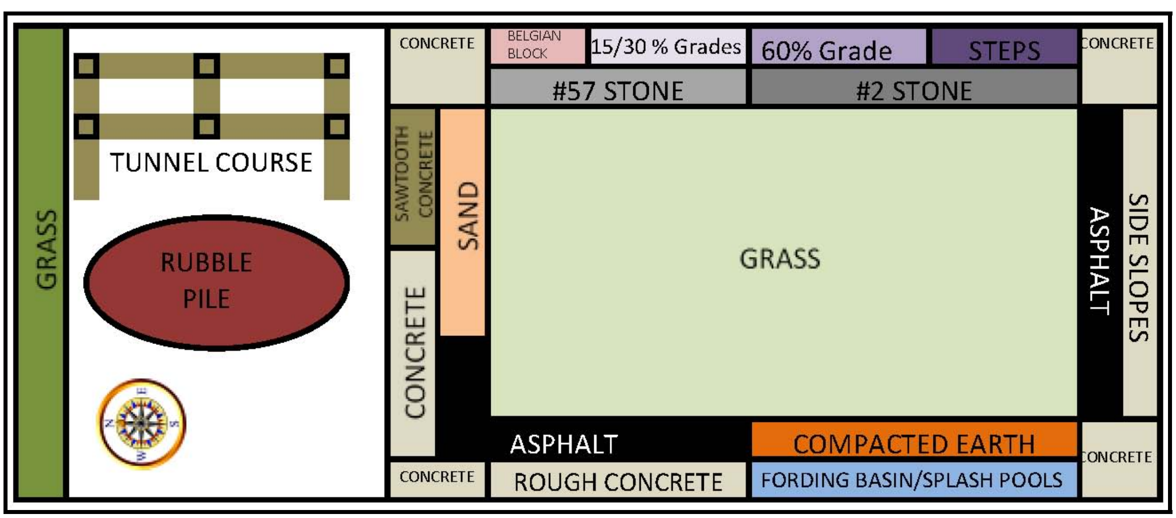

Figure 101a. Plan View of the Interim SUGV Test Course.

Figure 101b. The SUGV Test Course.

2.13.2 Large Unmanned Ground Vehicle (LUGV) Test Course (Proposed).

This course is geared for safety and performance testing of LUGVs up to 9,100 kg (20,000 lbs) gross vehicle weight. The eventual goal is to operate UGVs on standardized automotive test courses in order to adequately evaluate system performance and reliability. However, because this will require the UGVs to operate in the vicinity of manned vehicles and personnel, it's critical that extensive safety and performance testing be conducted prior to these operations. This course will be used to evaluate these safety and performance characteristics; specifically vehicles equipped with autonomous navigation systems. The course will replicate operational conditions that will be encountered by these systems and assess their ability to negotiate obstacles and terrain expected to be encountered during UGV operations.

2.14 Rail Transport Facility.

The facility is designed to ensure compliance of materiel transported by rail with Military Surface Deployment and Distribution Command transportation certification requirements in accordance with MIL-STD-810G. The facility is fully instrumented to record velocity and shock levels, and includes still photography, video, and high-speed video. The site features a covered railcar loading/unloading and tie-down facility with stocked supplies of rigging materials, tools, and wood-working machinery for producing required chocks and cribbage. On-site locomotive and standard railcar equipment is available, and the determination of tunnel clearance of loaded railcars is also available.

3. YUMA TEST CENTER COURSES AND FACILITIES

Figure 102 shows the layout of the over 100 miles of vehicle test courses and test facilities available at YTC, situated within the desert terrain of Southwest Arizona. Although YTC spans over 1,300 square miles, the automotive durability and performance courses and test facilities are situated within close proximity of each other within the southern portion of YTC, which allow for tailoring vehicle tests to any specified mission profile.

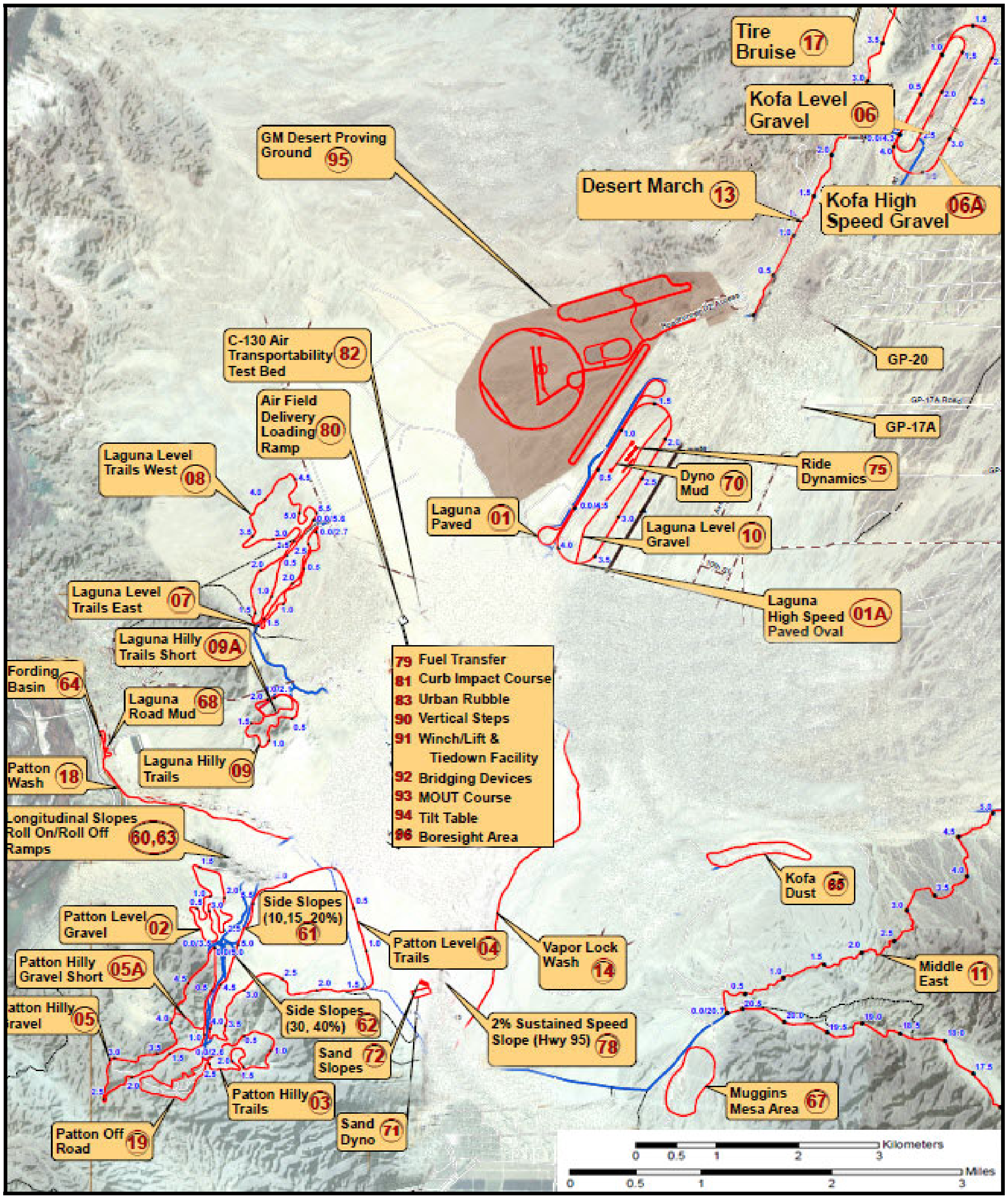

Figure 102. YTC Courses.

3.1 Yuma Test Center Durability Courses.

a. Patton Level Gravel. The Patton Level Gravel Course is a 5.63 km (3.5 mi) secondary course where the terrain is basically Limey Upland, Deep and is composed of the River-bend Family- Carrizo Family Complex which are comprised of extremely gravely-coarse soils. Figure 103 shows the typical terrain of the course and a course map. The course is designed in a loop configuration consisting of short straight sections, and curves of various radii. The course provides an excellent surface for evaluating steering performance, track durability, and vehicle operations at medium speeds. The average rms is 1.09 cm (0.43 in.).

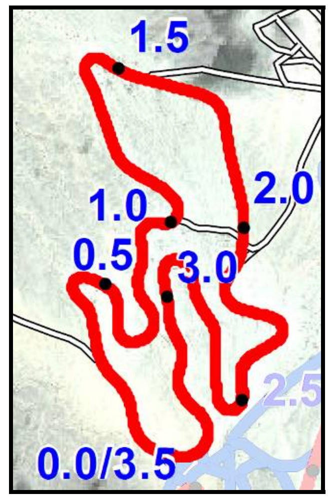

Figure 103. Typical terrain of Patton Level Gravel Course (left) and course map (right).

b. Patton Hilly Trails. Patton Hilly Trails is a 4.2 km (2.6 mi) loop course situated on a Basalt Hill Range site which is located on a series of relic beach terraces. The course begins on the edge of a heavily dissected beach terrace complex and climbs up the side slope of the terrace and then proceeds down the opposite side of the terrace down into the wash bottom. This pattern is repeated numerous times along the 4.2 km (2.6 mi) of the course. Several of the slopes on the course are as steep as 34 percent. The design of the course allows testing the full function of the transmission, braking, steering, suspension, and track systems. The average rms is 5.96 cm (2.35 in.). Figure 104 shows the typical terrain of the course and a course map.

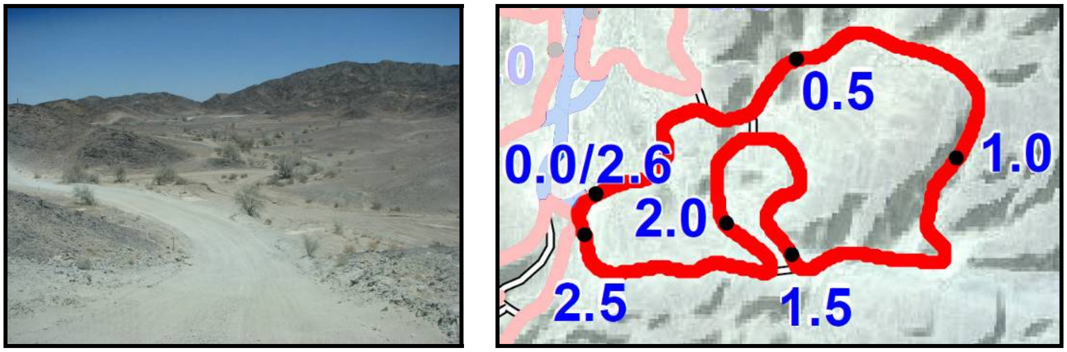

Figure 104. Typical terrain of Patton Hilly Trails Course (left) and course map (right).

c. Patton Level Trails. The Patton Level Trails course is a 10.5 km (6.5 mi) trails course that traverses a wide range of terrain types including alluvial landforms with various dust contents, sand dunes and badlands. Bedrock is not present on this course. The terrain is all low gradients with grades ranging from 0 to 30 percent, but is mostly less than 10 percent. The level sandy terrain is interspersed with many bumps to provide a severe test of vehicle suspensions with moderate loads on the drive train. The sandy to dusty conditions found within the course are typical of cross-country operations on dry soil. Figure 105 shows the typical terrain of the course and a course map. The average rms is 2.92 cm (1.15 in.).

Figure 105. Typical terrain of Patton Level Trails Course (left) and course map (right).

d. Patton Hilly Gravel. The Patton Hilly Gravel Course is an 8.0 km (5.0 mi) long course with grades up to 25 percent, each several hundred feet in length. The course is built into the slopes of the Muggins Mountain and consists of primarily stretches of very cobbled surface interspersed with rock outcrops and bedrock. The course terrain is basalt hills with some volcanic hills inclusions. Climbing the long grades places prolonged high torque demands on the transmission which results in lower gear ratios and increased engine speed, placing a greater demand upon the cooling system. The downgrades have the opposite effect of the climbing scenarios with higher gear ratios, less engine speed, but with increased braking demands being placed on the service brake system. The average rms value is 2.1 cm (0.83 in). Figure 106 is a characteristic photograph of the terrain and a course map.

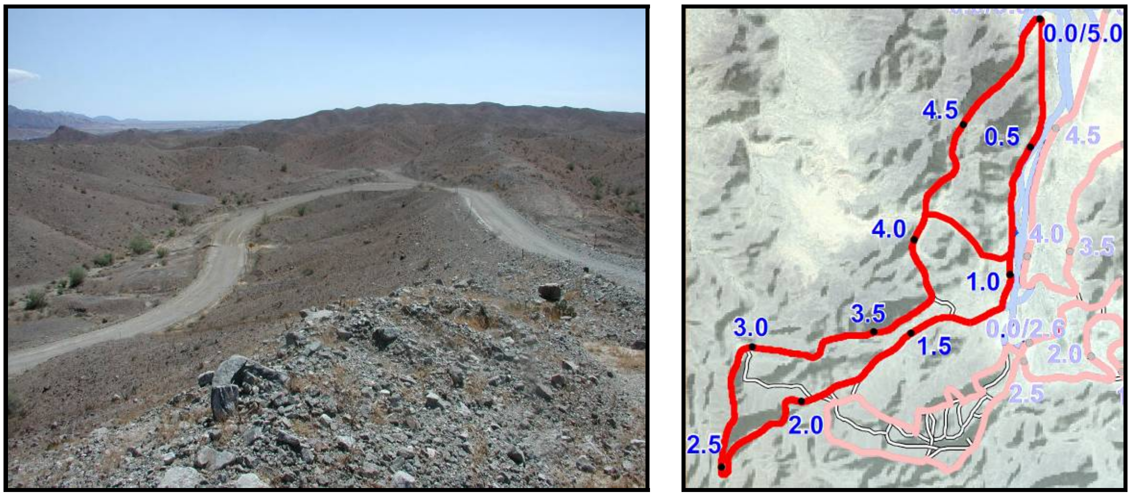

Figure 106. Typical terrain of Patton Hilly Gravel (left) and course map (right).

e. Kofa High Speed Gravel. Kofa High Speed Gravel is a 6.7 km (4.2 mi) oval loop that circles around the Kofa Level Gravel loop, as shown in Figure 107. The course is composed of quarried road construction grade gravel that has been compacted and graded. Compared to Kofa Level Gravel, the course is smoother, with fewer washboards. The larger size and the larger turns allow vehicles to maintain higher sustained course speeds. The average rms is 0.25 cm (0.1 in).

f. Kofa Level Gravel Course. Kofa Level Gravel is designed to simulate an improved secondary gravel road, and is located roughly 16.1 km (10.0 mi) north of the Mobility Complex. The course is a nearly level oval loop 5 km (3.0 mi) long and 12 meters (40 ft) wide. The course is composed of quarried road construction grade gravel that has been compacted and is regularly graded. Mild washboarding is present on the course. The average rms for the course is 0.58 cm (0.23 in.). Figure 108 shows a vehicle on the course and a course map.

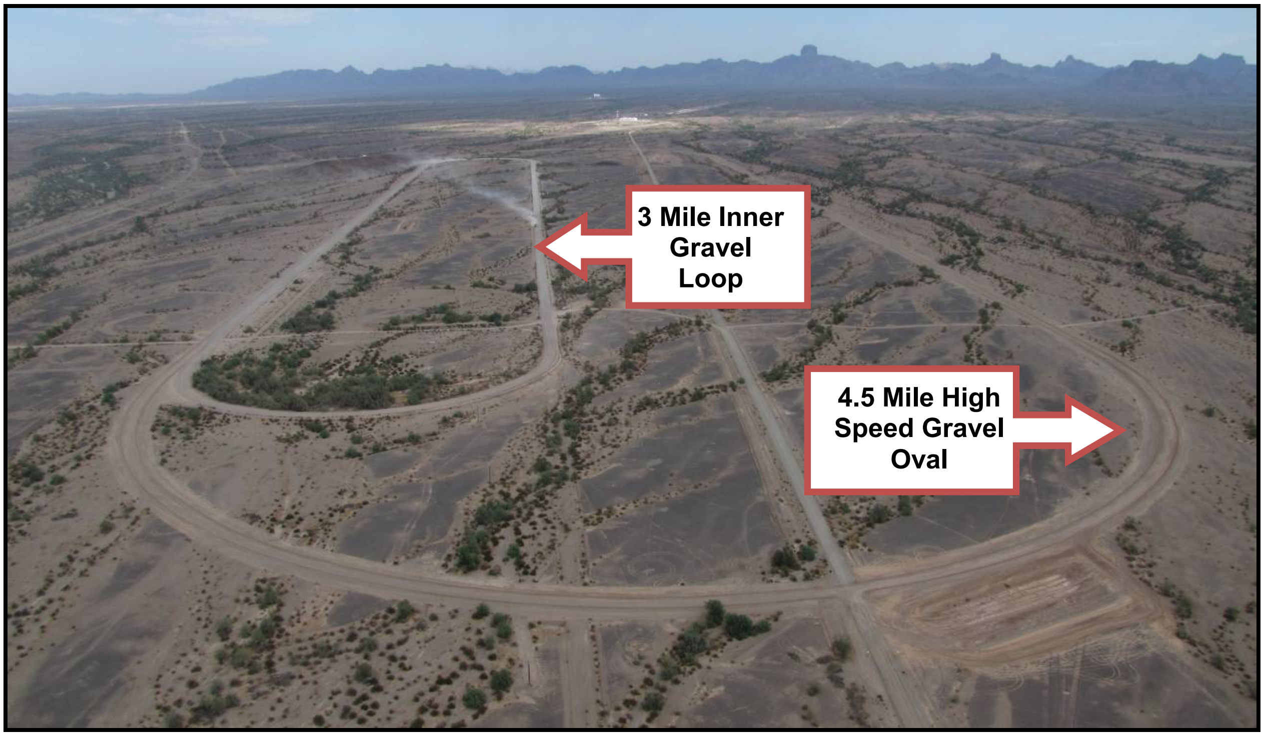

Figure 107. Aerial view of Kofa Level Gravel and Kofa High Speed Oval.

