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MAPPING OF SELECTED ARSV TEST COURSES AT FORT KNOX, KENTUCKY, AND COMPARISON WITH OTHER SELECTED TERRAINS

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Army Engineer Waterways Experiment Station

Prepared for:

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by

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Two test courses (FKDC and FKNC) at Fort Knox, Kentucky, totaling approximately 37.4 miles of roads and trails that had been used for conducting vehicle tests with Armored Reconnaissance Scout Vehicles (ARSV's) and comparable vehicles, were mapped by techniques developed by the U. S. Army Engineer Waterways Experiment Station. The factors mapped were soil type, soil strength, topographic slope, obstacles, surface roughness, and visibility. Standing vegetation was not present on any of the trails. The study also included
(Continued)

20. ABSTRACT (Continued).

a limited comparison of the two test courses (FKDC and FKNC) with other Fort Knox terrains (FK1, FK2) and West Germany terrain (WGT). FK1, FK2, and WGT were mapped in previous studies on the basis of the single factors used to describe these test courses, i. e. soil strength, slope, surface roughness, obstacle magnitude, and visibility. It was concluded that the surface strengths of FKDC and FKNC are greater than those of FK1, FK2, and WGT. The slopes in FKDC and FKNC are similar to those in FK2 and WGT. The surface roughness and obstacle magnitude are greater in FKNC than in any of the other areas. The obstacle vertical magnitude factor classes are greater for FKNC than for FKDC or WGT. The visibility is somewhat similar and quite good in all the areas considered. Based on the five factors considered (soil strength, slope, surface roughness, obstacle vertical magnitude, and visibility), FKDC is more similar to WGT than is FKNC, and FKNC is more similar to FK2 than to FK1, FKDC, and WGT. It is recommended that the AMC-71 Mobility Model be used to compare speed performance of the ARSV vehicles and comparison vehicles over the test courses.

Preface

The study reported herein was conducted during August-September 1974 for the U. S. Army Materiel Systems Analysis Agency (AMSAA) by personnel of the U. S. Army Engineer Waterways Experiment Station (WES) under the general supervision of Messrs. W. G. Shockley, Chief, Mobility and Environmental Systems Laboratory (MESL); A. A. Rula, Chief, Mobility Systems Division (MSD), MESL; and E. S. Rush, Chief, Mobility Investigations Branch, MSD. The field data at Fort Knox were collected under the supervision of Mr. D. D. Randolph, Mobility Research and Methodology Branch, MSD, by Messrs. D. E. Andrews, C. D. Currie, D. E. Strong, and J. N. Peacock, WES, who also prepared the terrain factor complex maps of the selected Fort Knox terrain. The report was prepared by Mr. Randolph.

Acknowledgment is made to Mr. A. W. Criswell, U. S. Army Materiel Systems Analysis Agency, for his aid in analysis of data.

COL G. H. Hilt was Director of WES during the conduct of this study and preparation of the report. Mr. F. R. Brown was Technical Director.

Contents

Conversion Factors, British to Metric and Metric to British Units of Measurement

Birtish units of measurement used in this report can be converted to metric units as follows:

Multiply	By	To Obtain
	British to Metric	
inches	2.54	centimeters
feet	0.3048	meters
miles (U. S. statute)	1.6093	kilometers
square miles	2.58999	square kilometers
	Metric to British	
centimeters	0.3937	inches

MAPPING OF SELECTED ARSV TEST COURSES AT FORT KNOX, KENTUCKY, AND COMPARISON WITH OTHER SELECTED TERRAINS

Background

1. During July-August 1974, the Armored Reconnaissance Scout Vehicle (ARSV) Task Force conducted tests with ARSV's and comparable vehicles over two test courses at Fort Knox, Kentucky, one designated the "day course" (FKDC), over which tests were conducted during the day, and the other the "night course" (FKNC), over which tests were conducted at night. Each course consisted of several segments of trails or secondary roads. Some segments were linked together, and some were separated by segments of trails or roads that were not considered part of the test course.

2. The U. S. Army Materiel Systems Analysis Agency (AMSAA) asked the U. S. Army Engineer Waterways Experiment Station (WES) to prepare terrain maps for portions of each of the test courses, and to compare these test courses with selected Fort Knox and West Germany terrains investigated in a previous WES study.*

Purpose and Scope

3. The main purpose of this study was to describe the two test courses at Fort Knox (FKDC and FKNC) for ground mobility purposes, thereby acquiring data for use in the AMC Ground Mobility Model (AMC-71). A secondary purpose was to compare these courses with selected Fort Knox terrain (FK1 and FK2) and West Germany terrain (WGT) in terms of the most important road, trail, or terrain factors used to describe them.

4. Road or trail units for the two courses were established, sufficient data were collected to describe each unit in terms of road or trail factor classes, and road-trail factor complex maps and legends for the two courses were prepared. In addition distributions of factor

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* D. D. Randolph and C. A. Blackmon, "Terrain Analysis for the Armored Reconnaissance Scout Vehicle Test Program," unnumbered report, Mar 1974, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.

classes for each factor used to describe both courses were compiled. The test courses were compared with other Fort Knox and West Germany terrains (FK1, FK2, and WGT) in terms of the most important factors (same factors used to describe road, trails, and terrain). Terrain data used to characterize FK1, FK2, and WGT and the distribution of terrain factor classes used to describe these areas were available from previous studies.