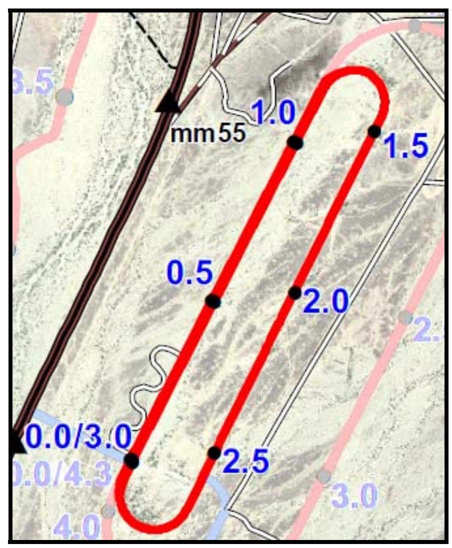

Figure 108. Vehicle on Kofa Level Gravel (left) and a course map (right).

g. Laguna Level Trails East. This course is a 4.5 km (2.8 mi) loop constructed on a relic lake floor, and is mostly level with the exception of gentle slopes associated with desert wash bottoms and is suitable for testing commercial trucks. The course terrain features are best described as Limey Upland Deep and provides an excellent example of the unimproved roadways of the Middle East. The course is composed of the Gilman family, Harqua Family, Glenbar Family Complex soils. These soils compact easily and provide a hard surface which is susceptible to erosion by the winds. The eroding of the surfaces produce mild wash boards which add to overall effects of the course. The average rms for the course is 2.0 cm (0.80 in). Figure 109 shows the typical terrain of the course and a course map.

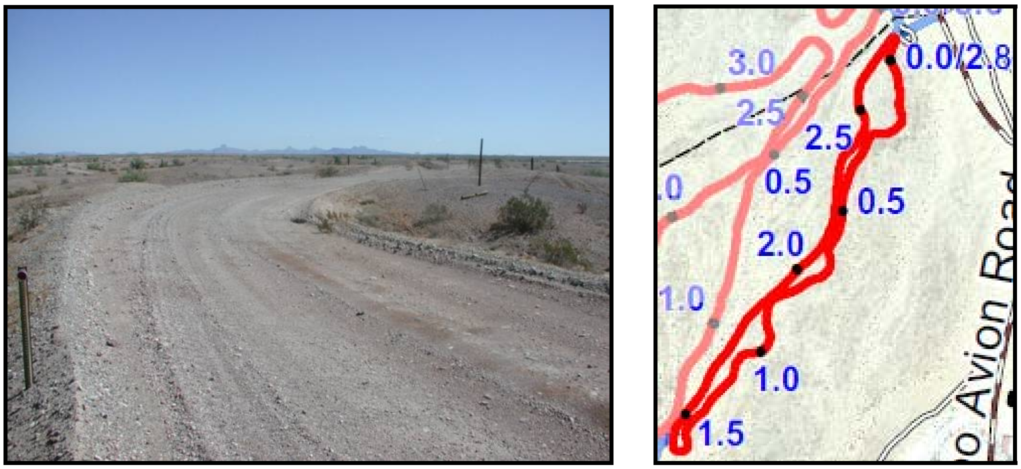

Figure 109. Typical terrain of Laguna Level Trails East (left) and course map (right).

h. Laguna Level Trails West. The Laguna Level Trails West is 9.0 km (5.6 mi) in length loop course. The loop crosses surfaces composed mostly of sand and gravel. The Laguna Level Trails West has more gravel and sand washes than the East Loop. The course is nearly level except for gentle embankments where alluvial washes are crossed. The four landforms that the Laguna Level Trails West course crosses are dissected fan, alluvial fan and terrace, and wash. The surface cover of the upper 5 cm (2 in.) of these landforms are mostly sub-rounded to angular gravel that range from poorly-graded gravel with either silt, sand or clay to well-graded gravel with sand. The average rms is 1.78 cm (0.70 in.). Figure 110 shows the typical terrain of the course and a course map.

i. Laguna Hilly Trails. The Laguna Hilly Trails is a 3.3 km (2.1 mi) loop course that traverses hilly terrain composed of loose rock, gravel, and sand with grades up to 30% with a length of 30 meters (100 ft). The four landforms that the Laguna Hilly Trails course crosses are bedrock, dissected fan, alluvial terrace, and alluvial wash. The surface cover of the upper 5 cm (2 in.) of these landforms are mostly sub-rounded to angular gravel that range from poorly-graded gravel with either silt, sand or clay to well-graded gravel with sand. The average rms is 2.13 cm (0.84 in.). Figure 111 shows the typical terrain and a course map.

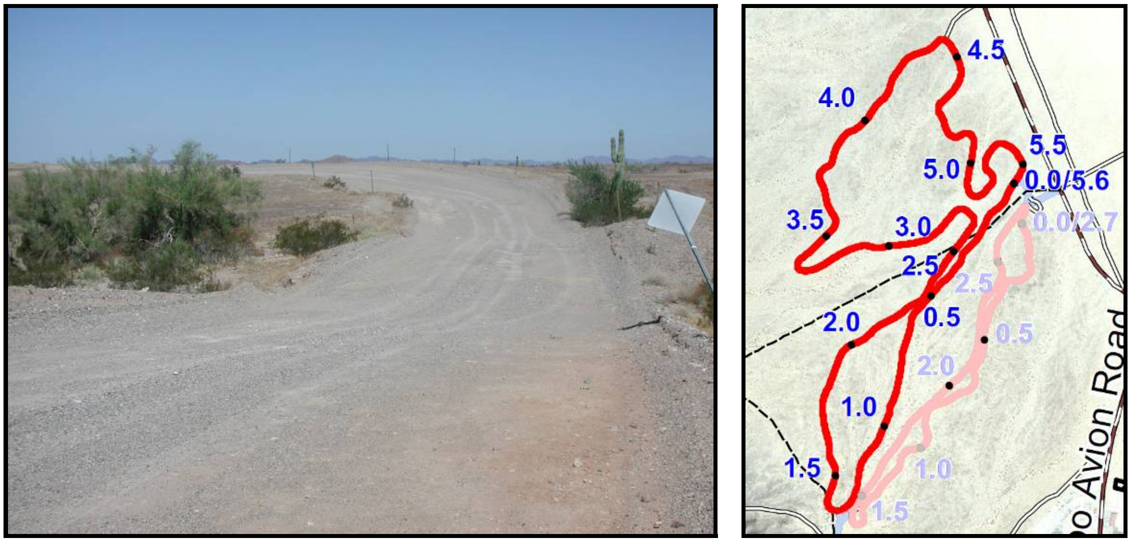

Figure 110. Typical terrain of Laguna Level Trails West (left) and a course map (right).

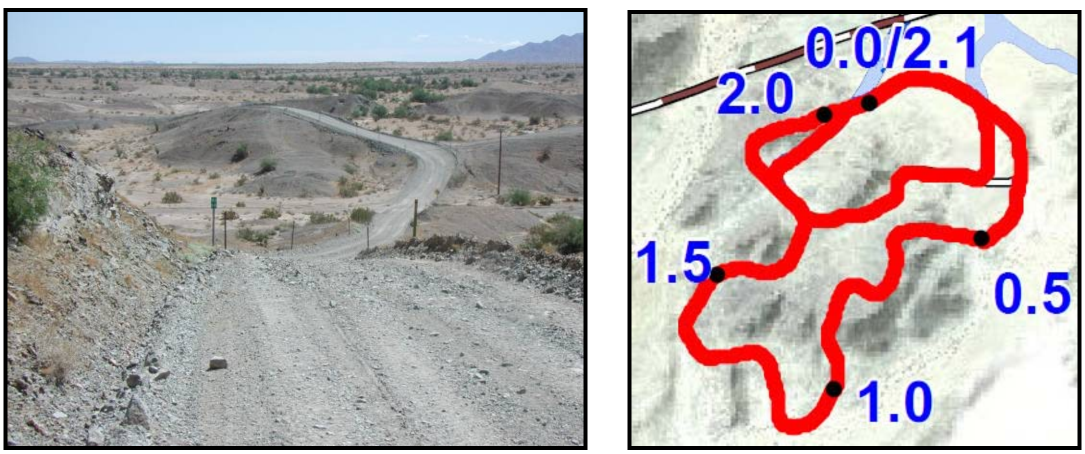

Figure 111. Typical terrain of Laguna Hilly Trails (left) and a course map (right).

j. Middle East Course. The Middle-East course is a 33.3 km (20.7 mi) composite course representative of comparable operations in the deserts of the Middle East. The terrain for the Middle East cross-country course was selected with comparisons of YTC terrain (soils, slopes, barriers) to deserts of the Middle East. The course takes advantage of wash bottoms for concealment, terrace side slopes for speed, terrace tops for orientation, and basin floors for speed and concealment. Some of all the 9 soil complexes found at YTC are encountered around the 33.3 km (20.7 mi) course. The varied landforms and terrain features found on the Middle East Course provide an excellent composite of desert conditions to test the vehicle durability and performance parameters. The average rms for the Middle-East course is 4.95 cm (1.95 in.). Figure 112 shows examples of the typical terrain on the course and Figure 113 is a course map.

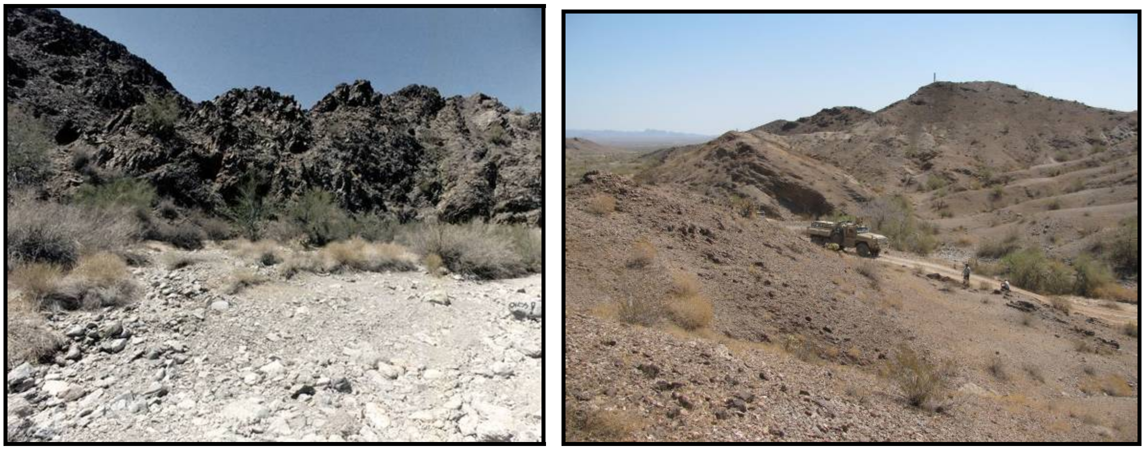

Figure 112. Rough, rocky wash at mile marker 15.8 (left) and vehicle on course (right).

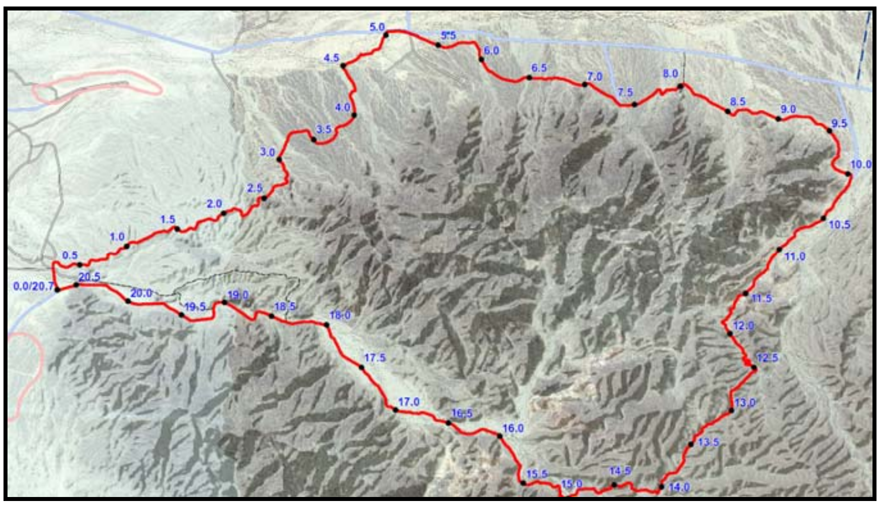

Figure 113. Middle East Course map.

k. Rock Ledge Course. This course is 6.3 km (3.9 mi) long, is located between two vertical rock outcroppings, and is traversed with several exposed rock ledges. The course follows a natural water course through the mini canyon. The terrain is classified as basalt hills, and volcanic hills. The surface of the trail is primarily composed of Riverbend Family-Carrizo Family Complex soils which are very coarse sands which are very heavily cobbled. The second soil class is the Lithic Torriorthents and Typic Torriorthents complex. These soils are composed of fragmented bedrock, vertical rock outcrops and very thin soil layers. They are usually strewn with large stones up to 76 cm (30 in.) in diameter that have spalled off the vertical ledges. In many sections there are no soils, just rocks of various sizes. The average rms is 3.35 cm (1.32 in). A characteristic photograph of the terrain and an overall course map is presented in Figure 114.

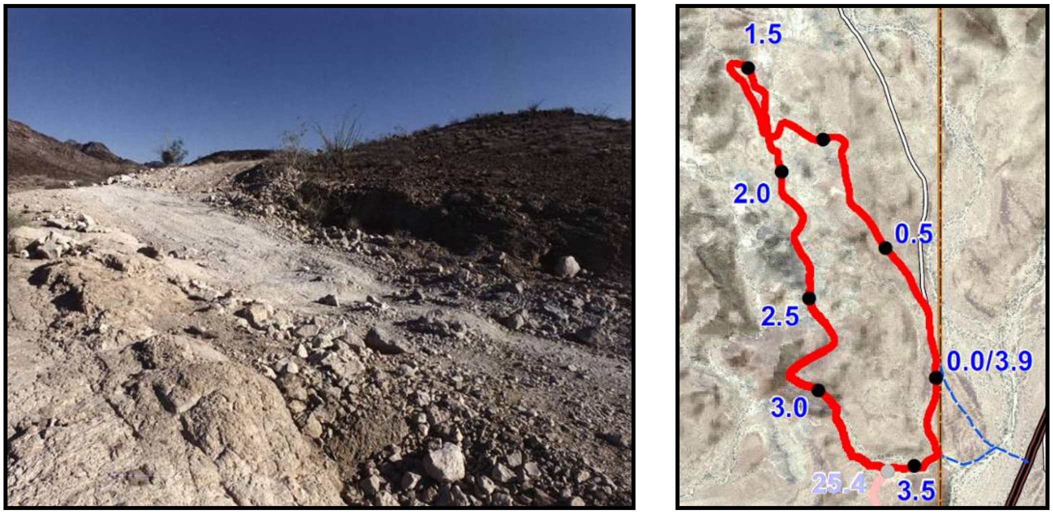

Figure 114. Typical terrain of Rock Ledge (left) and course map (right).

l. Desert March Course. The Desert March course is a 40.8 km (25.4 mi) course through a variety of desert terrain features including limey fans, limey fan sandy, sandy uplands, sandy bottoms, and gravely hills. The route exposes a test vehicle to a rigorous test condition which exercises the suspension system, braking systems and the transmission with repeated shifting due to the torque requirements needed to traverse the varied terrain. The average rms is 2.71 cm (1.07 in.). Figure 115 shows the typical terrain and a course map.

Figure 115. Typical terrain of Desert March (left) and course map (right).

m. Vapor Lock Wash. The Vapor Lock Wash Course is a course located along the bottom of a watercourse at the foot of an ancient beach terrace, and is classified as sandy bottom, deep. The course follows the natural wash bottom for some 4.0 km (2.5 mi). The course provides deep sand and consists of many twists and turns along its course. The course was previously used to test for vapor locking of fuel feed systems. Presently it is used for vehicle maneuverability and handling in deep sand conditions. Figure 116 shows the typical terrain and a course map.

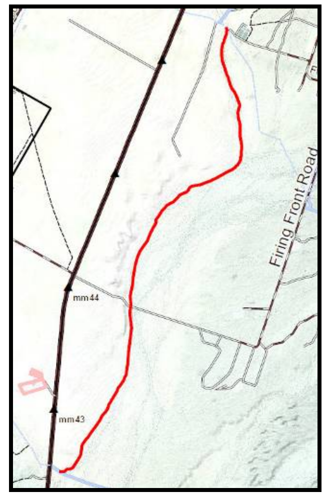

Figure 116. Typical terrain of Vapor Lock Wash (left) and course map (right).

n. Highway 95. YTC has use of an 80 km (50 mi) stretch of US Highway 95 spanning from the intersection with Imperial Dam Road at the guns north almost to Quartzite AZ at mile marker 105. The asphalt highway is used to conduct endurance operations over primary terrain at speeds up to the 105 kph (65 mph) speed limit. A stretch of US Highway Route 95 running through YTC is shown in Figure 117.

o. Bereznuk Track Evaluation. Bereznuk Track Evaluation is an approximately 2.4 km (1.5 mi) course over relatively undisturbed rocky terrain. Tracked vehicles are tested on this course to evaluate the durability characteristics of track systems over rocky terrain. Figure 118 shows the course map.

Figure 117. Aerial view of Highway 95.

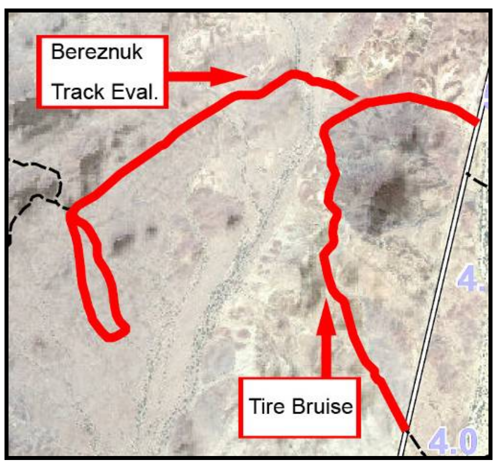

Figure 118. Course map for the Bereznuk Track Evaluation and Tire Bruise.

p. Tire Bruise. Tire Bruise test course is approximately 2.1 km (1.3 mi) in length and is used primarily for evaluating tire durability and exercising suspension components. The surface of the course contains many 10 to 20 cm (4 to 8 in.) diameter rocks. Figure 118 shows the course map.

q. Patton Wash. The Patton Wash test course is located within a gravel and sand wash that runs approximately parallel to the Imperial Dam road. The start of the course is located with the YTC fording basin, which has been used as a water source to allow pipeline or flexible conduit water pumping operations along the length of the 3.7 km (2.3 mi) course, and lends itself to testing deployment and distribution petroleum and water systems. The Patton Wash is an active wash, which during heavy rainfall periodically restores the terrain. The layout of the course is shown in Figure 119 and the typical terrain is shown in Figure 120.

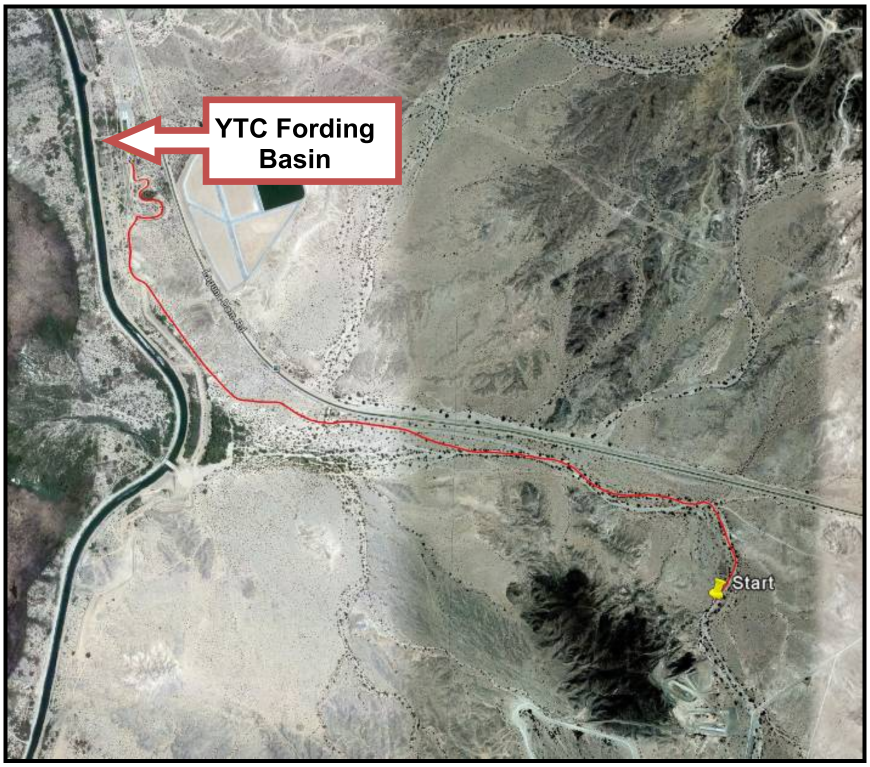

Figure 118. Overview of Patton Wash Course.

Figure 120. Typical terrain of Patton Wash.

r. Patton Off-Road. The Patton Off-Road Course is a severe cross country course with the steepest grades, approaching 50-percent, of any course at YTC. In addition to the steep grades sever terrain obstacles are present due to rocky terrain and washout of the material. The course is situated on a Basalt Hill Range site which is located on a series of relic beach terraces. Due to the severity of the terrain, the course is generally used for mobility evaluations of lighter wheel vehicle platforms with significant off road capability. The 5.0 km (3.1 mi) course layout allows for different routes to be followed through the course to tailor the profile for the system. The grade profile of the course is shown in Figure 121 and the course terrain and map are shown in Figure 122.

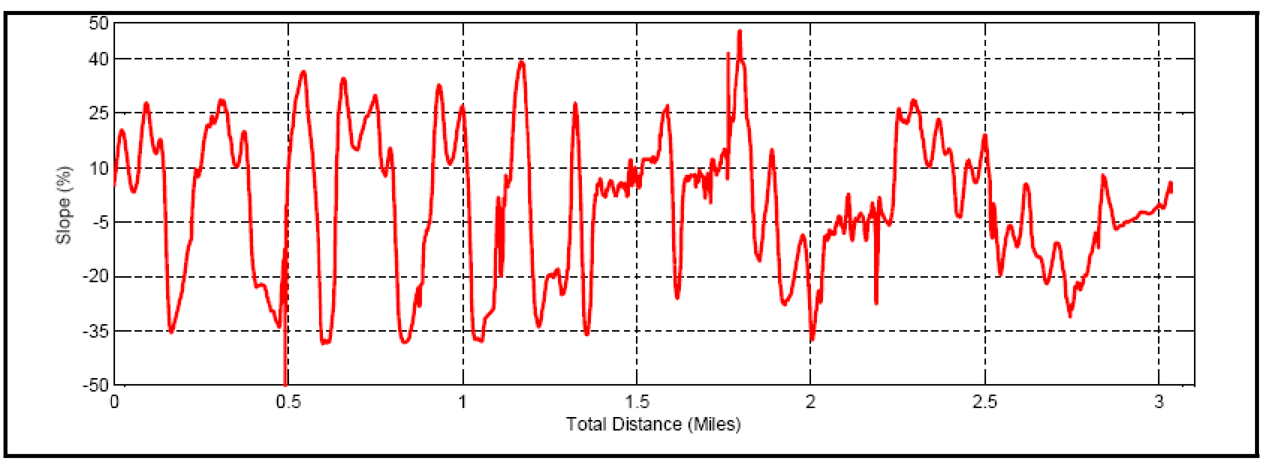

Figure 121. Patton Off Road Course grade profile.

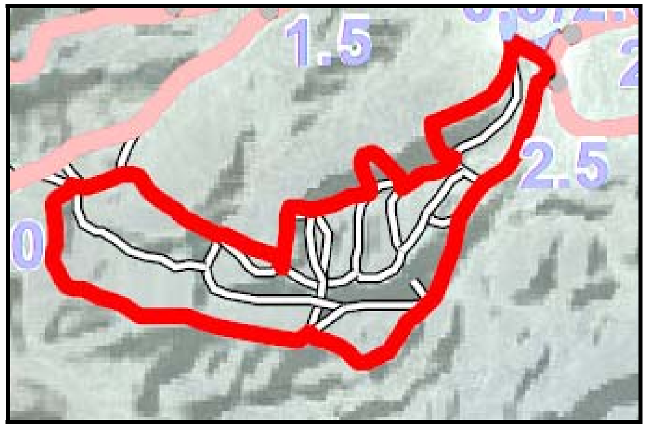

Figure 122. Patton Off Road Course terrain (left) and course map (right).

3.2 Yuma Test Center Performance Courses.

a. Longitudinal Grades. At the longitudinal grade facility, test vehicles can ascend or descend concrete grades ranging from 5 to 60 percent, as well as demonstrate both service and parking brake hold testing; maintainability of satisfactory lubricant and fluid levels; engine restart capabilities; and proper and satisfactory operation of vehicle component systems. Table 6 shows the dimensions of the longitudinal grades. Figure 123 shows the 20 through 60% concrete surfaced longitudinal grades.

TABLE 6. YTC LONGITUDINAL GRADE DIMENSIONS

SLOPE (percent)	WIDTH (ft)	LENGTH (ft)
5	30	124
10	30	148
15	14	300
20	20	238
30	15	257
40	15	155
60	20	106

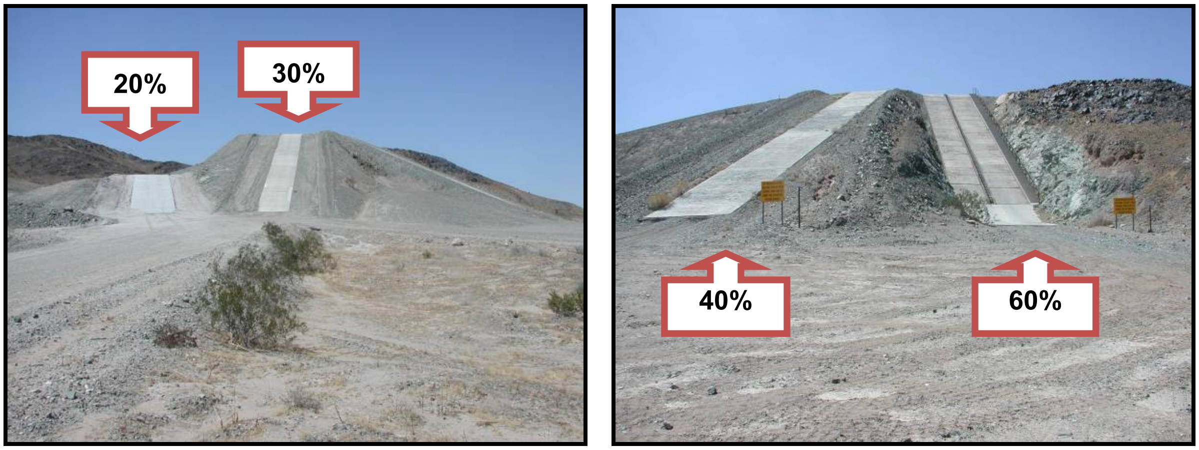

Figure 123. 20 and 30 - percent grades (left) and 40 and 60 - percent grades (right).

b. Roll On/Roll Off Ship Ramps. The roll on/roll off ramp facility consists of two metal ramps, one at an approach angle of 12 degrees and the other at an approach angle of 15 degrees, as shown in Figure 124. The ramps simulate the loading ramps for a roll on/roll off ship. Ship loading operations do not occur when the ramp angle is in excess of 15 degrees, whereas the interior deck ramps of the ship are at approximately 12 degrees, which is the basis of the ramp angles. The ramps are used to evaluate adequate power and traction as well as ramp approach and exit clearance and interference. This simulated test can also provide procedural checks for proper negotiation. The dimensions of the 12 degree ramp are 3 m (10 ft) wide and 18 m (60 ft) long. The 15 degree ramp is nearly identical to the 12 degree ramp; however the dimensions are 3 m (10 ft) wide and 15 m (48 ft) long.

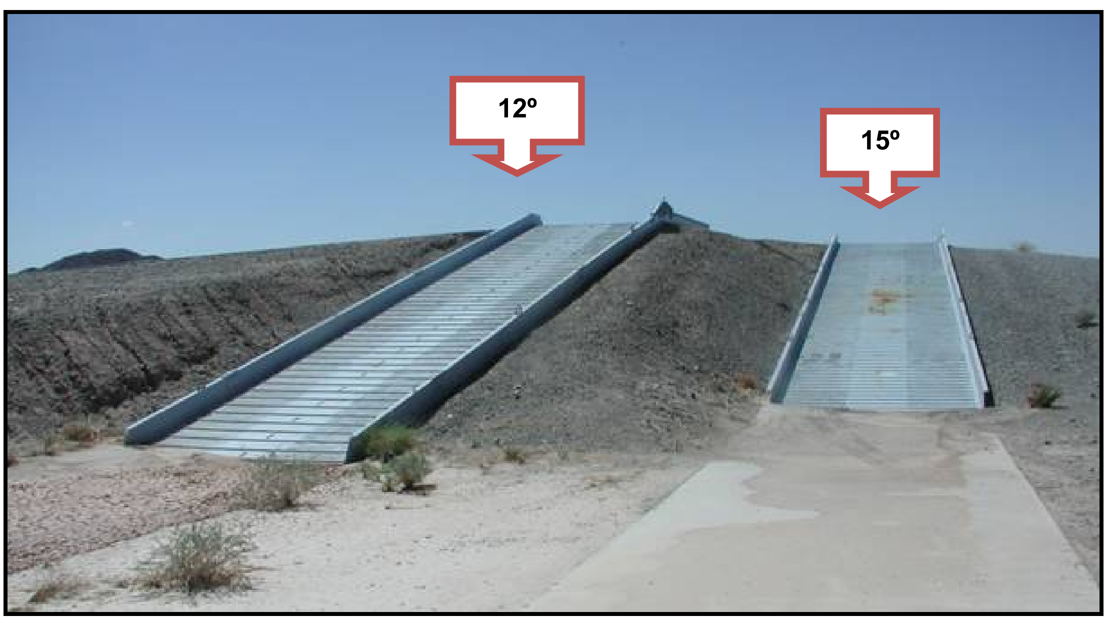

Figure 124. 12 degree roll on/roll off ramp (left) and 15 degree roll on/roll off ramp (right).

c. Side Slopes. At the concrete side slope facilities, test vehicles can demonstrate satisfactory traverse and stability on side slopes from 10 to 40 percent, as well as the maintainability of satisfactory fluid levels and integrity of seals. Table 7 shows the side slope dimensions. Figure 125 shows the 30, and 40 percent concrete surfaced side slopes.

TABLE 7. SIDE SLOPE DIMENSIONS

SLOPE (percent)	WIDTH (ft)	LENGTH (ft)
10	30	495
15	34	496
20	30	495
30	31	398
40	32	239


Figure 125. 30-percent side slope (left) and 40-percent side slope (right).

d. Sand Grades. The longitudinal sand grades are located in an alluvial plain that lies next to Hwy 95. Figure 126 shows the four grades of the course area, and Figure 127 shows the 20% sand slope. The course material is, soft, loose, dry, wind sorted beach sand that was imported from southern California. The sand slopes have nominal grades of 5, 10, 15, and 20 percent, respectively, and are prepared prior to test for a uniform condition by disc harrowing. The testable portions of each grade is a different length: 5% grade is 61 m (200 ft), 10% grade is 30 m (100 ft), 15% grade is 55 m (180 ft), and the 20% grade is 37 m (120 ft) in length.

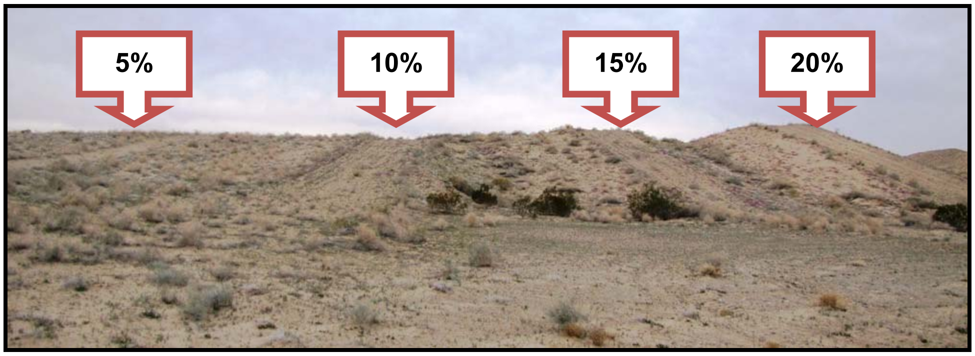

Figure 126. Overview of Sand Grades: 5, 10, 15, and 20% nominal longitudinal grades.

Figure 127. Overview of the 20-percent Sand Grade.

e. Fording Basin. Vehicles and equipment are evaluated for the ability to ford deep and shallow water in the fording basin. This facility (see Figure 128) is approximately 67 m (220 ft) long, 25 m (82 ft) wide, and adjustable to a maximum 2.3 m (7.7 ft) deep and has a concrete bottom. The basin is filled with water from a nearby canal to any depth required prior to test. There are two sides to the fording basin with two different approach and departure slopes described in Figure 129.

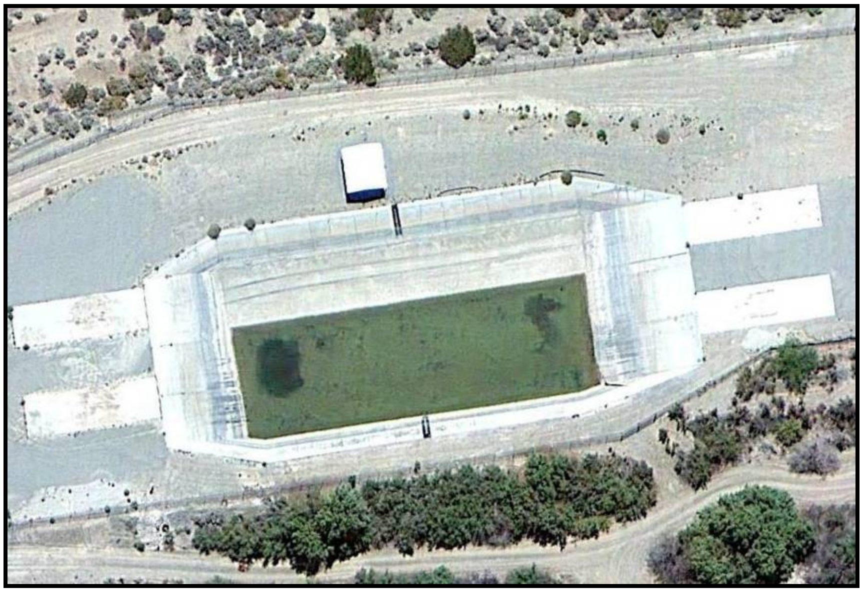

Figure 128. View of Fording Basin.