Location of Test Courses

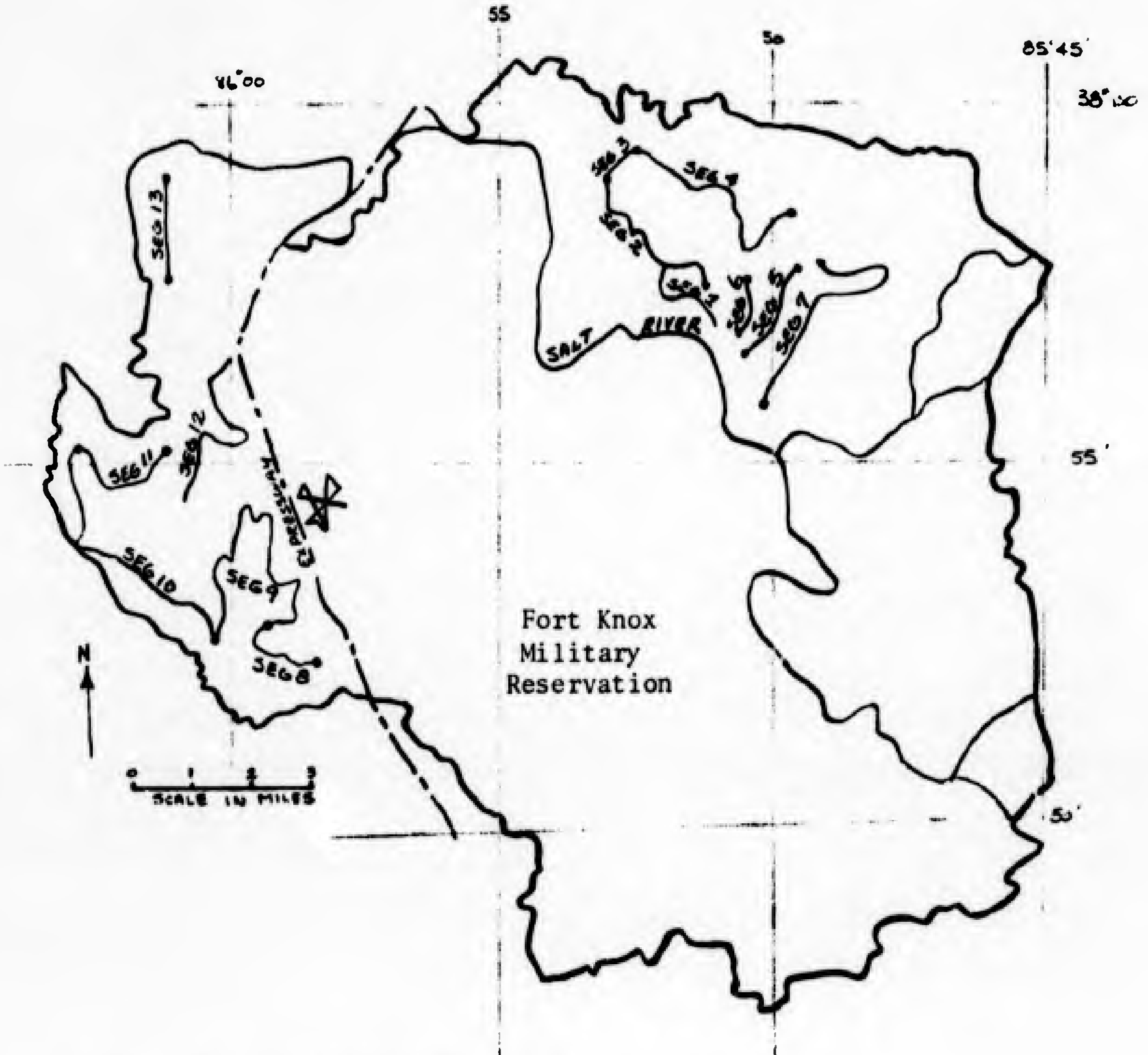
5. The day course (FKDC) is in the north-central portion of Fort Knox (fig. 1) and consists of trail or road segments 1-7. The night course (FKNC) is in the western portion of Fort Knox and consists of trail or road segments 8-13 (fig. 1). It is to be noted that some of the segments of the test courses are not connected. The reason for such a layout is not known.

Data Collection and Mapping Procedures

6. Data were collected between 15 and 24 August 1974. The test courses were divided into road and trail units on the basis of segments that appeared similar in that they could be described by the same group of terrain factor classes (table 1). During this period, data were collected in the road or trail units at 128 locations.

7. The procedures used to map each terrain factor were essentially the same as described in the report referenced previously.* Only the techniques used to map the visibility factor, recognition distance, were changed because of the effects of slope and curvature on the reduction of a driver's ability to recognize an oncoming vehicle or an obstacle along the courses. Visibility distances were measured by positioning two M151 vehicles on a curve or slope until the vehicles were just visible and the minimum distance between bumpers was recorded as the recognition distance. For sections of the course that contained both curves and short,

* Randolph and Blackmon, _Op. cit._, page 4.



NOTE: FKDC contains segments 1-7
FKNC contains segments 8-13

Fig. 1. Location of ARSV day course (FKDC) and night course (FKNC) at Fort Knox, Kentucky

straight portions, an average visibility factor, or recognition distance, was obtained by also considering visibility along the straight portions of the section.

Factor Complex Maps

8. Following data collection, factor complex maps were prepared for each of the test courses. The factor complex map for the day course (FKDC) is shown in fig. 2 and its legend is given in table 2. The factor complex map for the night course (FKNC) is shown in fig. 3 and its legend is given in table 3. Each map shows the segment number that the ARSV Task Force assigned to portions of the test course, and the location of each terrain unit with respect to each other terrain unit and to the entire test course. Each factor complex map unit legend contains an array of numbers that designate the class used to describe each factor. The range associated with each terrain factor class number is given in table 1. Since no vegetation was present on the test courses, class 1 was used to describe the vegetation stem spacing for each stem diameter. The use of class 1 to describe stem spacing will result in no effect on vehicle performance due to vegetation.

9. Distances for each trail or road unit of the day and night courses were measured and are given in tables 4 and 5, respectively.

10. By using the factor classes assigned to each trail or road unit and the length of each trail or road unit, distribution of terrain factor classes used to describe each trail or road factor was obtained for each test course. These distributions are given in table 6.

Comparison of Test Courses with Selected Terrains

11. The terrain selected for comparison with test courses FKDC and FKNC consisted of FK1 (location in the Salt River area of Fort Knox Military Reservation), FK2 (located in the Mill Creek area of Fort Knox Military Reservation), and WGT (located in the southwestern part of West