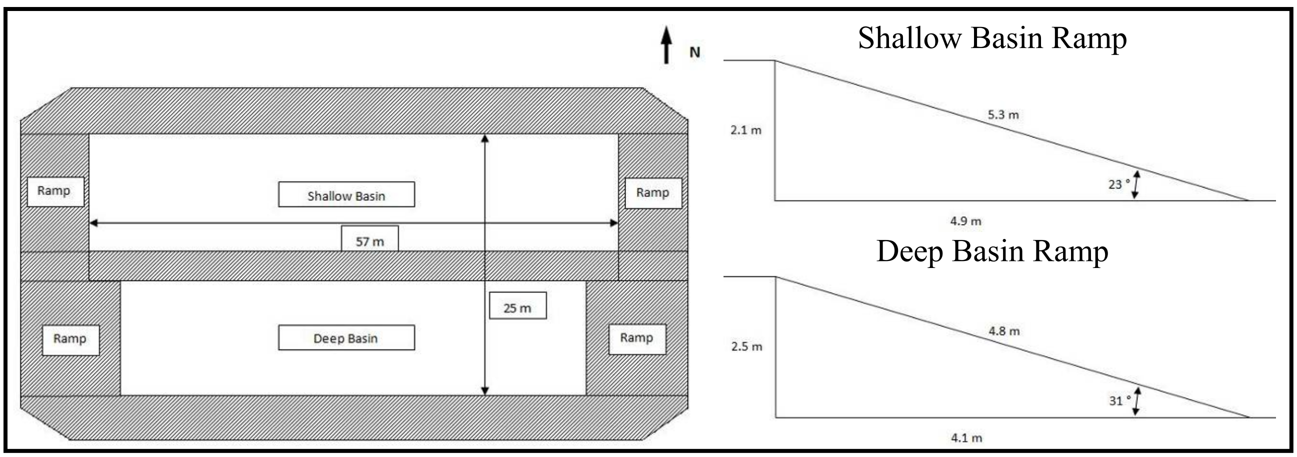

Figure 129. Fording basin layout.

f. Kofa Dust Course. This course is a 3.2 km (2.0 mi) long circular track through a classical basin floor composed of Gilman Family-Harqua Family, Glenbar Family Complex soils. The terrain is classified as limey fan and is characterized as very fine silty-loams, which are easily elevated into the air producing very dense dust clouds which remain suspended for significant periods of time. The particles in these soils are extremely small, in some cases less than 5 microns, and are slightly abrasive. This course is used to test the ability of engine filtration systems to filter out the dust particles. Additionally, the course is used to evaluate the filtration systems and sealing capabilities of the vehicle and crew compartments. Figure 130 shows a vehicle on the Kofa Dust Course and a map of the course.

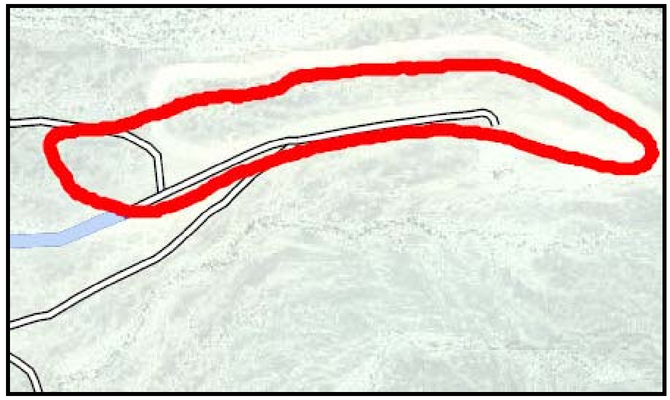

Figure 130. Vehicle performing non-convoy dust testing on Kofa Dust Course (left) and map of Kofa Dust Course (right).

g. Cibola Dust Course. The Cibola Dust course is located north of the Mobility Complex and west of US Highway 95 mile marker 70. This course branches off the Desert March vehicle endurance course at mile marker 24.4. The Cibola Dust course is a wide segment approximately 6.3 km (3.9 mi) that crosses surfaces composed mostly of silt and sand with gravel. The percent mean dust content of the alluvial fan generally ranges from 40 to 50 percent. The particles in these soils are extremely small, in some cases less than 5 microns, and are slightly abrasive. This course is used to test the ability of engine filtration systems to filter out the dust particles. Additionally, the course is used to evaluate the filtration systems and sealing capabilities of the vehicle and crew compartments. Figure 131 shows the typical terrain of the Cibola Dust course and a course map.

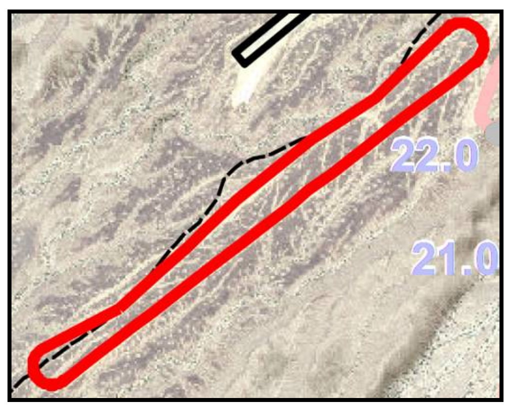

Figure 131. Vehicle performing convoy testing on Cibola Dust Course (left) and map of Cibola Dust Course (right).

h. Cibola Mud Course. The Cibola Mud Course is a prepared pad 91.4 m (300 ft) wide by 152.4 m (500 ft) long with a mud surface consisting of fine grained clay soils in combination with water to produce muddy surface approximately 1.2 cm (3 in.) deep to perform tire traction testing.

i. Dyno Mud Course. This course is 0.6 km (0.4 mi) long and is maintained at an approximately 46 cm (18 in) depth, over a firm base. The mud is a mixture of sand, clay, and silt. Water is added to the course with a sprinkler array and the quantity of water added to the course can change the consistency of the mud. The course provides a severe test of seals on road wheels, road arms, constant velocity joints, suspensions, brakes and steering components. Figure 132 shows a vehicle operating on the YTC Dyno Mud Course.

Figure 132. Vehicle operating on Dyno Mud.

j. Laguna Mud Course. This course is approximately 0.6 km (0.4 mi) length with a very uniform soil distribution over its entire length. The soil is classified as inorganic clays with high compressibility. The clay/sand surface can be wet to produce a representative muddy surfaced clay road used for maneuverability testing of vehicles. The mud is created by flooding the course from a nearby canal. Figure 133 shows a vehicle operating on Laguna Mud Course.

Figure 133. Vehicle operating on Laguna Mud.

k. Sand Dynamometer. The sand dynamometer course is composed of primarily Gilman Family, Harqua Family, and Glenbar Soils which are very sandy silty loams with very fine particles. These soils are easily moved by wind action and tend to build extensive low dunes. The sand dynamometer terrain is described as sandy upland. The course is built upon one the larger dunes and has adequate space for multiple passes over untracked terrain between surface preparations. The consistence and uniformity of the course surface is maintained by disc harrowing. The course is used primarily to determine vehicle speeds and mobility in deep sand. Figure 134 shows the Sand Dynamometer Course.

Figure 134. YTC Sand Dynamometer Course.

l. Ride Dynamics Course. YTC has five ride dynamics courses developed by the US Army Corps of Engineers Waterways Experiment Station. These courses are used to determine vehicle and human response to a specific, frequency-based road input. YTC's ride quality courses vary in length from 251 to 305 m (825 to 1000 ft) and in surface roughness from 1.0 to 8.6 cm (0.4 to 3.4 in.) rms (Figure 135).

Figure 135. RMS 5 Ride Dynamics course.

m. Fuel Transfer and Test Site Area. The Fuel Transfer and Test Site Area is designed for fuel truck, tanker-to-fuel truck, and tanker transfer endurance tests inside a inside a 33.5 m by 61 m (110 ft x 200 ft) fenced area. The area has a 12 m by 37 m (40 ft by 120 ft) concrete parking and fuel spill containment pad. The facility is equipped with a 19,000 L (5000 gal) fuel spill collection tank. Figure 136 shows fuel tanks undergoing storage testing and a fuel tanker at the Fuel Transfer and Test Site Area.

Figure 136. Fuel tanks undergoing storage test (left) and fuel tanker at the Fuel Transfer and Test Site Area (right).

n. Airfield Delivery Loading Ramp. The Airfield Delivery Loading Ramp at Laguna Army Airfield (LAAF) is used as a skid pad for steady-state cornering testing. The concrete pad measures 96 by 148 m (315 by 485 ft). Figure 137 shows a vehicle undergoing testing on the Airfield Delivery Loading Ramp.

Figure 137. Vehicle undergoing testing on the Airfield Delivery Loading Ramp.

o. Half Rounds and Curb Impact Course. The half rounds and curb impact courses evaluates the vehicles ability to absorb impacts at various speeds and assesses the input into the vehicle operator. The half round course consists of interchangeable 10, 15, 20, 25, 30 cm (4, 6, 8, 10, 12 in.) steel half rounds. Figure 138 shows the ten inch half rounds. The curb impact course consists of one concrete curb as shown in Figure 139. The height of the curb can be adjusted up to 2 feet in height by grading the gravel surface below the curb.

Figure 138. Ten Inch Half Rounds.

Figure 139. Curb Impact Course.

p. C-130 Air Transportability Test Bed. The C-130 Aircraft Transportability Test Bed (ATTB) at the Air Delivery complex is a C-130A fuselage designed to provide a cost effective alternative for test loading combat vehicles and logistics systems under development, as shown in Figure 140. The ATTB allows programs the opportunity to determine if their test items will fit onboard a standard military cargo craft. The cargo compartment dimensions, concentrated cargo/pneumatic tire load limits and aircraft tiedown points onboard the ATTB (shown in Figure 141) are fully representative of all C-130 E/H and J model aircraft currently in service. The ATTB is equipped with fully functional electrical and hydraulic systems, cargo ramp and door, ground loading ramps, paratroop doors, cargo winch, aerial delivery system components (excluding static line retrieval winches), A/A32H-4A cargo handling system, pendulum release, static-line cable system, and an internal climate control system. Additional uses of the ATTB include fit/function aircraft interface developmental testing of aerial delivery systems and components, and use as an airborne test mission rehearsal simulator.

Figure 140. Aircraft Transportability Test Bed.

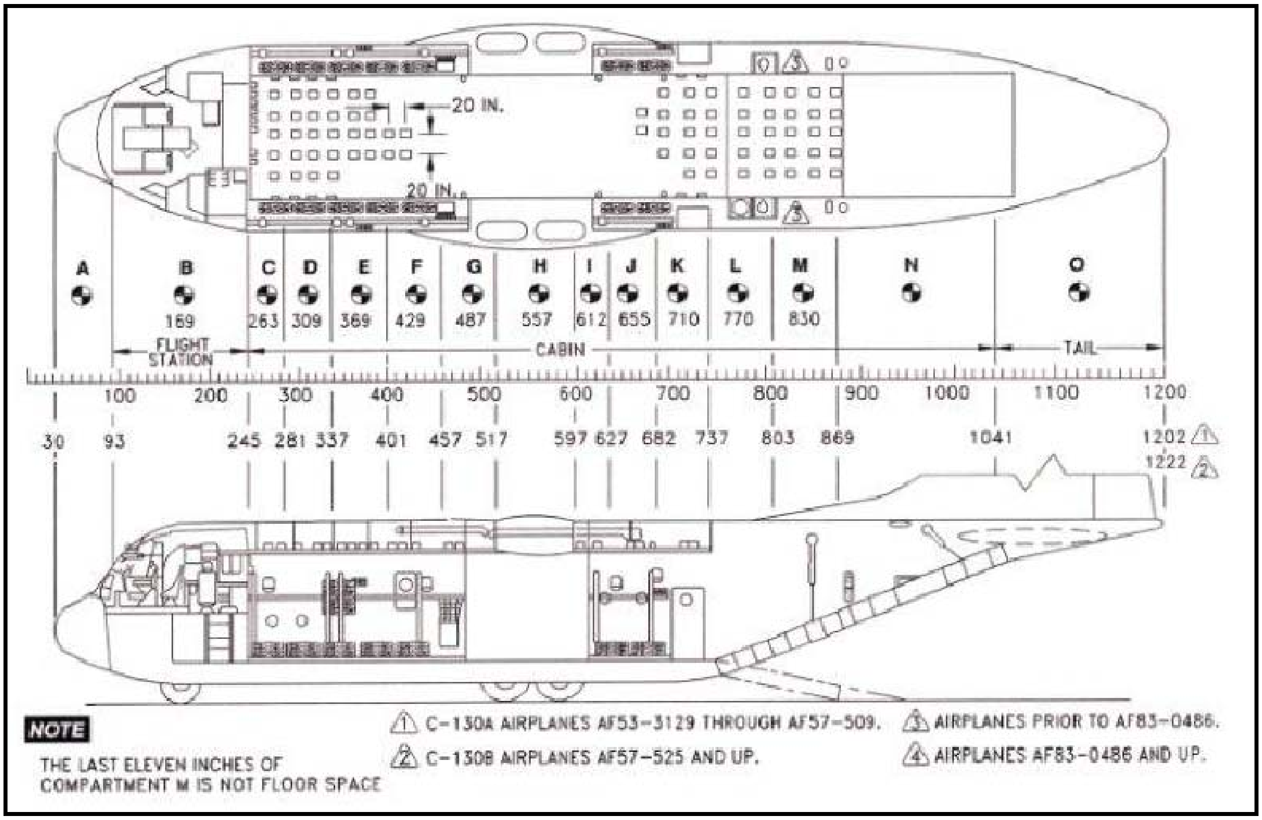

Figure 141. C-130 ATTB dimensions.

q. Urban Rubble. The Urban Rubble Course is approximately 91.5 meters (300 feet) in length and 6 meters (20 feet) wide. The course consists of large boulders, pieces of concrete and construction debris spread throughout the length of the course as shown in Figure 142.

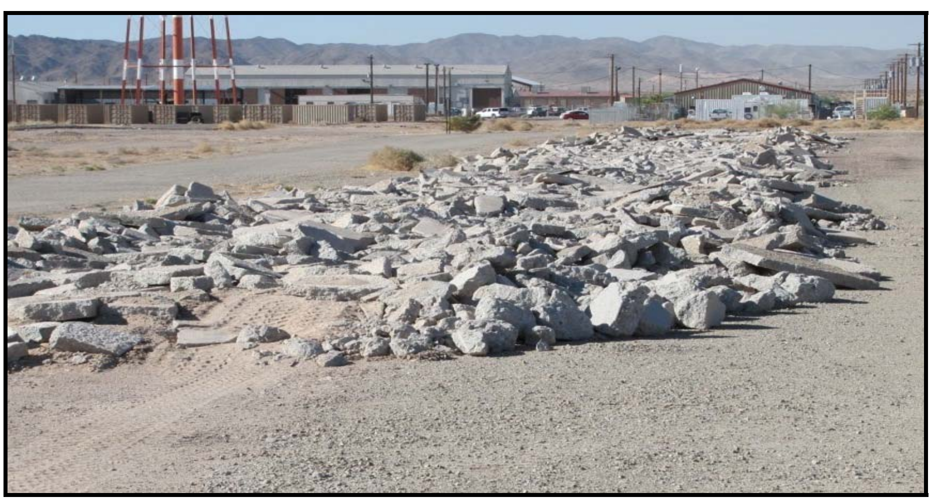

Figure 142. Urban Rubble Course.

r. Hot Weather Test Complex. The Hot Weather Test Complex (HWTC) is a joint use facility located at YTC comprised of two test complexes; one a series of test courses constructed for the Army, and the other the General Motors (GM) Desert Proving Grounds - Yuma. The HWTC contains the Laguna High Speed Paved Oval, Laguna Paved, and GM Performance Test Courses. The Army HWTC facilities were constructed to give YTC the ability to test the heaviest combat and combat support vehicles at the high sustained speeds coupled with the high temperatures experienced in the Middle East. Figure 143 shows a map of the HWTC. Testing at the complex allows for the full range of testing to include, but not limited to: maximum and minimum speeds, acceleration, braking (including split friction, low friction and J-turn), steering and handling, drawbar pull, fuel consumption, cooling, rolling resistance, tractive effort, durability testing of wheeled and tracked vehicles, and evaluation of overweight and over length vehicles.

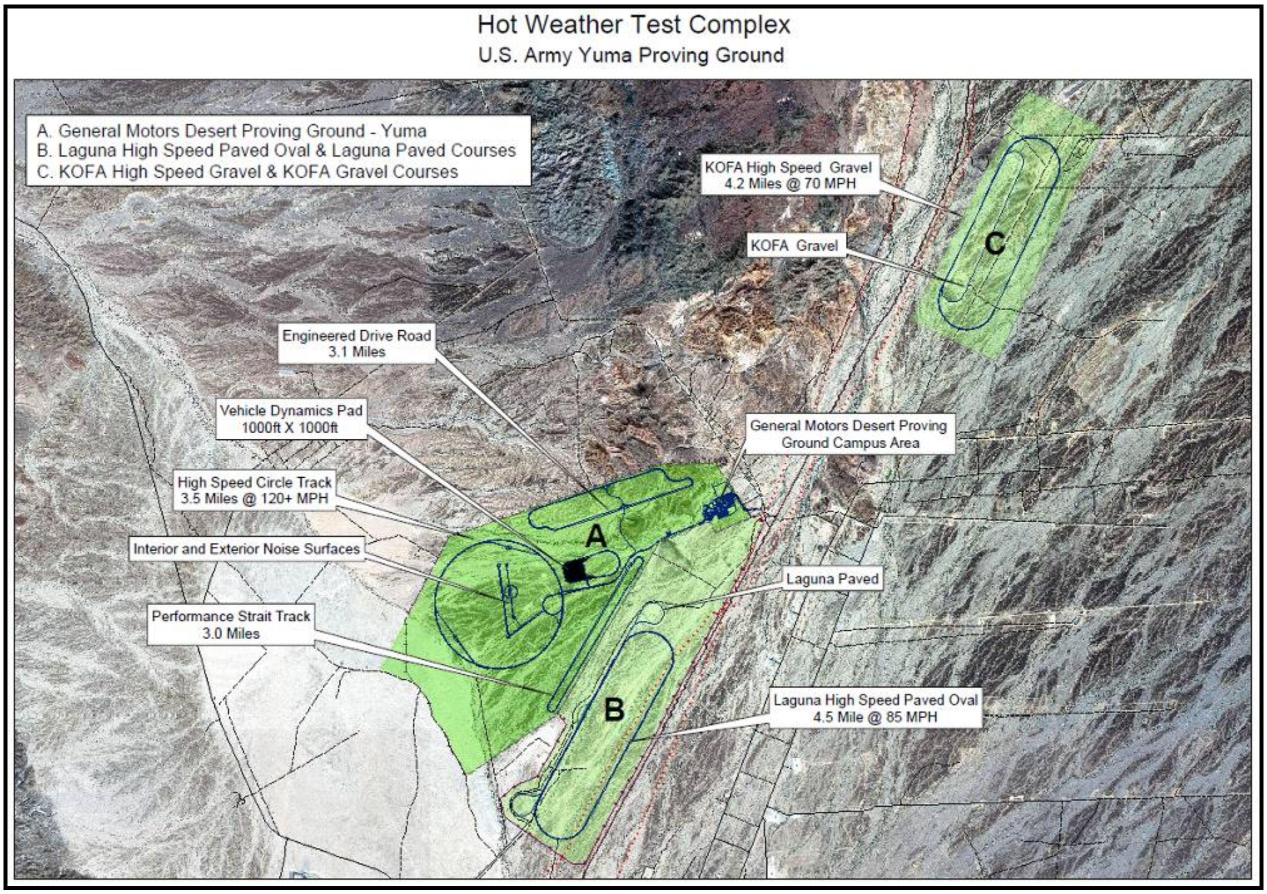

Figure 143. HWTC map.

s. Laguna High Speed Paved Oval. The Laguna High Speed Paved Oval course is a 7.2 km (4.5 mi) long two lane oval (straight-aways are 7,780 ft in length) as shown in Figure 144. The courses are level with a minimal 0.8 percent grade, are 143 m (470 ft) above sea level and consist of firm reinforced bed covered with a high-strength asphalt coating. The

Laguna High Speed Paved Oval course allows for wheeled vehicles with weights up to 113,398 kg (250,000 lb).

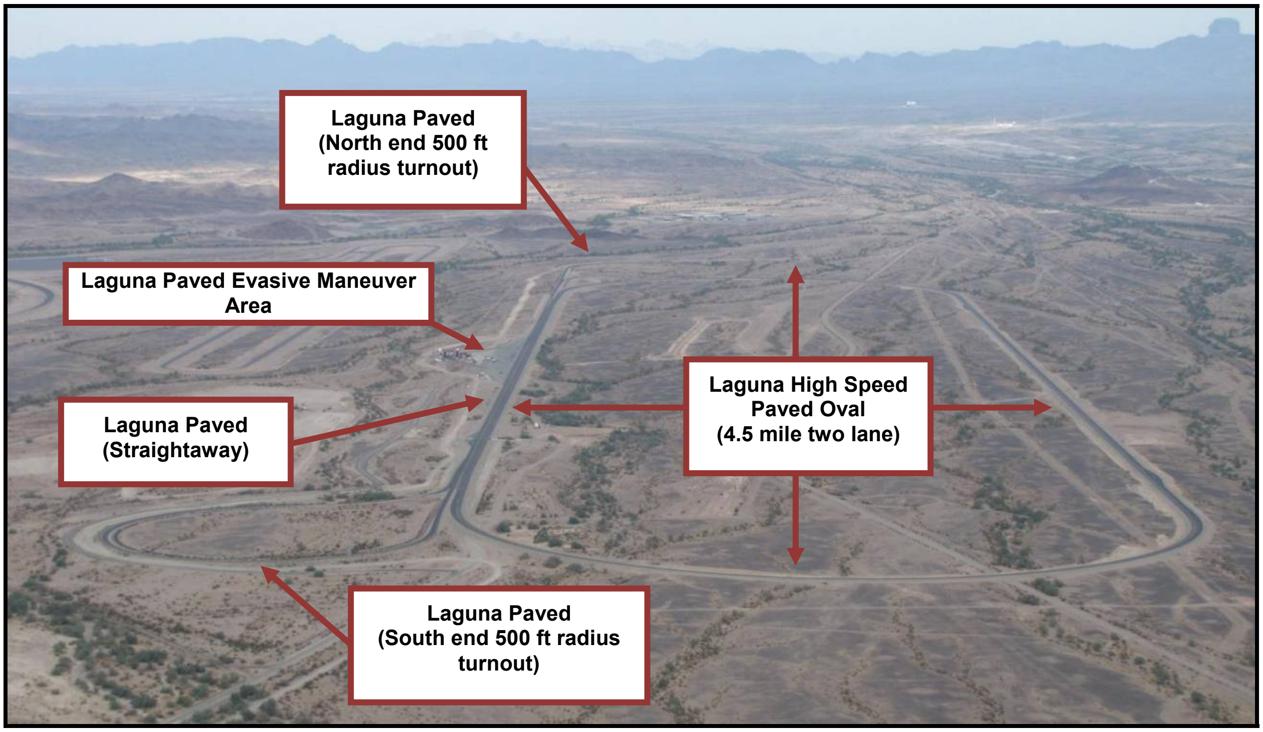

Figure 144. Aerial view of the Laguna Paved and Laguna High Speed Paved Oval.

t. Laguna Paved. The Laguna Paved course is 3.2 km (2 mi) in length, comprising of a single lane straightaway and two 500 foot radius turnouts at each end as shown in Figure 144. The Laguna Paved course accommodates both track and wheeled vehicles with weights up to 113,398 kg (250,000 lb). Track and wheeled vehicles utilize Laguna Paved for both durability and performance testing. This course along with the capability of the YTC Mobile Dynamometers provides the capability of conducting Full Load Cooling, Tractive Effort, and other performance tests plus paved highway endurance testing. The Laguna Paved course is level with a minimal 0.8 percent grade, and is 143 m (470 ft) above sea level. The course consists of firm reinforced bed covered with a high-strength asphalt coating. The peak coefficient of adhesion varies slightly between 0.89 and 0.93 depending on the section of the course used. There is a 305 m (1000 ft) long by 30.5 m (100 ft) wide automotive handling and evasive maneuver testing area co-located with the Laguna Paved course also show in Figure 144. The evasive maneuver testing area contains two low friction jennite surface sections for low friction or split friction testing. The first is a straight 122 m x 4 m (400 ft x 12 ft) lane. The second section is a 107 m x 7 m (350 ft x 24 ft) curved section with a 152 m (500 ft) radius of curvature. Figure 145 shows the layout of the low friction test areas.

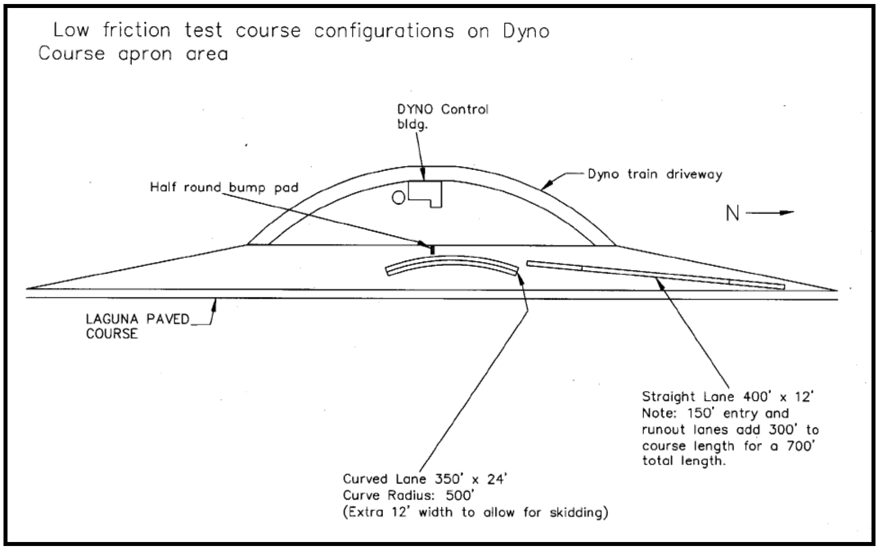

Figure 145. Low friction areas of the Laguna Paved Test Course.

u. GM Desert Proving Grounds Yuma Courses. As part of the Enhanced Use Lease agreement which developed the Hot Weather Test Complex, YTC has access to the GM performance courses for use in vehicle tests within the weight limits of the facilities.

(1) GM High Speed Circle Track. The High Speed Circle Track is a three lane 5.6 km (3.5 mi) asphalt circle with the lanes banked parabolicly enabling speeds to be reached in excess of 190 kph (120 mph). Wheeled vehicles with a gross vehicle weight (GVW) of 36,200 kg (80,000 lb) and axle weights of 9,000 kg (20,000 lb) are able to be tested on this test course. This test course is used primarily for endurance operations.

(2) GM Vehicle Dynamics Pad. The Vehicle Dynamics Pad is a 304 m by 304 m (1,000 ft x 1,000 ft) square of asphalt with two ingress/egress lanes running into the test area. Wheeled vehicles with a GVW of 36,200 kg (80,000 lb) and axle weights of 9,000 kg (20,000 lb) are able to be tested on this test course. Limited testing can be conducted on wheeled vehicles with a GVW of 63,500 kg (140,000 lb) and axle weights of 11,300 kg (25,000 lb). This test course is used primarily for vehicle dynamics testing such as North Atlantic Treaty Organization (NATO) lane change, lateral stability, and National Highway traffic Safety Administration (NHTSA) J-turn maneuver, steady increasing steer or sine with dwell maneuvers.

(3) GM Performance Straight Track. The Performance Straight Track is 4.8 km (3.0 mi) in length and consists of two parallel 2.3 km (1.4 mi) asphalt straight-aways connected with 180-degree curves at either end. Wheeled vehicles with a GVW of 36,200 kg (80,000 lb) and axle weights of 9,000 kg (20,000 lb) are able to be tested on this test course. This test course is used primarily for automotive performance such as acceleration and braking.

(4) GM Engineered Ride Road. The Engineered Ride Road is 5 km (3.1 mi) in length with two to three lanes of specially constructed asphalt and concrete road sections. Each road section has been specially designed to replicate real world road surfaces that have been found to

excite a vehicles suspension and affect ride dynamics in a unique way. Due to the sensitive nature of the specially constructed road surfaces, testing on this course is determined on a case by case basis depending on program requirements.

(5) GM Belgian Block and Granite Block. A 76 m (250 ft) section of Belgian block and a 152 m (500 ft) section of granite block is used for ride dynamics and shock and vibration testing. Wheeled vehicles with a GVW of 36,200 kg (80,000 lb) and axle weights of 9,000 kg (20,000 lb) are able to be tested on these road surfaces.

v. Pothole Course. The potholes consist of six steel fabricated potholes. The potholes range in size from 10 to 30 cm (4 to 12 in.) in depth, 1.2 to 2.4 m (4 to 8 ft) in length, and 1.2 to 1.8 m (4 to 6 ft) in width respectively, sunk flush with the gravel surface. Figure 146 shows a close-up of a pothole on the course and describes in detail the dimensions and spacing of each pothole. The sides and ends of the two 30 cm (12 in.) deep potholes are sloped 45 degrees, whereas the smaller potholes are sloped 45 degrees on the sides, with one end open and the other end sloped at 90 degrees. The course is laid out to allow vehicles ample room to reach desired speeds and approach each pothole with either the right or left side tires. The potholes are designed to be approached individually, from the right or left sides, with the vehicle entering the course perpendicular to the line of potholes. The potholes are not staggered such that they can be run successively in a straight line.

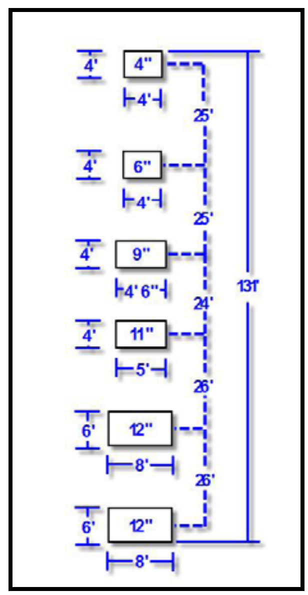

Figure 146. YTC Potholes Course (left) and dimensions of the YTC Potholes Course (right).

w. Vertical Steps. The vertical steps consist of permanent concrete walls of 15, 30, 46, 61, 76, and 91 cm (6, 12, 18, 24, 30, and 36 in.) in height with replaceable timbers placed at the vehicle approaching end. The replaceable timbers minimize damage to test vehicles components upon contact with the steps. This course is use to determine the test vehicles capability to climb vertical objects. Figure 147 shows the characteristics of the vertical steps.

Figure 147. Vertical Steps.

x. V Ditch. The V-ditch obstacles consist of a direct approach concrete V-ditch, and an angled approach concrete V-ditch. The direct approach V-ditch is 4.6 m (15 ft) wide, and 7.6 m (25 ft) from crest to crest. The angled approach V-ditch is 12.2 m (40 ft) wide, and 7.0 m (23 ft) from crest to crest. The angled approach V-ditch can be traversed so that either the right or left side tires drop into the V-ditch first. Figures 148 and 149 show the V-ditches.

Figure 148. Direct approach V-ditch.

Figure 149. Angled approach V-ditch side view (left) and 45 degree front view (right).

y. Military Operations on Urban Terrain (MOUT) Obstacle Course. The MOUT Obstacle Course consists of a curb obstacle, log obstacle, washboard terrain, 23 cm (9 in.) half rounds, 35-percent longitudinal grade, and staircase obstacle. The obstacles are designed to be run individually or in series as an obstacle course. The curb obstacle (Figure 150) is 4.3 m (14 ft) in length and 6.1 m (20 ft) wide, and consists of five concrete barriers laying on their sides and sunk into the gravel. The curbs are angled at 45 degrees in one direction and 90 degrees in the opposite direction, and range in height from 15 to 21.6 cm (6 to 8.5 in.). The log obstacle (Figure 151) is 9.1 m (30 ft) in length and 6.1 m (20 ft) wide, and consists of logs laid side-by-side varying in diameter from 18 to 35 cm (7 to 14 in.). The washboard terrain (Figure 152) is 6.1 m (20 ft) in length and 4.6 m (15 ft) wide. The half round obstacles (Figure 153) consists of 7 half rounds, each 23 cm (9 in.) high, and offset so that a vehicle's right and left side tires alternate traversing the obstacle every 3.4 m (11 ft) (center to center). The half rounds cover a span of 16.8 m (55 ft) in length and a maximum track width of 2.7 m (9 ft). The staircase obstacle (Figure 154) is a series of 17 steel steps with antiskid coating. The stairs treads are 38 cm (15 in.) deep, and have a rise of 15 cm (6 in.) each (approximately 23 degree longitudinal grade). The staircase is 6.1 m (20 ft) long (hypotenuse) and 4.3 m (14 ft) wide.

Figure 150. Curbs obstacle.

Figure 151. Logs obstacle.

Figure 152. Washboard terrain obstacle.

Figure 153. 9-inch Half Rounds obstacle.

Figure 154. Staircase obstacle.

z. Winch Test Facility. The winch facility provides the capability to test the operational characteristics of winches. The winch facility is equipped with a concrete deadman that can be used to secured the winch cable to, or secure the vehicle itself, as shown in Figure 155. The concrete deadman can resist a maximum load of 578,000 N (130,000 lb). Winch testing can also be performed at the Lift and Tiedown Facility (LTTF) facility, discussed in Paragraph aa.

Figure 155. Vehicle undergoing winch testing.

aa. Lift/Tiedown Test Facility. The LTTF provides the capability to test the strength of lifting and tiedown provisions on military equipment with the purpose of validating compliance with the requirements of Military Standards 209 and 913. The LTTF is equipped with hydraulic rams, platform, and deadmen to setup and restrain the test item and apply the required loads to the lift and tiedown provisions. The layout of the facility is shown in Figure 156. The primary components of the LTTF facility are a longitudinal-force cylinder with a 1,000,000 N (240,000 lb) maximum longitudinal force capacity, a downward-force cylinder with a 400,000 N (90,000 lb) maximum lateral force capacity, and a downward-force cylinder with a 266,000 N (60,000 lb) maximum vertical force capacity. The longitudinal-, lateral-, and vertical-force hydraulic rams are shown in Figures 157 to 159. The LTTF facility is also equipped with additional items that facilitate the setup and restraining of test equipment. The facility is equipped with a large deadman that can resist a longitudinal force of up to 1,000,000 N (240,000 lb) and a lightweight deadman that can resist a longitudinal force of up to 711,000 N (160,000 lb) as shown in Figure 160. The deck of the lift and tiedown table has six rows of anchor points for use with chain or clevis attachments to restrain test items, and each anchor can resist a maximum pull of 178,000 N (40,000 lb) in any direction.