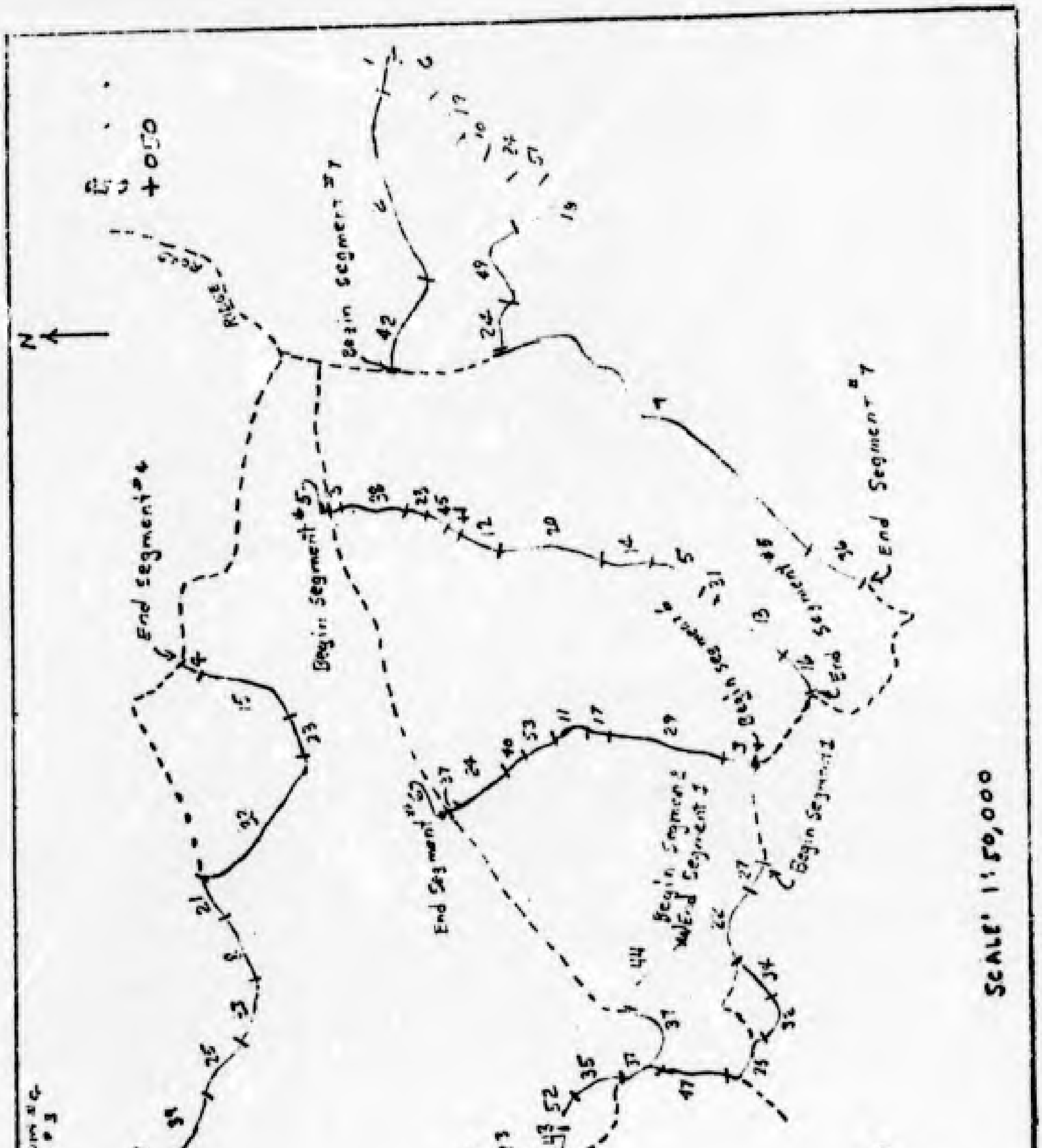


Fig. 2. Factor complex map of FKDC

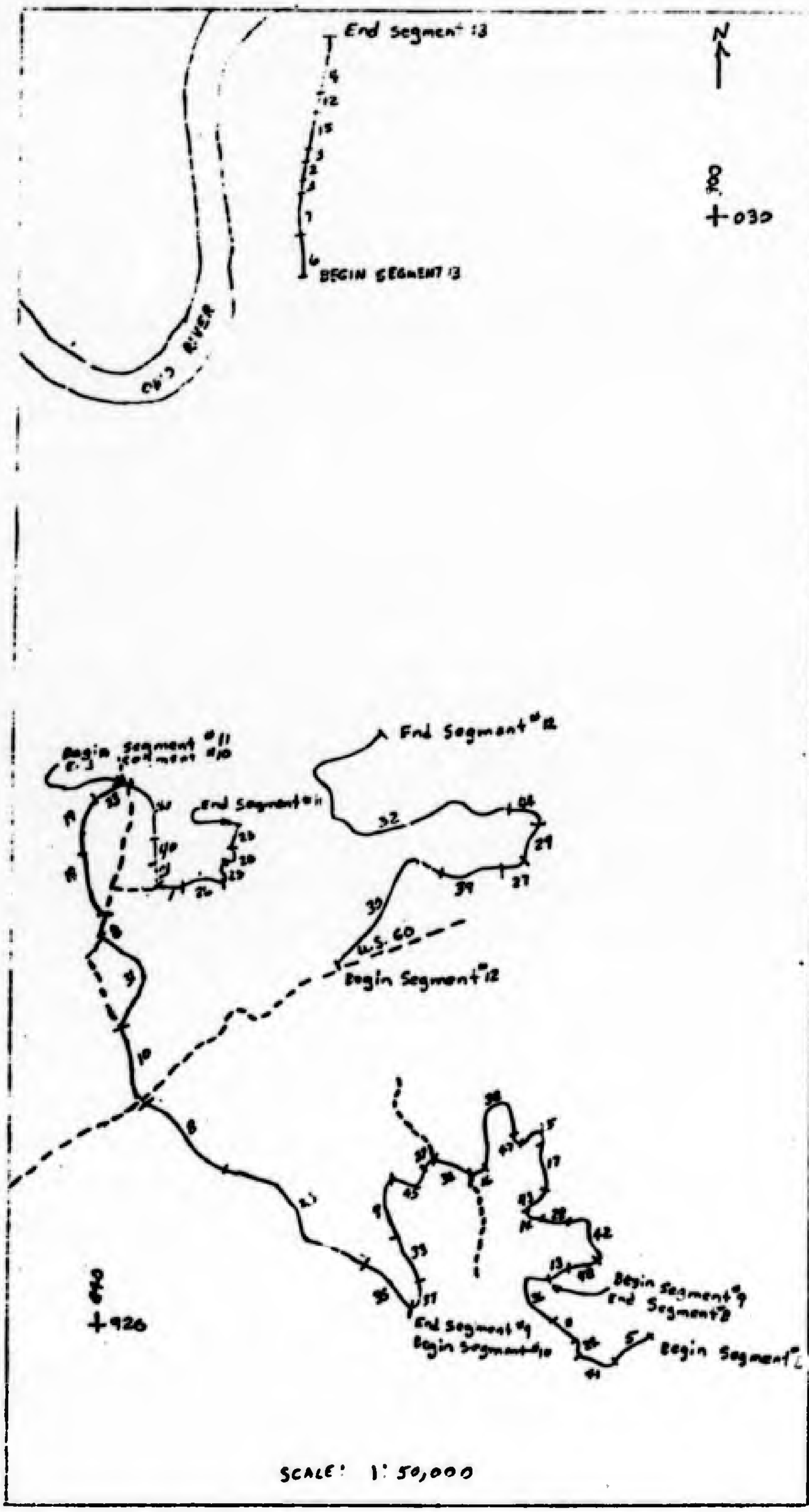


Fig. 3. Factor complex map of FKNC

Germany). FK1 contains 6.1 sq miles,* FK2 contains 4.7 sq miles, and WGT contains 60 sq miles. FKDC is 20.15 miles long and FKNC is 17.25 miles long.

12. The factor class distributions for each test course (FKDC and FKNC) were experessed as a percentage of the length of the test course, and the factor class distributions for each selected comparison terrain (FK1, FK2, and WGT) were experessed as a percentage of the area.

13. Comparison of the factors used to describe the test course and the selected terrains was limited to surface strength, slope, surface roughness, and obstacle height (figs. 4-8). Other obstacle factors, such as approach angle, width, spring, spacing, and type, and vegetation stem size-spacing factors are often confused when discussed separately; therefore, they were deliberately excluded from the comparison. However, it is worth noting that there was no standing vegetation on FKDC and FKNC.

Surface strength

14. As shown in fig. 4, both FKDC and FKNC contain the highest strength class (class 1) over their entire length. FK1, FK2, and WGT all show class values less than the highest class. Therefore, FKDC and FKNC definitely have stronger surface materials than the other study areas. The stronger surface material (soils) of the FKDC and FKNC trails may reflect the effect of repetitive traffic on trails, and improved surfaces on roads. The lower strenght in WGT may reflect the effect of farm cultivation, and in FK1 the presence of a high water table during March, when the Salt River was at a high water level.

Slope

15. The distributions of the slopes on FKDC and FKNC are very similar to those in WGT, as shown in fig. 5. The greatest differences are the higher percentage of class 1 slopes (0-2%) on FKDC and the higher percentage of slopes greater than class 5 (20%) on WGT, i.e. the West Germany slopes are slightly more severe. It should be noted, however, that the slopes on the FKDC were measured along trails that often had

* A table of factors for converting British units of measurement to metric units, and metric to British, is given on page 3.