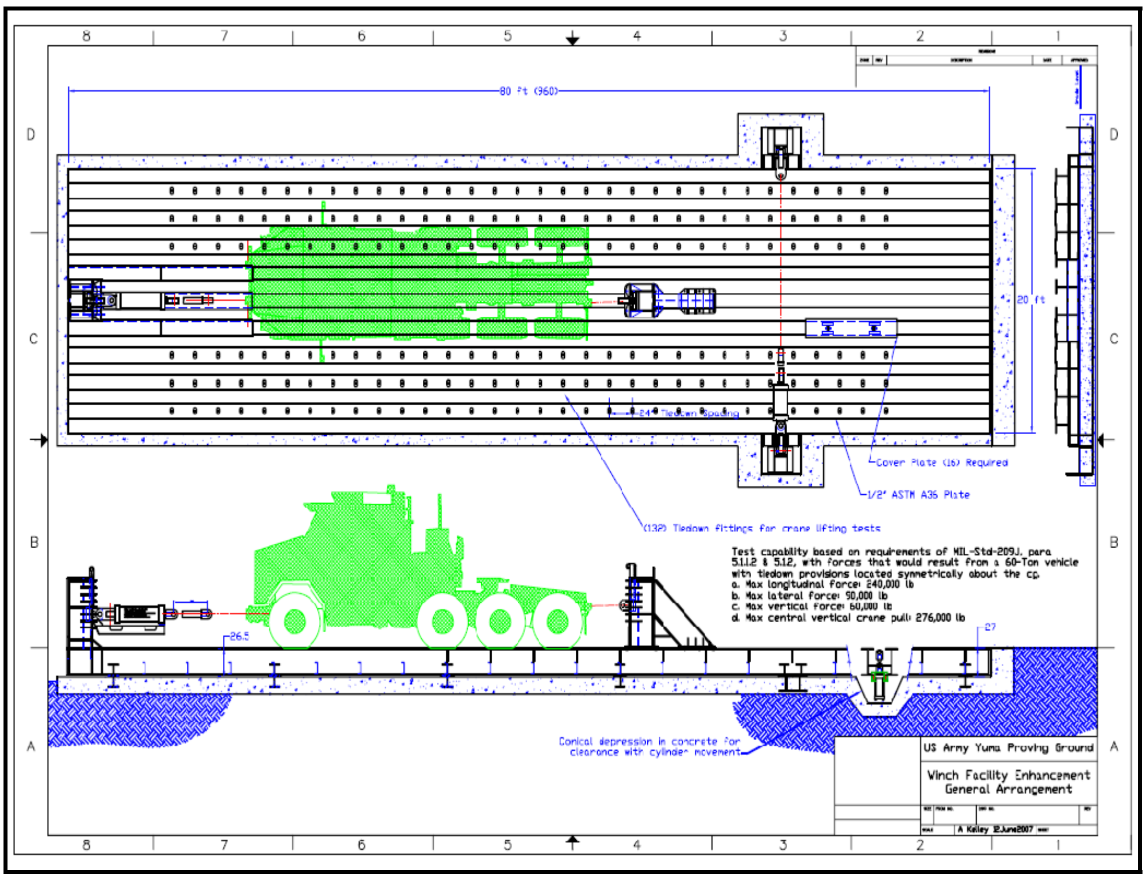

Figure 156. Lift and Tiedown Facility (LTTF).

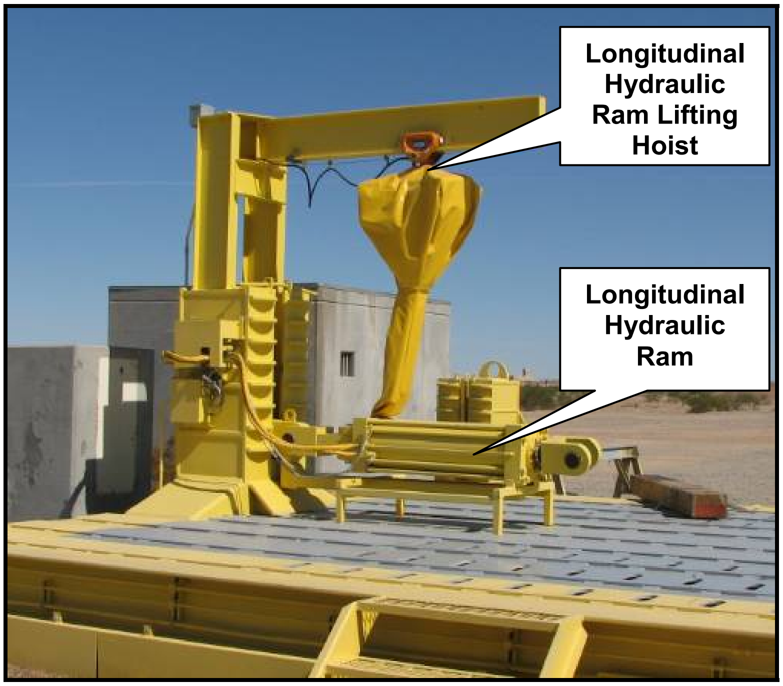

Figure 157. LTTF longitudinal hydraulic ram.

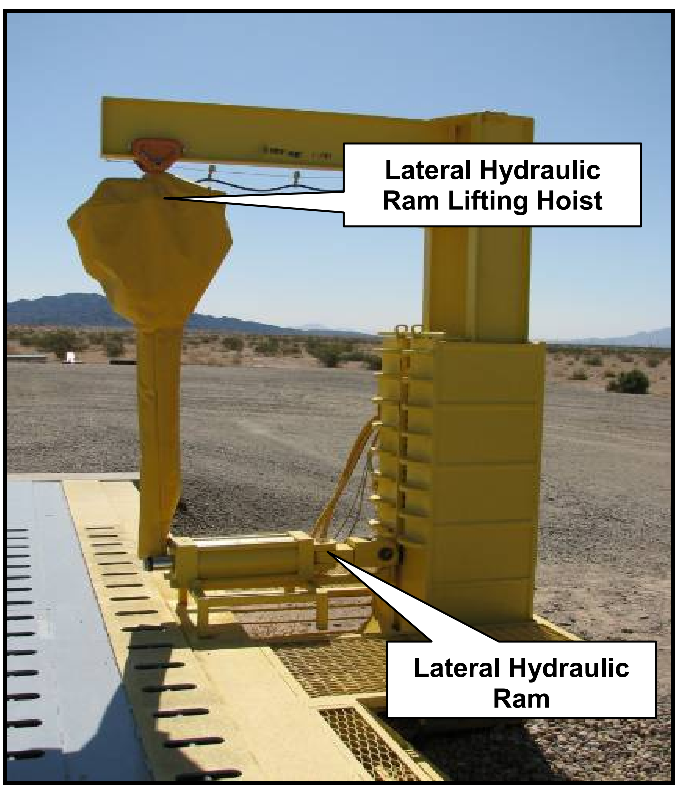

Figure 158. LTTF lateral hydraulic ram.

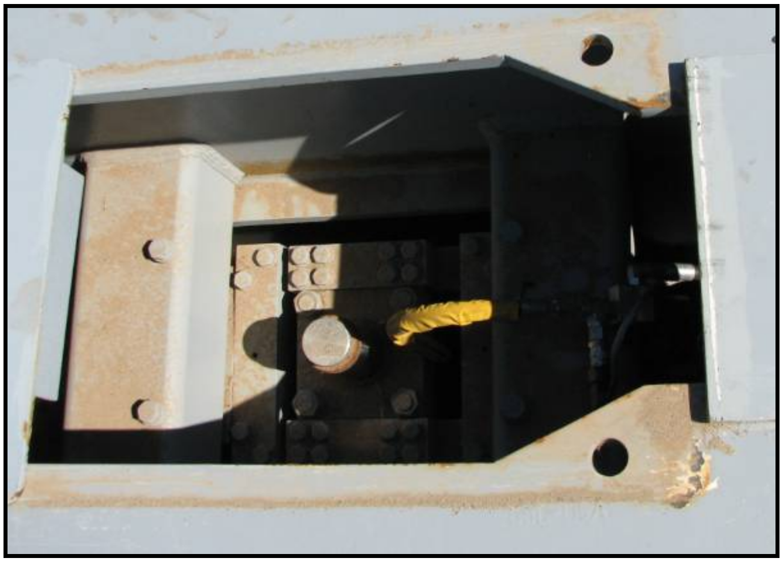

Figure 159. LTTF vertrical hydraulic ram (located under the surface of the LTTF bed).

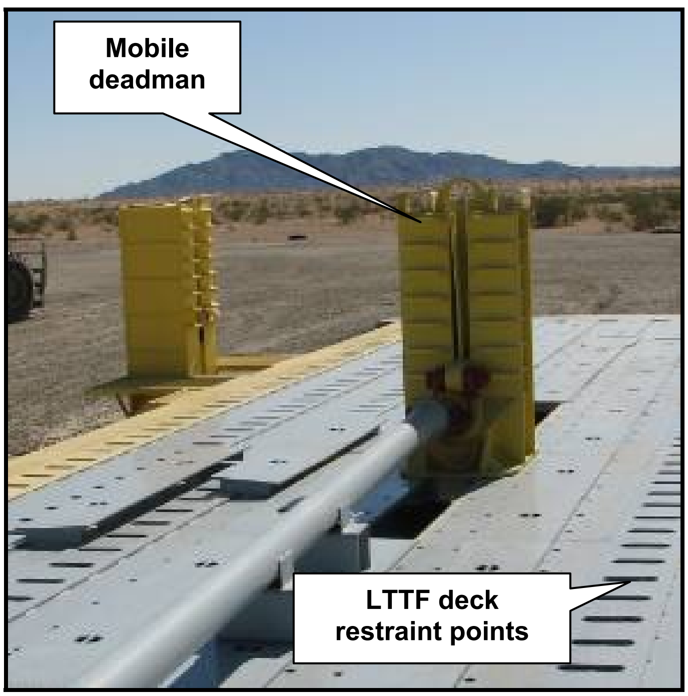

Figure 160. LTTF deadman and deck restraints.

bb. Bridging Area. Areas are available for testing bridging devices and systems. The area to the north of the concrete 10% side slope has been disturbed by earth moving equipment leaving an assortment of trenches and steps that can be used as obstacles for deploying and retrieving bridging equipment. Figure 161 illustrates a typical ‘trench’ or ditch feature with a bridging device being deployed. The surface of this area can be altered to suit test scenario needs on a case by case basis. For floating type bridging devices (pontoon bridge assemblies) the fording basin and Senators Wash are available for deploying and retrieving trials. Figure 161 illustrates a pontoon bridge segment being deployed into the fording basin. YTC can use Senator Wash Reservoir for amphibious testing of vehicles and bridging systems by arranging on a case by case basis with the US Bureau of Reclamation. The reservoir is primarily an irrigation storage facility, and is used to hold excess water from the snowpack run-off in the spring to be used during the dry months. At normal levels, the reservoir provides water depths of 50 feet and over, near the main dam structure. Access to the lake is made via a concrete boat launching ramp, as shown in Figure 162.

Figure 161. Bridging device test ditch.

Figure 162. Senator’s Wash Reservoir Swim Test Facility.

cc. Tilt Table. The YTC tilt table is a facility designed to determine the static rollover threshold of vehicles following SAE tilt table procedures. The steel table structure has a platform size of 3.6 m (12 ft) wide by 27 m (90 ft) long, accommodating up to the largest Army vehicles, including a full loaded Heavy Equipment Transporter System. The table provides a maximum tilt angle of 47 degrees, a 0.3 degree per second angle speed, and a lift capacity of 136,000 kg (300,000 lb). The facility includes tiedown provisions on the table and necessary restraints to prevent vehicle rollover from the table. The tilt table facility is shown in Figure 163.

Figure 163. YTC Tilt Table Facility.

dd. Boresight Slopes. The boresight slopes is a central location where multiple test vehicles on YTC start and end daily mission operations, and is shown in Figure 164. The boresight pad is marked as a surveyed location so the vehicles can compare the Easting, Northing, and altitude grid information recorded from the vehicles navigational system to the Easting, Northing and altitude grid information to address position/navigation test requirements of the onboard vehicle systems.

(1) There are two target grid boards located at the boresight slopes that provides vehicles with a set target at the distance of 500 meters to perform daily mission boresight operations. In addition to the grid boards, there are multiple targets with pre-established ranges that enable test of range acquisition systems. Typical targets are shown in Figure 165.

Figure 164. Boresight slopes.

Figure 165. Typical boresight targets.

3.3. Yuma Test Center Off-Site Courses.

a. California Algodones Sand Dunes. The Algodones Dunes located in the California Desert Conservation Area within the Sonoran Desert occupy and area approximately 48.3 km (30 mi) wide by 64.4 km (40 mi) long just west of the Colorado River. The Glamis or Imperial

Dunes is a belt approximately 4.8-9.6 km (3-6 mi) wide and approximately 48.3-64.4 km (30-40 mi) long located within the larger Algodones Dunes. This area features large areas of sand hills, sand plains, and a variety of dune formations with sand grades up to 60 percent and is classified as sandy upland and sandy bottom, deep. This area also contains areas with slip faces up to 91.4-121.9 m (300-400 ft) high, which overlook large flat-floored basins sand free depressions, which are interpreted as exposed parts of the desert floor with a succession of advancing barchans. Within this area an 11.3 km (7 mi) marked course incorporating a variety of the terrain features available, is used by YTC for mobility testing. This area for mobility testing is coordinated with the Bureau of Land Management (BLM) on a test by test basis. Figure 166 shows a vehicle undergoing test at the California Algodones Sand Dunes.

Figure 166. Vehicle undergoing testing in California Algodones Sand Dunes.

b. Rail Impact Site. The YTC rail impact site (located at Blaisedale) is a facility where equipment is tested to evaluate the structural integrity to withstand the impacts that can occur during rail transport, shown in Figure 167. The rail impact site and equipment outsourced to support rail impact testing varies to meet specifications set forth in MIL-STD-209K and MIL-STD-810G test requirements. The rail site is composed of a straight, dry, level, inclined ramp section of railroad track 480 m (1575 ft). The rail impact instrumentation package utilized during testing includes (but not limited to) the emergency brake system (Figure 168), optical fifth wheel (monitor speed), and accelerometers at prescribed locations to record shock.

Figure 167. YTC Rail Impact Site.

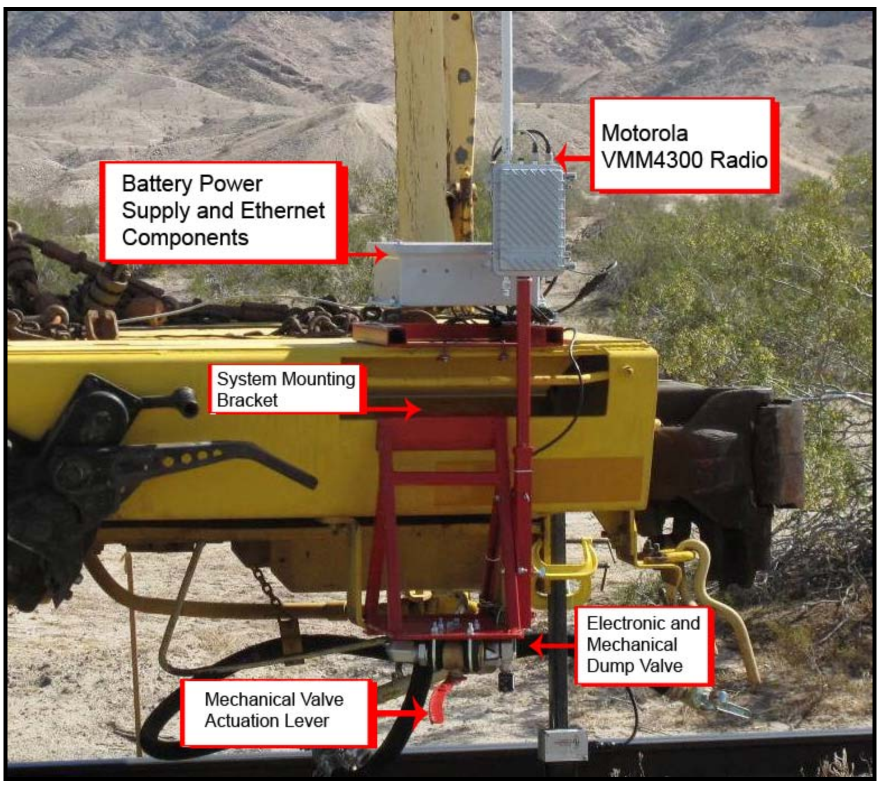

Figure 168. YTC Rail Impact emergency brake system components

c. Interstate 8. Part of the US Interstate system I-8 runs from I-10 south of Phoenix at its eastern point to Sunset Cliffs Blvd and Nimitz Blvd in San Diego at it western terminus, with a total length is 560 km (348 mi). This multi lane highway offers a variety of terrain from below sea level to mountain passes over 1,219 m (4000 ft) in elevation. In California, west bound from mile marker 89 to the top of the Mountain Springs/In Ko Pah grade, the route is divided through two separate canyons, as the freeway ascends/descends 1,219 m (4000 ft) vertically in 17.7 km (11 mi). Also long relatively flat sections Interstate-8 within CA and AZ provide opportunities for un-interrupted high speed operations at 105-120 kph (65-75 mph) for 96.5-246.2 km (60-153 mi). It can be accessed easily from YTC at the intersection of US 95 or Dome Valley road.

(1) Sustained Speed Operations. Beginning at mile marker 21 and continuing east bound, sustained speed operations 105-120 kph (65-75 mph) can be accomplished for up to 246.2 km (153 mi). The terrain is generally flat with a slight rise over Mohawk pass (1.2% up grade, 2.3 % slope down grade in the east bound direction). As it continues east from Mohawk pass, the road averages less than 1% to Gila Bend (exit 119) and then through the Sonoran Desert National Monument it begins a steady climb of 1-1.4% grade until mile marker 161. It maintains a slight down grade/level profile to its eastern terminus at I-10. Diesel fuel can be obtained at Dateland (mile marker 67) and Gila Bend (mile marker 116 and 119).

(2) 5% grade near El Cajon CA. Located in San Diego County, between mile marker 27 and 30, is a section of road way with a sustained 5% grade for 1.1 miles in the east bound direction. The test vehicle can exit at mile marker 27 (Dunbar Lane- Harbison Canyon), pass under the free way, and gather speed on the slight down grade/on ramp east bound. Once at required speed the vehicle then proceeds up the 5% grade to mile marker 30 (Tavern Road). Diesel fuel is available to Tavern Road.

d. Death Valley National Monument. The road network in the Death Valley National Monument is utilized on a special permit basis coordinated by YTC. A 183-mile paved test route between Beatty, Nevada, and Panamint Springs with grades up to 14 percent is used for tests of wheeled vehicles, engines, and transmission and automotive lubricants. Summertime temperatures on the valley floor frequently reach 125 ºF and elevations that can be reached by roads and trails ranging from 280 feet below to 8,000 feet above mean sea level. Beatty, Nevada, is located 414 miles from YTC.

3.4 Yuma Test Center Direct Fire Ranges.

a. Combat Systems Direct Fire Range. Combat Systems Direct Fire Range is an area 2 km by 7 km (3,460 acres) located on the Kofa range approximately 16 km (10 mi) down Pole Line Road. The course is configurable for an Elevation Stabilization Course in accordance with International Test Operations Procedure (ITOP) 03-2-836 (1.3.2.2)[12] which consists of a series of trapezoidal metal blocks that can be configured at specified positions on a straight, level compacted gravel road in a direct line with a stationary target. The layout of the elevation bump courses can be configured according to the performance of the stabilization system. The course is also configurable for Table V Gunnery in accordance with Field Manual (FM) 3-20.21[13] with 14 radio controlled stationary infantry targets (SIT) shown in Figure 169, 2 moving infantry targets (MIT), 15 stationary armored targets (SAT) shown in Figure 170, and 2 moving armored targets (MAT). SAT and MAT targets are hit sensor capable for .50-cal up to 120-mm ammunition, and the SIT and MIT targets are hit sensor capable for small arms ammunition up to 25-mm. Target dimensions are in accordance with FM 17-12-7[14] and can be configured with an infrared (IR) signature and are multiple integrated laser engagement system (MILES) XXI adaptable. The characteristics of target pop-up and fall are programmable for firing scenarios. The range is not authorized for high explosive (HE) or depleted uranium (DU) munitions. A map of Combat Systems Direct Fire Range is shown in Figure 171.

Figure 169. Stationary Infantry Target (SIT) System.

Figure 170. Stationary Armor Target (SAT) System.

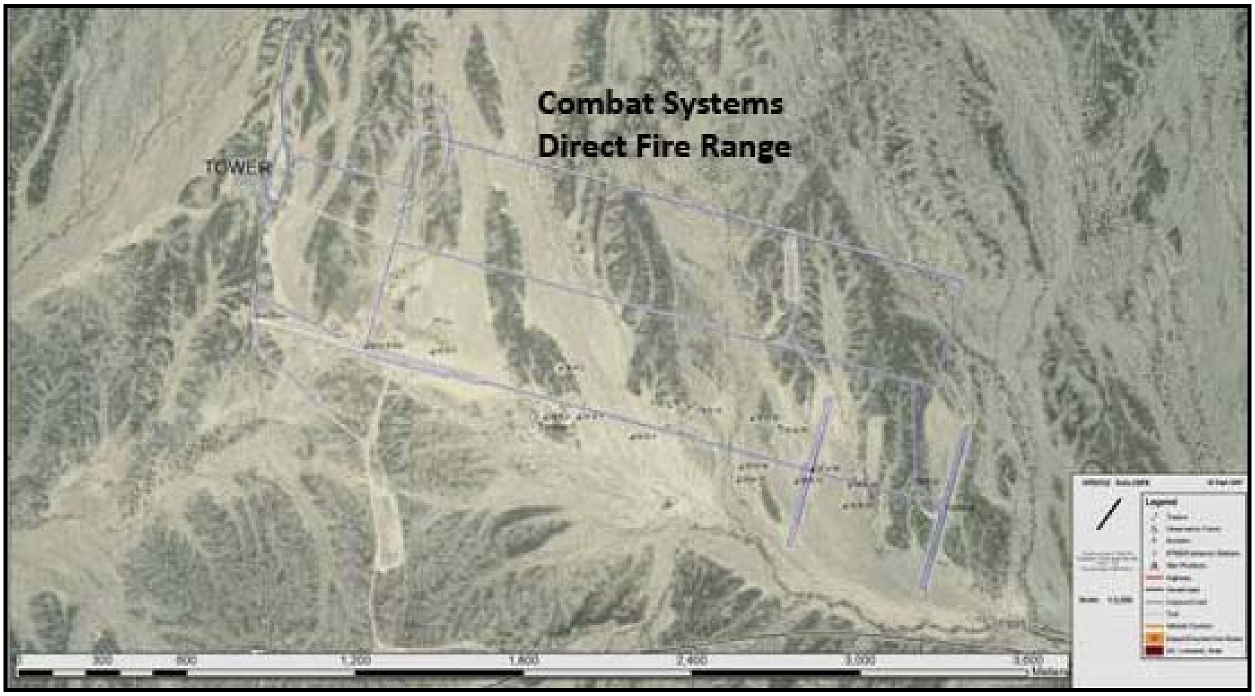

Figure 171. Combat Systems Direct Fire Range map.

b. Moving Target Range. The Moving Target Range consists of two remote controlled rail-mounted carriers equipped with pop-up targets (cloth or plywood) up to 3 m by 6 m (10 ft by 20 ft) which are capable of speeds of 32 kph (20 mph). In addition, the rail mounted carriers can be equipped with a 6 m x 6 m (20 ft x 20 ft) moving armored target with the Oehler acoustic scoring system capable of speeds of 18 kph (11 mph). Both configurations can be used to test ground vehicle mounted direct fire weapons at ranges of to 1500 or 2500 m (to 0.9 or 1.6 mi), depending on which target line is utilized. A characteristic photograph of the two targets is shown in Figure 172.

Figure 172. Remote controlled rail-mounted carriers equipped with pop-up targets and an Oehler acoustic scoring system target.

3.5 Yuma Test Center Test Facilities.

a. Rain and Blowing Rain Facility. This facility provides rain and blowing rain testing capabilities that comply with specifications set forth in MIL-STD-810G (procedures I and II). The facility simulates static and wind-driven rain and high winds for testing the adequacy of military equipment against the effects of wet weather and near-hurricane conditions. The facility consists of 580 adjustable nozzles (with a pressure up to 275 kPa (40 psi)) that are capable of simulating rain on the top and sides of the item(s) under test. Wind-driven rain can be simulated via a movable machine that produces up to 80 km/hr (50 mph) simulated wind. The rainfall rate per hour may be adjusted to the specific needs of the test. The facility is 6.1 meters wide by 12.2 meters long by 4.1 meters high (20 ft wide by 40 ft long by 13.5 ft high). The chamber has a 9.6 meter wide by 5.5 meter high (31.5 ft wide by 18 ft high) door. The facility does not provide for temperature conditioning so testing is performed under ambient conditions. Figure 173 shows a vehicle under test in the Rain Facility.

Figure 173. Vehicle inside Rain and Blowing Rain Facility.

b. Blown Air Dust and Sand System (BADSS). The BADSS is an environmental simulation apparatus available as alternative to dust chamber testing as described in MIL-STD-810G, Method 510.5, and compliant with the specifications provided in TOP 01-2-621[15]. Testing is generally performed in order to assess the effectiveness of protective covers, cases, and seals; the effectiveness of intake filters; the effects of sand or dust accumulation on the test item and any physical deterioration that may result; and the capability of the test item to satisfy its performance requirements after exposure to the sand and dust environment. It should be noted that the BADSS system is for the static assessment of dust exposure, and should not be confused with dynamic sand and dust testing (e.g. vehicle in motion), described in TOP 02-2-819[16]. The BADSS is comprised of a 6-foot diameter fan with flow guide, and particulate feed mechanism, mounted on a two-axle trailer. Figure 174 shows the BADSS system in use. The BADSS is capable of producing wind speeds in excess of 60 mph, with sufficient capacity to perform 90-minutes of uninterrupted testing with an adjustable material feed rate. The BADSS is capable of blown dust densities in excess of the 2.2 grams per square meter (g/m^2) required by MIL-STD-810G.

Figure 174. BADSS System (right) and system under test (left).

c. Load Handling System (LHS) Simulators. The LHS Simulators are located in Building 2090 and have the capability to perform load/unload cycles with a fully loaded (16,400 kg or 36,250 lb) flatrack. The simulators have two 1.5 m (5 ft) hydraulic cylinders that power the LHS hook arm, and two 2.1 m (7 ft) hydraulic cylinders that power the main arm. The hydraulic system is run from electric motors connected to the building electrical system. The simulator can be operated from the control panel or by using the remote control box. One of the two LHS Simulators is shown in Figure 175.

Figure 175. LHS Simulator.

d. Environmental Chamber with Weapons Firing Capabilities. The weapons firing environmental chamber is able to simulate environmental testing while maintaining the ability to directly and indirectly fire artillery weapons (up to 8 inches) at various quadrant elevations (up to 60 degrees) while being subjected to high or low extreme temperatures and humidity. The facility can also be closed and utilized as a hot or cold environmental chamber for items without weapons firing capabilities. The facility's Virtual Private Network (VPN) allows remote access to the control site, resulting in 100 percent monitoring even when personnel are not on-site. Extensive instrumentation and monitoring capabilities record the test item's performance throughout the full range of operation, including the ability to measure downrange performance of projectiles with ballistic cameras and radar.

(1) The chamber can host a wide variety of test vehicles and items including remote piloted vehicles, artillery, direct fire systems, tactical wheeled and tracked vehicles, and helicopters. The chamber can attain temperature and humidity combinations from -54 to +71 ºC (-65 to +160 ºF) and 5 to 95 percent relative humidity (RH) to simulate worldwide conditions. The hot and dry settings can reach up to +71 C (+160 ºF) with less than 5 percent RH and hot and humid up to 71 ºC (+160 ºF), with up to 95 percent RH. Extreme Cold can reach down to -54 ºC (-65 ºF). The chamber dimensions are 13.7 m long by 8.8 m wide by 4.4 m high (45 ft x 29 ft x 14.5 ft), with the height measured at the center of the chamber. The floor area is 7 m wide by 14 m long (23 ft x 45 ft), with an access door opening to the chamber of 5.2 m wide by 4.0 m high (17 ft x 13.2 ft), and the firing port is 1.2 m wide (4 ft).

(2) All calibers of direct and indirect fire weapons systems can be fired through full range of quadrant elevations to maximum ranges of 60,000 meters). Weapons may be directly or

indirectly fired from inside the facility with 1 to 60 degrees of quadrant elevation. Figure 176 shows the exterior and a vehicle inside the Weapons Firing Chamber.

Figure 176. Exterior view (left) and vehicle inside the Weapons Firing Chamber (right).

e. Large Multipurpose Environmental Chamber (LMPEC). The LMPEC Chamber shown in Figure 177 is equipped with the chassis dynamometer which provides the unique capability of conducting simulated vehicle, weapon, and soldier system operation tests under extreme climatic conditions. The chamber also provides controlled climatic conditions for firing and functional testing of weapon systems up to 40-mm. Stationary testing of vehicles and equipment may also be conducted at required extreme temperatures/humidity parameters and tests include performance, reliability and durability. The chamber is equipped with a digital, programmable, and record management capable control system.

Figure 177. Outside view of LMPEC (left) and view into LMPEC
from access door opening (right).

(1) The LMPEC can achieve temperature-humidity combinations from -54 to +71 ºC (-65 to +160 ºF) and 5 to 95 percent humidity to simulate worldwide conditions from the one

extreme to the other. Figure 178 shows the chamber during extreme cold testing. The LMPEC can achieve hot/dry up to 71 ºC (+160 ºF) with less than 5 percent relative humidity, and hot/humid up to +71 ºC (+160 ºF) with up to 95 percent relative humidity. The LMPEC can achieve extreme cold down to -54 ºC (-65 ºF), and can operate with humidity at +48 ºC (+120 ºF) up to 100 percent. The LMPEC provides a transition environment which separates ambient air from chamber temperatures, and provides one additional chamber unit for conditioning other material to be included in test.

Figure 178. Test vehicle operating on the chassis dynamometer at -32 ºC (-26 ºF).

(2) The LMPEC is equipped with a chassis dynamometer, as shown in Figure 178, with a unique ten roller system that can handle a maximum vehicle weight up to 11,300 kg (25,000 lb) per axle, and can accommodate wheel bases up to 8.3 m (27.4 ft) from axle to axle. The rollers allow for repositioning from 134 to 157 cm (53 to 62 in.) from the center of the adjacent double roll set, for a total possible variation of 22.8 cm (9 in.). Vehicles may be tested at speeds up to 105 kph (65 mph) under controlled environmental conditions with a power absorption capability up to 373 kW (500 hp).

(3) In addition, the LMPEC has an adjustable firing port to accommodate the required elevation of the test item, and is capable of firing weapons up to 40-mm caliber out of the firing port. The chamber is 13.1 m long by 6.1 m wide by 3 m high (43 ft x 20 ft x 10 ft), with an access door opening of 5.1 m long by 3.9 m high (17 ft x 13 ft), and a firing port of 1.2 m wide by 2.4 m high (4 ft x 8 ft). The additional conditioning chamber is 1.8 m long by 1.8 m long by 2 m high (6 ft x 6 ft x 6.6 ft).

f. Climatic Simulation Facility. This facility enables YTC to perform a variety of environmental tests to individual vehicle components or equipment to the standards of the national and international Military Standards. These tests simulate the effects of a variety of environmental extremes and climatic conditions, and the facility is customizable to meet any specific requirements. Table 8 lists the different chambers at this facility and their specifications. Figure 179 shows the Climatic Simulation Facility. Figure 180 shows a test item after climatic icing test and Figure 181 shows a test item after climatic fog testing.

TABLE 8. CLIMATIC SIMULATION FACILITY SPECIFICATIONS.

CHAMBER TYPE	NO. OF CHAMBERS	TEMPERATURE AND HUMIDITY RANGE	DIMENSIONS
Hot/cold with humidity	4	-57 to +82 ºC (-70 to +180 ºF) Up to 100 percent humidity	3 m (L) x 2.1 m (W) x 2 m (H) (10 ft (L) x 7 ft (W) x 6.5 ft (H)) (3 chambers) 1.2 m (L) x 1.2 m (W) x 2 m (H) (4 ft (L) x 4 ft (W) x 6.5 ft (H)) (1 chamber)
Hot with humidity	6	+4 to +82 ºC (+40 to +180 ºF) Up to 100 percent humidity	3 m (L) x 2.1 m (W) x 2 m (H) (10 ft (L) x 7 ft (W) x 6.5 ft (H)) (5 chambers) 1.2 m (L) x 1.2 m (W) x 2 m (H) (4 ft (L) x 4 ft (W) x 6.5 ft (H)) (1 chamber)
Cold chamber without humidity	1	-57 degrees ºC (-70 degrees ºF)	NA
Hot/cold without humidity chamber	2	-54 to +63 ºC (-65 to +145 ºF)	3 m (L) x 2.1 m (W) x 2 m (H) (10 ft (L) x 7 ft (W) x 6.5 ft (H)) (1 chamber) 1.2 m (L) x 1.2 m (W) x 2 m (H) (4 ft L x 4 ft (W) x 6.5 ft (H)) (1 chamber)
Altitude chamber	1	Simulates up to 30,480 m (100,000 ft) Can be used as a cold box with a temperature range of -57 to +74 C (-70 to +165 F)	1.8 m (L) x 1.5 m (W) x 1.5 m (H) (5.7 ft (L) x 5 ft (W) x 5 ft(H))
Salt fog chamber	1	+35 ºC only (+95 ºF)	1.5 m (L) x 1.5 m (W) x 1.5 m (H) (5 ft (L) x 5 ft (W) x 4.8 ft (H))
Immersion (leak) tank	1	NA	Capacity of 113 L (4 cu ft)
Solar chamber	1	Combined solar, temperature and humidity Full solar spectrum (280 to 3000 nm wavelength) +4 to +82 ºC (+40 to 180 ºF), with 5 to 95 percent relative humidity	2.4 m (L) x 2.4 m (W) x 3.4 m (H) (8 ft (L) x 8 ft (W) x 11 ft (H)) room with approximately 0.46 sq meters (5 square feet) of test space

Figure 179. Component level climatic chambers.

Figure 180. Test item after climatic icing test.

Figure 181. Test item after climatic salt fog testing.

g. Material Analysis Laboratory. YTC's Material Analysis Laboratory has over 650 square meters (7,000 square feet) of internal air-conditioned laboratory and office space with both refrigerated and non-refrigerated external chemical storage space. A mobile van may be utilized for toxic fume gas analysis on site. Equipment is available for determining the physical and chemical properties of a wide variety of materials. The laboratory has an internal local area network (LAN) linking major equipment to the Laboratory Information Management System (LIMS) where laboratory data is stored.

(1) The chemical labs are located on the Cibola Range. Foremost among the laboratory test capabilities are the analysis of petroleum, oil, and lubricants (POL) and coolants, including such analytical techniques as wear metal, kinematic viscosity, carbon residue, sulfated ash, diesel fuel dilution, oil in fuel, closed cup flash point, American Petroleum Institute (API) gravity, water by distillation, water by Karl Fisher titration, total base number, free water, water reaction with fuel, sediment content, fuel distillation, coolant freezing point, low temperature characteristic, cloud point, arid pour point, low temperature pumping viscosity, sulfur content, insolubles, and particle counting in fluids analyses.

(2) Additional capabilities included analytical techniques such as Fourier Transform Infrared (FT-IR) spectroscopy, Energy Dispersive X-ray Fluorescence (ED-XRF) spectroscopy, granite furnace/flame Atomic Absorption (AA) spectroscopy, Inductively Coupled Plasma Mass Spectroscopy (ICP-MS), Ultraviolet/Visible (UV/NIS) spectroscopy, Gas Chromatography (GC), High-Performance Liquid Chromatography (HPLC), pH measurement of aqueous solutions, conductivity measurement of aqueous solutions, and melting point determination. The chemical laboratory is shown below in Figure 182 while Figures 183 through 186 show laboratory equipment contained within the facility.

Figure 182. Material Analysis Laboratory.