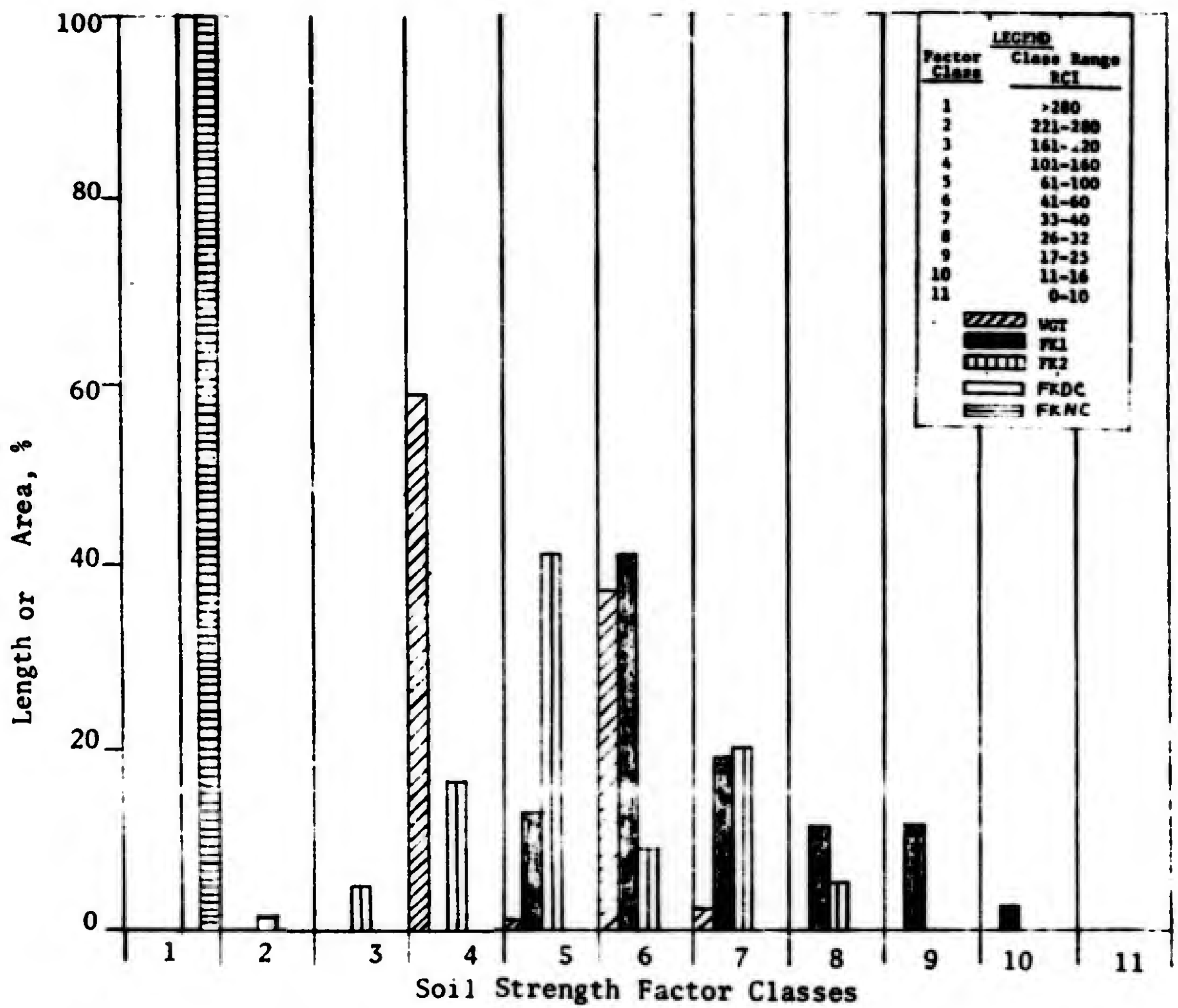


Fig. 4. Distribution of soil strength classes

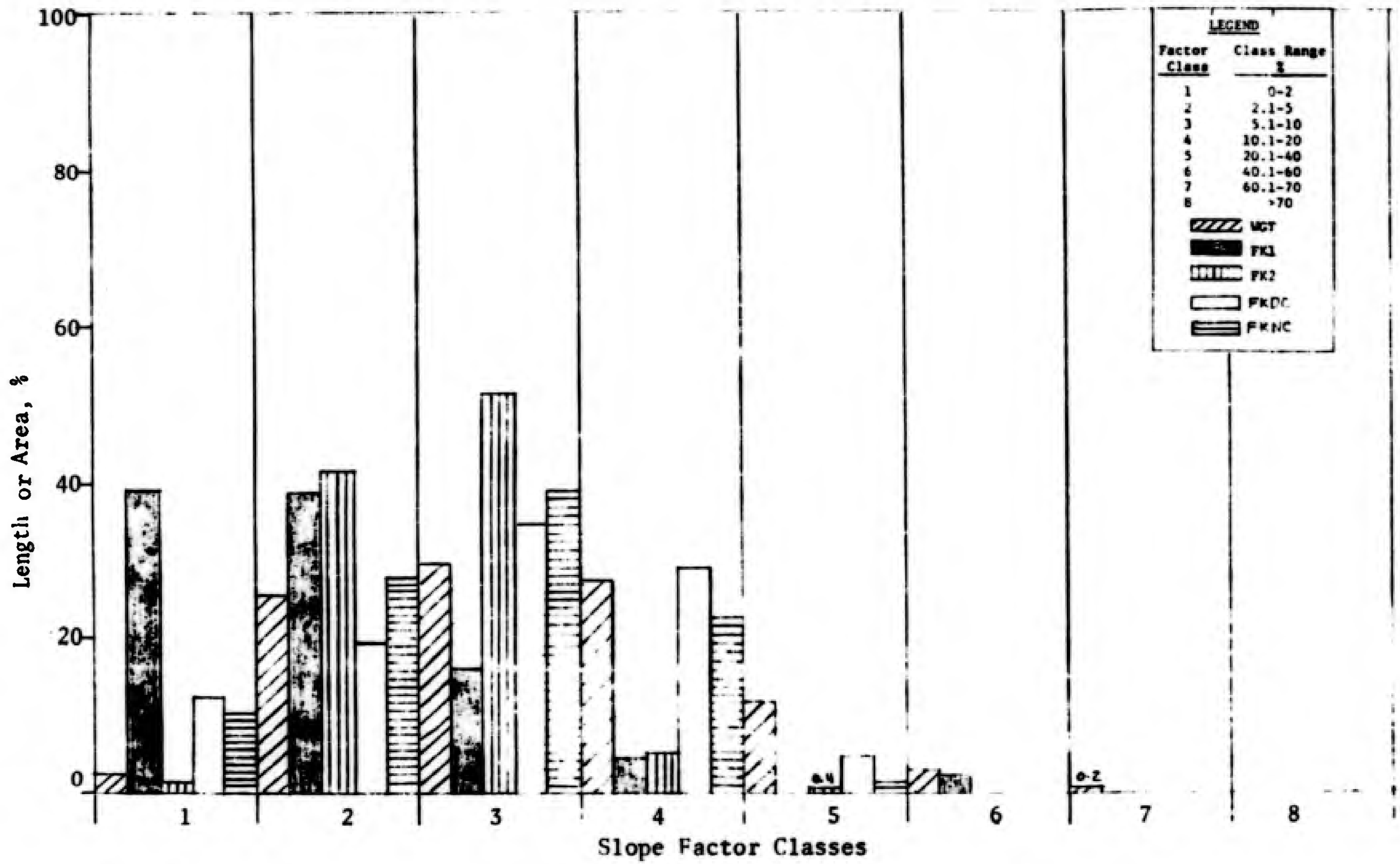


Fig. 5. Distribution of slope classes

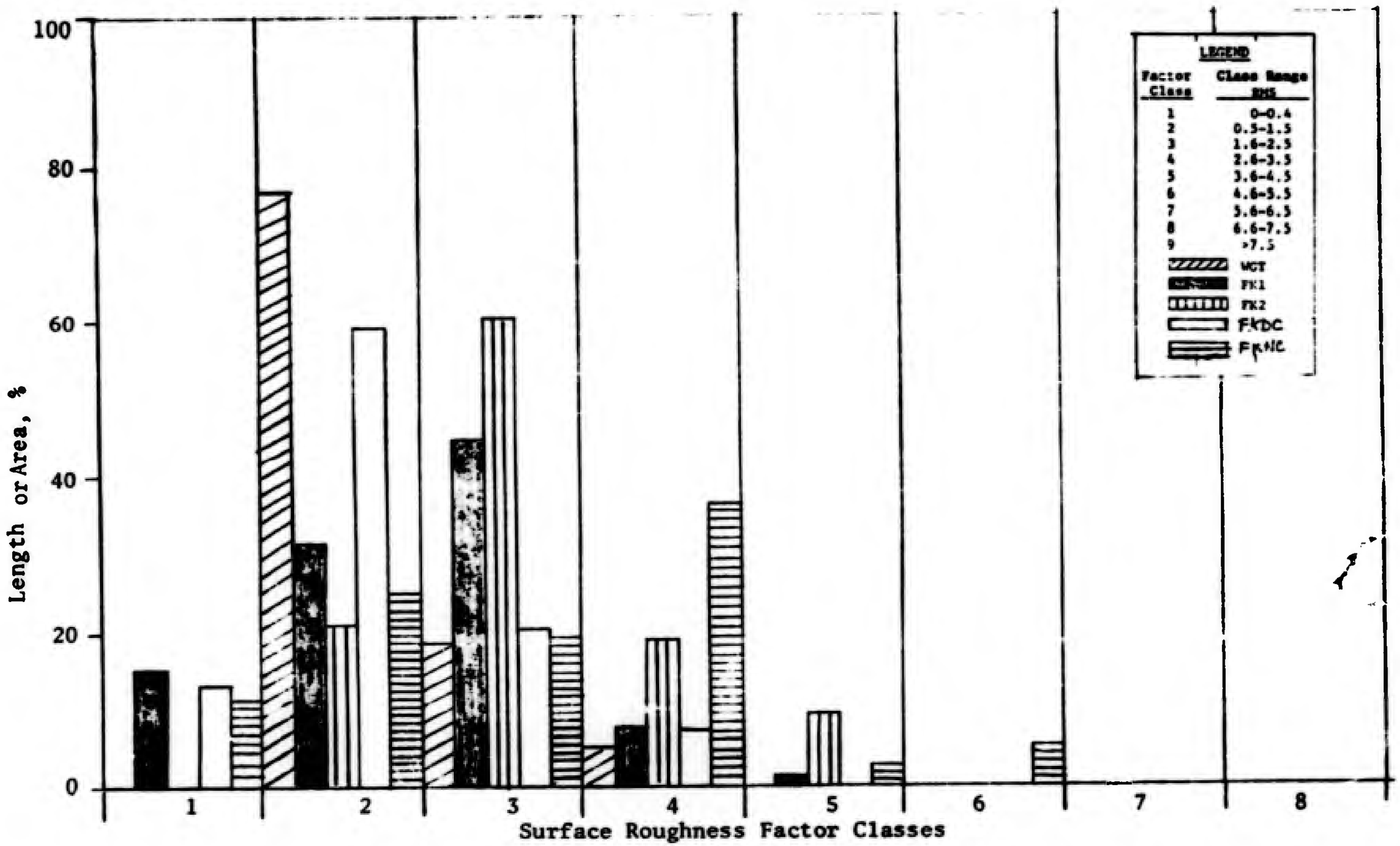


Fig. 6. Distribution of surface roughness classes

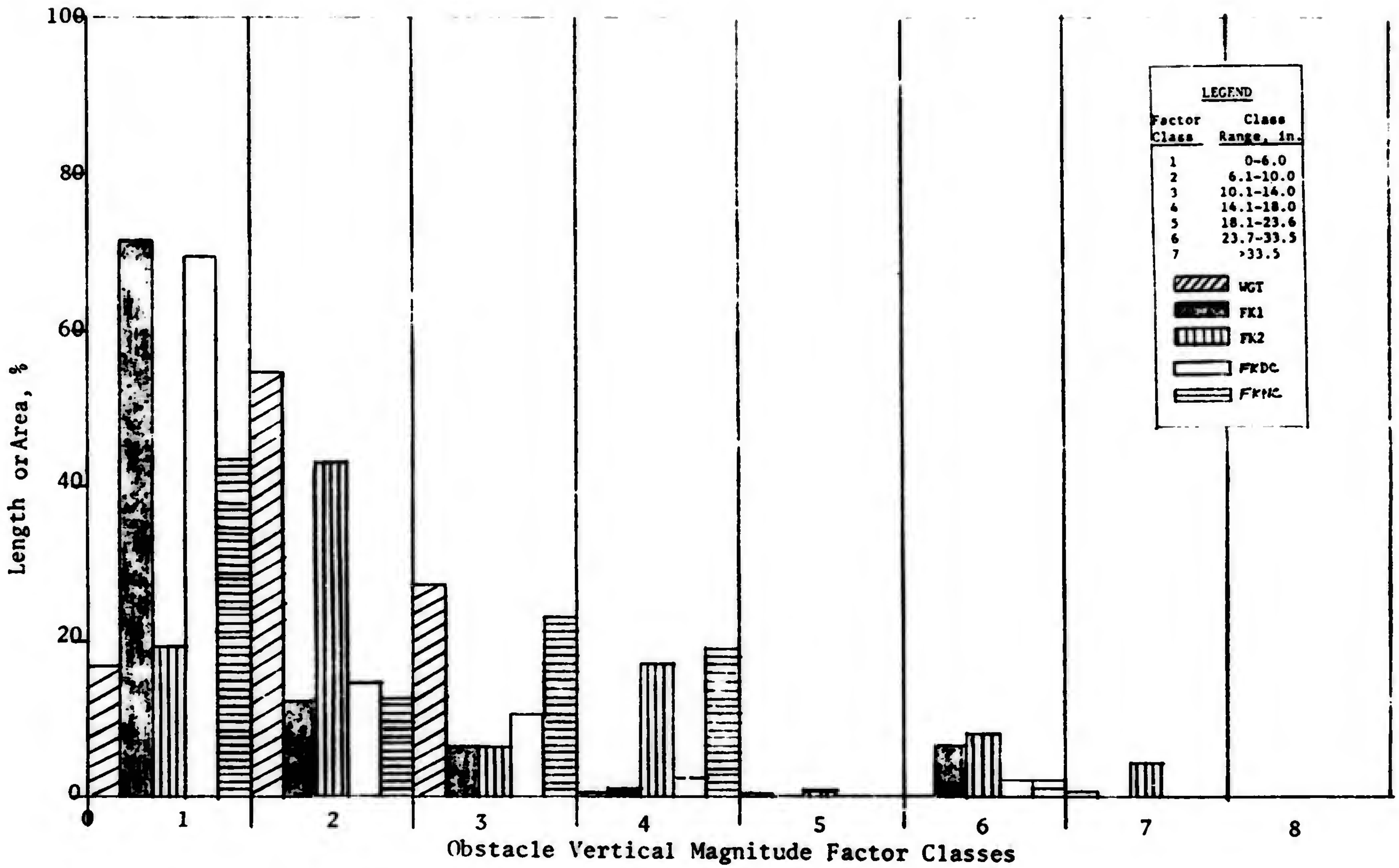


Fig. 7. Distribution of obstacle vertical magnitudes

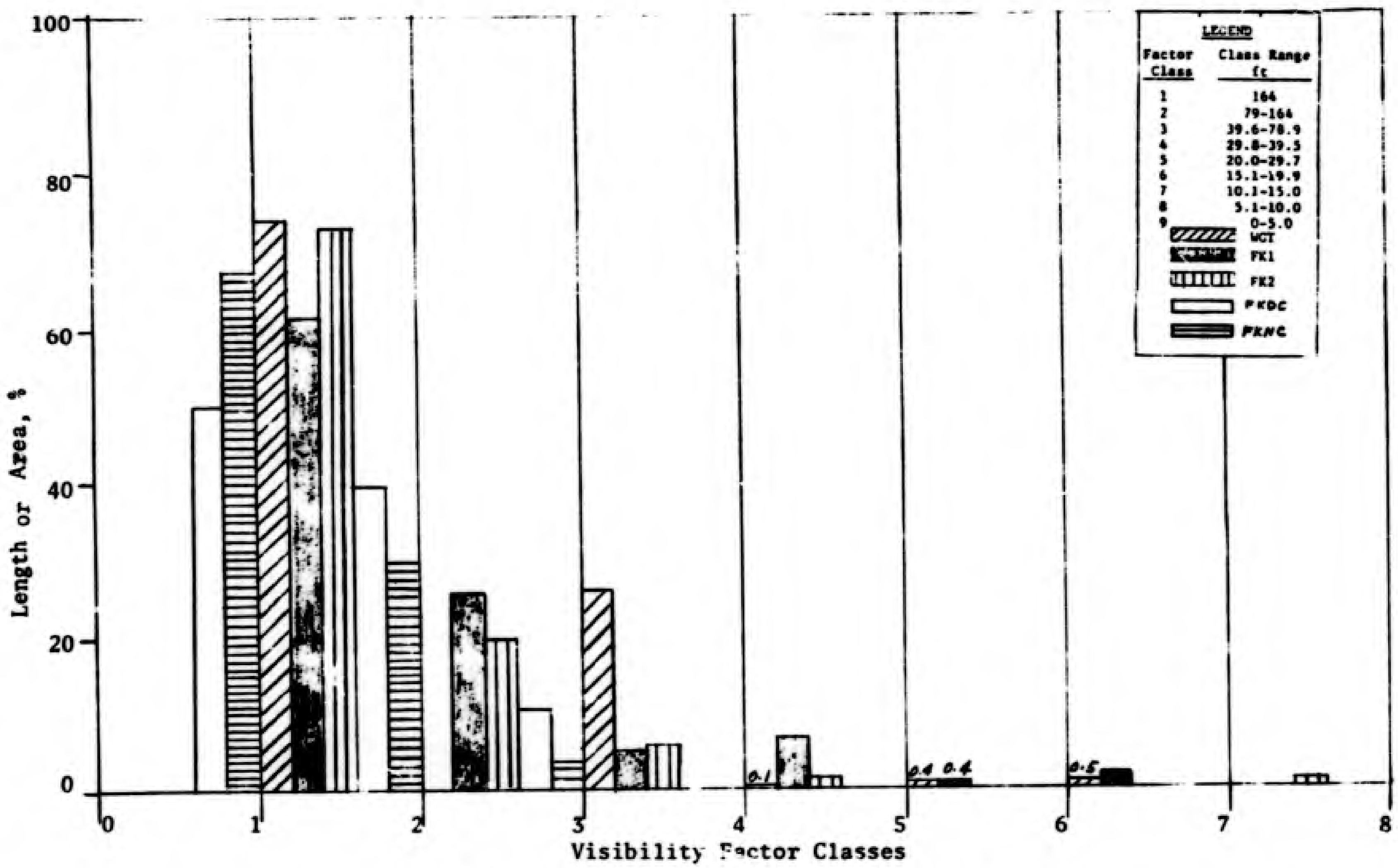


Fig. 8. Distribution of visibility factor classes

been plowed through the bank of much steeper slopes; whereas, the slopes on WGT were determined from contour lines on a 1:50,000-scale topographic map.

Surface roughness

16. The surface roughness distributions shown in fig. 6 indicate that FKDC is more similar to WGT than is FKNC. This probably reflects the extensive surface erosion found in FKNC and not present in WGT because of extensive application of erosion controls by farmers. There is some similarity between FKNC and FK2, both of which contain extensive erosion features.

Obstacle vertical magnitude
(obstacle height)