Figure 183. Spectroil rotating disk optical emission spectrometer used for wear metal analysis (left) and CAV2000 automatic viscometer used for measuring kinematic viscosity (right).

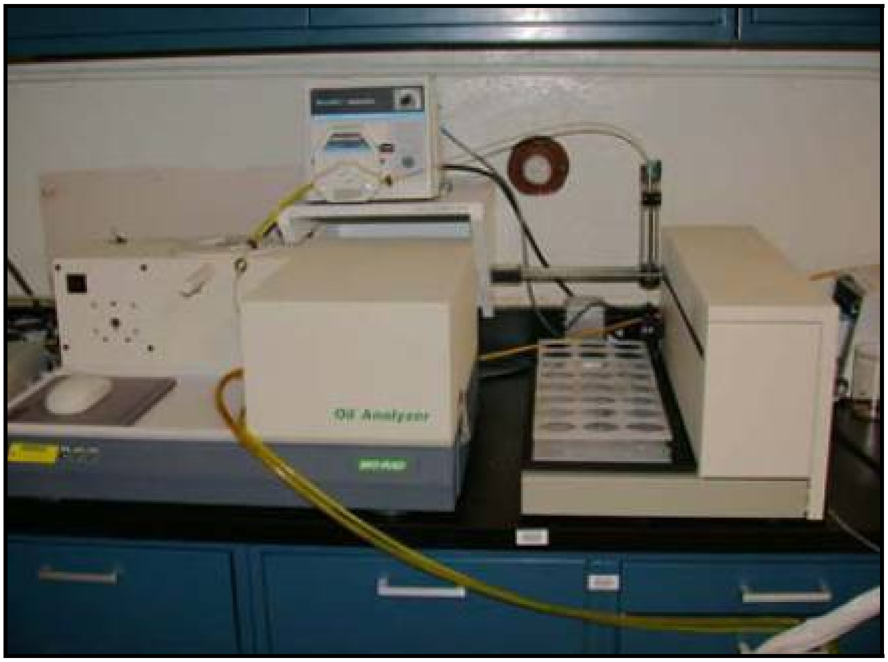

Figure 184. Advanced oil analyzer platform Fourier Transform Infrared Spectrometer used for molecular analysis of lubricants and hydraulic fluids.

Figure 185. Gas chromatograph with turbomatrix heads pace sampler used to measure diesel fuel dilution.

Figure 186. Automatic distillation unit used to measure fuel distillation (left) and automatic cloud and pour point used to measure low temperature characteristics (right).

h. Starter Test Stand. The ST-24 computerized starter tester checks automotive starters simulating real working conditions of the vehicle, analyzing the device timing to detect solenoid, drive and spring problems. The test stand is shown in Figure 187. During the test, the ST-24 automatically recognizes the starter rotation direction and applies a programmable load. The ST-24 returns the mechanical energy produced from the starter back to the power supply to reduce power consumption. The built in separate power supply for the starter and for the solenoid allows the solenoid function to be testing at a programmable reduced voltage during the test. The ST-24 is able to scan in a set of programmable points for the performance curve in less than 10 seconds, increasing the accuracy and decreasing result variation caused by temperature. The ST-24 provides a precise waveform analysis for accurate armature and commutator diagnostics and has the capability to check the results against preset limits and generate a programmable output report.

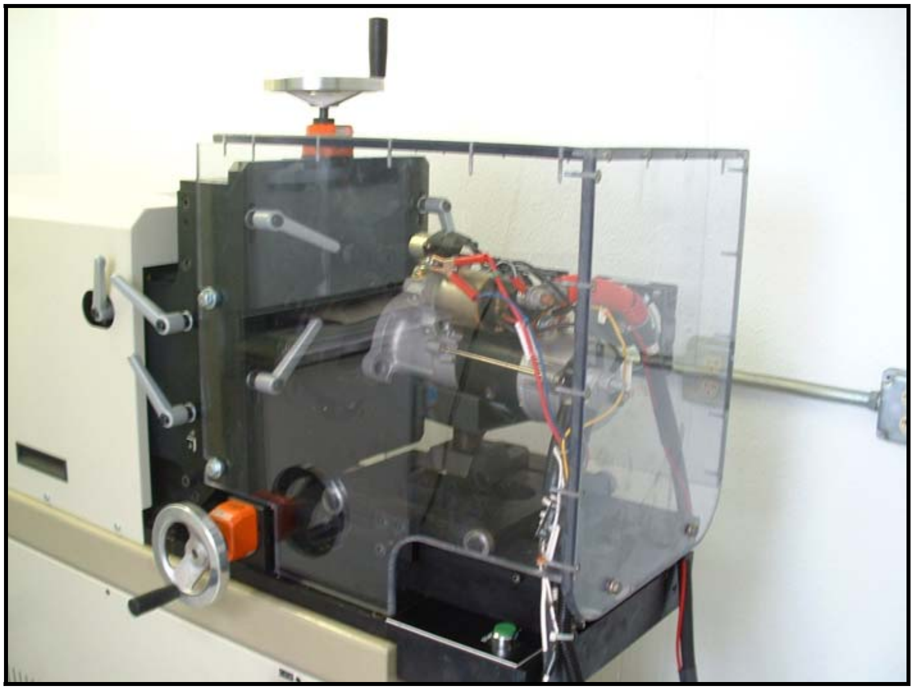

Figure 187. ST-24 starter test stand.

i. Tire Maintenance Facility. The tire maintenance facility provides equipment for the servicing of tires, including vehicle wheel alignment and tire balancing. The tire testing facility has two run flat machines capable of installing and removing run flats inserts from tires, a tire spreader for exposing tire defects, a tire inflation cage for safely inflating tires, two tire changing machines, and a computerized wheel balancer. In addition, the tire testing facility can measure the ground pressure footprint from a vehicle's tires.

j. Tire X-ray Facility. The Tire X-ray Facility has the capability to perform real time x-ray inspections on tires using the LumenX 1027B Inspection System as shown in Figure 188. The LumenX 1027B Inspection System is an automated PLC based on-line production machine designed to inspect passenger, truck, bus, and heavy equipment tires, bead to bead. The system allows the inspection of all tire construction parameters such as body ply cord spacing and turn ups, chamfer height, belt step-off and splice, and concentricity of bead bundles.

Figure 188. Tire Test Facility, overall (left) and Closeup Inspection Chamber (right).

k. Hybrid Electric Facility. The Hybrid Electric Facility allows for testing of hybrid electric vehicles and onboard power generation systems. The facility is equipped with an AV 900 load bank tied into the electrical grid as well as a smaller ABC 150 load bank. Numerous portable DC and AC load banks are available for onboard vehicle installation as well. The load banks allow for power absorption up to 250 kW, and accommodate up to 900 Volts direct current (DC) and current ranges up to 1000 amps. Extensive instrumentation to load and record the DC power and alternating current (AC) power circuits are available. The facility and AV 900 load bank system are shown in Figure 189.

Figure 189. Hybrid Electric Facility (left) and AV900 Load Bank (right).

l. Vibration Facility. The vibration test facilities are used to improve the reliability of military hardware, avionics instrumentation, and automotive components on a subsystem level. The vibration facility has six electrodynamic vibration systems available for testing, with two shown in Figure 190. All vibration test systems are controlled from remote data acquisition and processing centers capable of immediate data anaylsis for test control. The capabilities include various tests that specify sine random, shock, sine-on-random, random-on-random, and other complex waveforms as well as replicating data that are collected for real world conditions. Testing is conducted in accordance with national and international Military Standards. Custom vibration testing may also be supported.

Figure 190. T4000 Vibration Chamber (left) and T5000 Vibration Chamber (right).

m. Physical Test Facility. The Physical Test facilities at YTC are comprised of four major areas: physical measurements, non-destructive inspections, material properties testing, and mass properties measurements. The Physical Test facilities include a 30-inch optical comparator, a Faro laser tracker, a multi-sensor coordinate measuring machine, a high precision coordinate measuring machine for cannon gun tube measurement and inspection (173 cm (68 in.) long by 302 cm (119 in.) wide by 279 cm (110 in.) high). The Physical Test facilities are equipped with load cells capable of measuring from 9 to 445,000 N (2 to 100,000 lbf), a large capacity 711 kN (160 klbf) Universal Testing Machine, and a small capacity 55 kN (12.5 klbf) Universal Testing Machine. The physical test area includes a level concrete pad, a 136,000 kg (300,000 lbs) capacity platform scale, and mobile cranes up to a 63,500 kg (140,000 lbs) capacity.

n. Site 3 Drop Test Facility. The Site 3 Drop Test Site hosts a 9 m (30 ft) drop test tower that is capable of dropping up to 453 kg (1000 lb) from varying distances up to a maximum height of the tower which can be used for vehicle component level test or for test of vehicle transported equipment as shown in Figure 191. Three different surfaces can be selected from, to drop onto, including 7.6 cm (3 in.) of steel above 61 cm (24 in.) of concrete; 7.6 cm (3 in.) of steel above compacted earth; and a concrete steel mixture. An additional anvil top can be applied to any of the three aforementioned surfaces that consist of a 2.5 cm (1 in.) layer of iron aggregate attached to 30.5 cm (12 in.) of concrete. Three digital video recorders are available to capture the test from separate angles and a digital video disc of the test can be provided. Two environmental chambers are available for conditioning items with interior dimensions of 2 m (7 ft) wide, 2 m (7 ft) high, and 4.1 m (13.5 ft) deep. One of these chambers is used for cooling and is capable of cooling to-62 ºC (-80 ºF). The second chamber is used for heating and is capable of reaching temperatures in excess of 74 ºC (165 ºF).

Figure 191. Site 3 Drop Tower and inspection conex (left) with aerial view of Site 3 (right).

o. 12 Meter Drop Test Facility. The 12 Meter Drop Test Facility, as shown in Figure 192, hosts an 18 m (60 ft) drop test tower that is capable of dropping up to 1,800 kg (4,000 lb) from varying distances up to a maximum of 18 m (60 ft). The drop surface consists of one pad with 7.6 cm (3 in.) thick steel (with a Brinell hardness of 269 – 311) above 61 cm (24 in.) of concrete above 46 cm (18 in.) of crushed stone. Two digital video recorders are available to capture the test from separate angles and a digital video disc of the test can be provided. Two environmental chambers are also available at this site for conditioning items, with interior dimensions of 2 m (7 ft) wide, 2 m (7 ft) high, and 2 m (7 ft) deep with capabilities that allow conditioning to -62 ºC (-80 ºF) or 74 ºC (165 ºF).

Figure 192. 12 Meter Drop Test facilities.

3.6. Yuma Test Center Maintenance Facilities.

a. Operations and Maintenance Division Complex. This complex is centrally located to the primary automotive test areas. The facilities sit on a fenced 52,600 square meter (13 acre) compound with lighting for parking of test and fleet support vehicles, and to setup and conduct of tests of individual and troop support equipment such as shelters. The facility contains 891 square meters (9,600 square feet) of lighted work area with adjacent offices, support shops, and tire repair area. There is a complete tool room and supply function on-site. A fleet of host and test support vehicles including several types of tactical trucks, M88A1 Recovery Vehicles, M113 Personnel Carriers, tractor-trailer combinations for transport and recovery of test vehicles, generators, and other support equipment. The storage yard holds a 4,500 L (1,200 gal) fuel station for storing and dispensing test fuels, and 30 connex storage units measuring 2.4 m by 2.4 m by 6 m (8 ft by 8 ft by 20 ft), for storing dedicated test items, system support packages, and residue. Test and support facilities located adjacent to the complex include a 136,000 kg (150 ton) platform scale, tilt table, and test vehicle wash rack.

b. Main Test Maintenance Facility. The largest building on YTC, which is located on Kofa Firing Range, covers approximately 8,300 square meters (90,000 square feet). Maintenance is performed on tactical vehicles (wheeled and tracked), direct fire vehicles, and weapons systems in the southern three-quarters of the building. There are three large bays, two of which are served with overhead traveling cranes. There is a 36,000 kg (40 ton) and three 9,000 kg (10 ton) cranes. The repair of approximately 30 vehicles can be accommodated simultaneously. Compressed air is available to operate multiple air tools and a chassis lift. A unit supply section maintains bench stock, shop stock, and test system support packages; along with a tool room, it supports both the vehicle and artillery maintenance functions within the shop. Common shop tools, such as cutting torch, grinder, hydraulic press, drill press, and injector testers are available for issue to all personnel using the shop. The shop also has access to 208 VAC 3-phase and 440 VAC 3-phase power. An air-conditioned office space and break room are incorporated; however, the main work area is cooled with evaporative coolers, because some of the seven large electrically operated doors are frequently opened. An approximately

12 m (40 ft) wide concrete apron encircles the building. A wash rack with a steam cleaner, an outside shade area for work on approximately four test vehicles, a large 11,300 square meter (2.8 acre) asphalt-covered storage yard with lockable connex containers, a loading dock, an oil and fuel drum holding area, and over 2,200 square meters (5 acres) of gravel parking lot comprise the rest of the facility.

c. Ancillary Test Maintenance Facility. The facility is located adjacent to the main test maintenance facility on Kofa Firing Range. The facility provides organizational and direct support level maintenance and inspections for tactical vehicles, commercial light, medium, and heavy duty vehicles as well as emergency response and construction grade vehicles and cranes. The facility has access to parts management and storage areas as well as a secure storage area. The shop floor is cooled with an evaporative cooling system in the ventilated indoor work bays. The shop contains nine work bays in a 22 m by 113 m (72 ft x 371 ft) area of the facility. There is access to an 18,100 kg (20 ton) and 36,200 kg (40 ton) overhead crane. The shop features access to 208 VAC 3-phase power and has six portable axle/wheel lifts with a combined 40,800 kg (90,000 lb) lift capacity. A separated section of the facility offers offices, conference rooms, and staff office for maintenance and parts management personnel.

d. MT Test Maintenance Facility. This maintenance facility is located on the Cibola Range. The shop has full maintenance capabilities and equipment. There are six shop bays available that can support up to six test vehicles and two load handling systems. The shop features one 22,600 kg (25 ton) overhead crane, one 4,500 kg (5 ton) overhead crane, and eight portable axle/wheel lifts with a combined 54,400 kg (120,000 lb) lift capacity.

e. Welding and Metal Shop Facility. The Welding and Metal facility is located in the west side of the ancillary maintenance facility, and features full machine, fabrication, and welding support in a 5,417 square meters (58,310 square foot) facility. The welding and metals shop facility provides custom metal payloads for both wheeled and track vehicles to meet their test mission weight requirements as well as support vehicle modifications and repairs.

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APPENDIX A. ABBREVIATIONS.

AA	Atomic Absorption
ABS	anti-lock brake system
AC	alternating current
API	American Petroleum Institute
APG	Aberdeen Proving Ground
ATC	US Army Aberdeen Test Center
ATEF	Automotive Technology Evaluation Facility
ATTB	Aircraft Transportability Test Bed
BADSS	Blown Air Dust and Sand System
BLM	Bureau of Land Management
C	Celsius
cfm	cubic feet per minute
CISPR	Comite International Special de Perturbations Radioectriques
cm	centimeter
cmm	cubic meters per minute
CTA	Churchville Test Area
dB	decibel
DC	direct current
DoD	Department of Defense
DU	depleted uranium
ECU	electronic control unit
ED-XRF	Energy Dispersive X-ray Fluorescence
EMITF	Electromagnetic Interference Test Facility
ESC	electronic stability control
F	Fahrenheit
FCC	Federal Communications Commission
FM	Field Manual
ft	feet
FT-IR	Fourier Transform Infrared
g/m^2	grams per square meter
GC	Gas Chromatography
GHz	Gigahertz
GM	General Motors
GVW	gross vehicle weight

APPENDIX A. ABBREVIATIONS.

HBCT	Heavy Brigade Combat Team
HE	high explosive
hp	horsepower
HPLC	High-Performance Liquid Chromatography
hr	hour
HWTC	Hot Weather Test Complex
Hz	Hertz
ICP-MS	Inductively Coupled Plasma Mass Spectroscopy
in.	inch
IR	infrared
ITOP	International Test Operations Procedure
km	kilometer
km/hr	kilometer per hour
kN	kilonewton
kPa	kilopascal
LAAF	Laguna Army Airfield
LAN	local area network
lb	pound
LHS	Load Handling System
LIMS	Laboratory Information Management System
LMPEC	Large Multipurpose Environmental Chamber
LTTF	Lift and Tiedown Facility
LUGV	large unmanned ground vehicle
m	meter
MAT	moving armored target
MHz	Megahertz
mi	mile
MIL-STD	Military Standard
MILES	multiple integrated laser engagement system
MIT	moving infantry target
ml/hr	milliliter per hour
MOI	moment of inertia
MOUT	Military Operations on Urban Terrain
mph	miles per hour
MTA	Munson Test Area
MTS	moving target simulator

APPENDIX A. ABBREVIATIONS.

N	Newton
NA	not applicable
NaCl	sodium chloride
NATO	North Atlantic Treaty Organization
NHTSA	National Highway Traffic Safety Administration
PAAF	Phillips Army Airfield
POL	petroleum, oil, and lubricants
psi	pounds per square inch
PTA	Perryman Test Area
RAM	reliability, availability and maintainability
RH	relative humidity
rms	root mean square
RPC	remote parameter control
RWS	Roadway Simulator
SAE	Society of Automotive Engineers
SAT	stationary armored target
SIT	stationary infantry target
SNCTA	Scalable Net Centric Test Area
SUGV	small unmanned ground vehicle
TOP	Test Operations Procedure
TW	Trench Warfare
UGV	unmanned ground vehicle
USCS	unified soil classification system
UV/NIS	Ultraviolet/Visible
V/m	volts per meter
VDS	Vehicle Durability Simulator
VPN	Virtual Private Network
WES	US Army Waterways Experiment Station
YPG	Yuma Proving Ground
YTC	US Army Yuma Test Center

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