17. The types of obstacles most frequently encountered on FKDC and FKNC were erosion ditches. The obstacle height, or depth distributions, shown in fig. 7 show a much larger percentage of FKNC in the higher height classes than does FKDC or WGT. Here again this reflects the extensive erosion along FKNC. Also, the extensive farming and erosion practices in WGT tend to control the magnitude of obstacles formed by erosion in WGT.

Visibility

18. The visibility data shown in fig. 8 for WGT were developed by the WES standard technique for target recognition* and, therefore, are not directly comparable with the data obtained on FKDC and FKNC because of the different measuring techniques used (see paragraph 7). However, the data show good visibility in all of the areas, with each having greater than 70 percent in classes 1 and/or 2 even though vegetation was present and restricted visibility in some of the WGT terrain units.

All factors considered

19. Based on all the factors considered, FKDC is more similar to WGT than FKNC because of the greater surface roughness and obstacle magnitudes in FKNC. It should be noted, however, that both FK1 and FK2 have surface strength more similar to WGT than do FKDC or FKNC.

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* Randolph, Op. cit., page 4.

Conclusions

20. Based on the analysis presented herein, it is concluded that:

   a. Sufficient data were collected to warrant use of AMC-71 to evaluate mobility performance of vehicle over the two test courses (FKDC and FKNC).

   b. When the five factors (soil strength, slope, surface roughness, obstacle vertical magnitude, and visibility) are considered, FKDC is more similar to WGT than is FKNC.

   c. When the five factors are considered, FKNC is more similar to FK2 than is FK1, WGT, or FKDC.

   d. The surface material is stronger in FKDC and FKNC than in FK1, FK2, or WGT.

   e. The slopes in FKDC and FKNC are similar to those in FK2 and WGT.

   f. The surface roughness in FKNC is greater than that in FK1, FKDC, and WGT. The surface roughness in FKNC is almost similar to that found in FK2.

   g. Obstacle heights in FKNC are significantly greater than in FKDC or WGT.

   h. Good visibility exists in over 70 percent of all study areas.

Recommendations

21. It is recommended that the AMC-71 Mobility Model* be used to compare speed performance of the ARSVS and comparison vehicles over FKDC and FKNC.

* "The AMC-71 Mobility Model," Technical Report No. 11789 (LL 143), Volumes I and II, Jul 1973, U. S. Army Tank-Automotive Command, Warren, Mich.

Table 1

Factors and Class Numbers Used to Establish Trail and Road Units

	Class Numbers													
Terrain Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Surface Type	Fine-Grained Soil	Coarse-Grained Soil	Muskeg											
Surface Strength (CI or RCI)	>280	221-280	161-220	101-160	61-100	41-60	33-40	26-32	17-25	11-16	0-10	13-25	7-12	0-6
Slope (%)	0-2	2.1-5	5.1-10	10.1-20	20.1-40	40.1-60	60.1-70	>70						
Obstacle Approach Angle (deg)	178.6-180	180-181.5	175.6-178.5	181.5-184.5	170.1-175.5	184.5-190	158.1-170	190.1-202	149.1-158	202.1-211	135.1-149	211.1-225	90.0-135	226-270
Obstacle Vertical Magnitude (in.)	0-6	6.1-10	10.1-14	14.1-18.0	18.1-23.6	23.7-33.5	>33.5							
Obstacle Base Width (in.)	>47	36.1-47	24.1-36	12.1-24	0-12									
Obstacle Length (ft)	0-1	1.1-3.3	3.4-6.6	6.7-10.0	10.1-19.9	20.0-492	>492							
Obstacle Spacing (ft)	>197.0	65.7-197.0	36.4-65.6	26.5-36.3	18.3-26.4	13.4-18.2	8.3-13.3	0-8.2						
Obstacle Spacing Type	Random	Linear												
Surface Roughness	0-0.4	0.5-1.5	1.6-2.5	2.6-3.5	3.6-4.5	4.6-5.5	5.6-6.5	6.6-7.5	>7.6					
Stem Diameter (in.)	>0.1	>1.0	>2.4	>3.9	>5.5	> 7.0	>8.7	>9.8						
Stem Spacing (ft)	>328	65.6-328	36.4-65.5	26.5-36.3	18.3-26.4	13.4-18.2	8.3-13.3	0-8.2						
Visibility (ft)	>164	79.0-164	39.6-78.9	29.8-39.5	20.0-29.7	15.1-19.9	10.1-15.0	5.1-10.0	0-5.0					

Table 2

Legend for Factor Complex Map
of ARSV Day Course (FKDC)

	<<<<<<<<<<<<<<< FACTOR COMPLEX >>>>>>>>>>>>>>																				
		<< SOIL >>				< OBSTACLE >							<< SPACING OF STEMS EQUAL TO OR GREATER THAN GIVEN DIAMETER, CENTIMETERS >>								
MAP UNIT	SURFACE TYPE	DRY STRENGTH	AVG. STRENGTH	WET STRENGTH	TOPO. SLOPE	APPROACH ANGLE	VER. MAGNITUDE	BASE WIDTH	LENGTH	SPACING	TYPE	SURFACE ROUGHNESS	0	2.5	6	10	14	18	22	25	REC. OG. DIST.
1	1	1	1	1	1	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	2
3	1	1	1	1	1	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	2
5	1	1	1	1	1	6	2	1	6	1	2	1	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	8	3	1	6	1	2	2	1	1	1	1	1	1	1	1	2
7	2	1	1	1	2	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	1
8	1	1	1	1	2	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
9	1	1	1	1	2	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	2
10	1	1	1	1	2	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	3
11	1	1	1	1	2	1	1	1	6	1	2	3	1	1	1	1	1	1	1	1	2
12	1	1	1	1	2	6	2	3	6	1	2	3	1	1	1	1	1	1	1	1	3
13	1	1	1	1	2	8	1	4	6	1	2	1	1	1	1	1	1	1	1	1	1
14	1	1	1	1	2	8	2	1	6	1	2	2	1	1	1	1	1	1	1	1	2
15	1	1	1	1	2	8	2	1	6	2	2	3	1	1	1	1	1	1	1	1	2
16	1	1	1	1	2	8	3	1	6	1	2	3	1	1	1	1	1	1	1	1	1
17	1	1	1	1	2	8	3	3	6	2	2	3	1	1	1	1	1	1	1	1	1
18	1	1	1	1	2	10	3	1	6	1	2	2	1	1	1	1	1	1	1	1	1
19	1	1	1	1	2	10	3	4	6	1	2	2	1	1	1	1	1	1	1	1	1
20	1	1	1	1	2	10	4	1	6	1	2	2	1	1	1	1	1	1	1	1	2
21	1	1	1	1	3	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	3	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	2
23	1	1	1	1	3	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
24	1	1	1	1	3	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	2
25	1	1	1	1	3	8	1	4	6	1	2	2	1	1	1	1	1	1	1	1	2
26	1	1	1	1	3	8	1	5	6	1	2	3	1	1	1	1	1	1	1	1	2
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28	1	1	1	1	3	10	2	3	6	1	2	2	1	1	1	1	1	1	1	1	1
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30	1	1	1	1	3	10	3	4	6	1	2	2	1	1	1	1	1	1	1	1	2
31	1	1	1	1	3	10	3	4	6	2	2	2	1	1	1	1	1	1	1	1	1
32	1	1	1	1	3	10	6	1	6	2	2	4	1	1	1	1	1	1	1	1	3

(Continued)

Table 2 (Concluded)

	FACTOR COMPLEX																				
	SOIL					OBSTACLE							SPACING OF STEMS EQUAL TO OR GREATER THAN GIVEN DIAMETER, CENTIMETERS								
MAP UNIT	SURFACE TYPE	DRY. STRENGTH	AVG. STRENGTH	WET. STRENGTH	TOPO. SLOPE	APPROACH ANGLE	VER. MAGNITUDE	BASE WIDTH	LENGTH	SPACING	TYPE	SURFACE ROUGHNESS	0	2.5	6	10	14	18	22	25	RECOG. DIST.
33	1	1	1	1	3	12	2	3	6	3	2	2	1	1	1	1	1	1	1	1	2
34	1	1	1	1	3	13	2	5	6	1	2	4	1	1	1	1	1	1	1	1	2
35	1	1	1	1	3	13	2	5	6	2	2	4	[illegible]	1	1	1	1	1	1	1	2
36	2	1	1	1	4	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	1
37	1	1	1	1	4	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
38	1	1	1	1	4	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	2
39	1	1	1	1	4	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	3
40	1	1	1	1	4	1	1	1	6	1	2	3	1	1	1	1	1	1	1	1	1
41	1	1	1	1	4	1	1	1	6	1	2	3	1	1	1	1	1	1	1	1	2
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44	1	1	1	1	4	1	1	1	6	2	2	3	1	1	1	1	1	1	1	1	1
45	1	1	1	1	4	6	2	5	6	1	2	3	1	1	1	1	1	1	1	1	2
46	1	1	1	1	4	8	1	5	6	4	2	2	1	1	1	1	1	1	1	1	2
47	1	1	1	1	4	8	2	1	6	1	2	3	1	1	1	1	1	1	1	1	1
48	1	1	1	1	4	8	2	4	6	3	2	3	1	1	1	1	1	1	1	1	2
49	1	1	1	1	4	8	3	1	6	1	2	2	1	1	1	1	1	1	1	1	2
50	1	1	1	1	4	13	2	5	6	3	2	3	1	1	1	1	1	1	1	1	2
51	1	1	1	1	5	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
52	1	1	1	1	5	1	1	1	6	1	2	3	1	1	1	1	1	1	1	1	1
53	1	1	1	1	5	12	4	1	6	1	2	3	1	1	1	1	1	1	1	1	2
54	1	1	1	1	5	13	1	5	6	2	2	3	1	1	1	1	1	1	1	1	3
55	1	1	1	1	5	13	2	5	6	2	2	3	1	1	1	1	1	1	1	1	2

(Sheet 2 of 2)

Table 3

Legend for Factor Complex Map of AFSV Night Course (FKNC)

<<<<<<<<<<<<<<<< FACTOR COMPLEX >>>>>>>>>>>>>>

	<< SOIL >>					< OBSTACLE >							<< SPACING OF STEMS EQUAL TO OR GREATER THAN GIVEN DIAMETER, CENTIMETERS >>								
MAP UNIT	SURFACE TYPE	DRY STRENGTH	AVG. STRENGTH	WET STRENGTH	TOPO. SLOPE	APPROACH ANGLE	VER. MAGNITUDE	BASE WIDTH	LENGTH	SPACING	TYPE	SURFACE ROUGHNESS	0	2.5	6	10	14	18	22	25	RECOG. DIST.
1	2	1	1	1	1	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	6	3	1	6	1	2	4	1	1	1	1	1	1	1	1	1
3	1	1	1	1	1	6	3	1	6	2	2	2	1	1	1	1	1	1	1	1	1
4	1	1	1	1	1	6	3	3	6	2	3	3	1	1	1	1	1	1	1	1	1
5	1	1	1	1	1	6	3	2	6	1	2	3	1	1	1	1	1	1	1	1	1
6	1	1	1	1	1	6	4	1	6	2	2	3	1	1	1	1	1	1	1	1	1
7	1	1	1	1	1	6	4	1	6	2	2	4	1	1	1	1	1	1	1	1	1
8	1	1	1	1	2	1	1	1	6	1	2	1	1	1	1	1	1	1	1	1	1
9	1	1	1	1	2	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
10	2	1	1	1	2	1	1	1	6	1	2	4	1	1	1	1	1	1	1	1	1
11	1	1	1	1	2	1	1	1	6	2	2	2	1	1	1	1	1	1	1	1	1
12	1	1	1	1	2	[illegible]	4	1	6	2	2	[illegible]	1	1	1	1	1	1	1	1	1
13	1	1	1	1	2	6	1	5	6	1	2	3	1	1	1	1	1	1	1	1	2
14	1	1	1	1	2	3	4	1	5	1	2	4	1	1	1	1	1	1	1	1	2
15	1	1	1	1	2	6	2	1	6	2	2	3	1	1	1	1	1	1	1	1	1
16	1	1	1	1	2	3	1	1	6	1	2	3	1	1	1	1	1	1	1	1	2
17	1	1	1	1	2	3	1	5	6	1	2	4	1	1	1	1	1	1	1	1	2
18	1	1	1	1	2	8	2	5	6	2	2	4	1	1	1	1	1	1	1	1	2
19	1	1	1	1	2	8	3	5	5	1	2	4	1	1	1	1	1	1	1	1	1
20	1	1	1	1	2	12	4	1	6	1	2	3	1	1	1	1	1	1	1	1	1
21	1	1	1	1	2	12	4	4	6	1	2	1	1	1	1	1	1	1	1	1	1
22	1	1	1	1	2	13	2	5	6	1	2	3	1	1	1	1	1	1	1	1	2
23	2	1	1	1	3	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
24	1	1	1	1	3	1	1	1	6	1	2	3	1	1	1	1	1	1	1	1	1
25	1	1	1	1	3	1	1	1	6	1	2	4	1	1	1	1	1	1	1	1	3
26	2	1	1	1	3	1	1	1	6	2	2	3	1	1	1	1	1	1	1	1	1
27	1	1	1	1	3	5	1	4	6	1	2	4	1	1	1	1	1	1	1	1	2
28	1	1	1	1	3	5	2	1	6	1	2	4	1	1	1	1	1	1	1	1	2
29	1	1	1	1	3	8	3	1	5	1	2	4	1	1	1	1	1	1	1	1	2
30	1	1	1	1	3	8	3	3	5	1	2	4	1	1	1	1	1	1	1	1	1
31	1	1	1	1	3	3	4	3	5	1	2	1	1	1	1	1	1	1	1	1	1
32	1	1	1	1	3	12	4	5	6	2	2	5	1	1	1	1	1	1	1	1	1

(Continued)

(Sheet 1 of 2)

Table 3 (Concluded)

	FACTOR COMPLEX																				
	SOIL				OBSTACLE								SPACING OF STEMS EQUAL TO OR GREATER THAN GIVEN DIAMETER, CENTIMETERS								
MAP UNIT	SURFACE TYPE	DRY STRENGTH	AVG. STRENGTH	WET STRENGTH	TOPO. SLOPE	APPROACH ANGLE	VER, MAGNITUDE	BASE WIDTH	LENGTH	SPACING	TYPE	SURFACE ROUGHNESS	0	2.5	6	10	14	18	22	25	RECOG. DIST.
33	1	1	1	1	3	12	[illegible]	1	6	1	2	2	1	1	1	1	1	1	1	1	2
34	2	1	1	1	[illegible]	1	1	1	6	1	[illegible]	1	1	1	1	1	1	1	1	1	1
35	1	[illegible]	1	1	4	1	1	1	6	1	2	2	1	1	1	1	1	1	1	1	1
36	1	1	1	1	4	1	1	1	6	1	[illegible]	[illegible]	1	1	1	1	[illegible]	[illegible]	1	1	2
37	1	1	1	1	[illegible]	6	1	4	6	1	2	2	1	1	1	1	1	1	1	1	1
38	1	1	1	1	4	[illegible]	1	3	6	1	2	3	1	1	1	1	1	1	1	1	[illegible]
39	1	1	1	1	4	[illegible]	1	3	[illegible]	[illegible]	[illegible]	[illegible]	1	1	1	1	1	1	1	1	2
40	1	1	1	1	[illegible]	[illegible]	2	4	6	1	2	4	1	1	1	1	1	1	1	1	3
41	1	1	1	1	4	6	4	3	6	1	2	5	1	1	1	1	1	1	1	1	2
42	1	1	1	1	4	[illegible]	3	4	6	1	2	3	1	1	1	1	1	1	1	1	2
43	1	1	1	1	4	[illegible]	4	3	6	2	2	4	1	1	1	1	1	1	1	1	1
44	1	1	1	1	4	15	6	3	6	1	2	4	1	1	1	1	1	1	1	1	3
45	1	1	1	1	4	14	2	1	6	2	2	3	1	1	1	1	1	1	1	1	2
46	1	1	1	1	4	14	2	5	6	3	2	4	1	1	1	1	1	1	1	1	1
47	1	1	1	1	5	0	1	1	6	1	2	3	1	1	1	1	1	1	1	1	1
48	1	1	1	1	5	12	4	3	6	1	2	3	1	1	1	1	1	1	1	1	2

(Sheet 2 of 2)

Table 4

Trail Unit Distances for Each Traverse Segment
Fort Knox Day Courses (FKDC)

Segment No. 1

Trail or Road Unit	Distance miles
27	0.20
22	0.30
34	0.25
32	0.05
23	0.45
47	0.40
37	0.20
44	0.40
Total	2.25

Segment No. 2

Trail or Road Unit	Distance miles
44	0.30
37	0.35
35	0.10
52	0.10
43	0.05
1	0.10
23	0.20
28	0.20
54	0.15
3	0.15
55	0.20
26	0.10
50	0.15
30	0.65
39	0.20
37	0.30
4	0.10
Total	3.40

Segment No. 3

Trail or Road Unit	Distance miles
9	0.55
38	0.10
46	0.15
48	0.20
Total	1.00

Segment No. 4

Trail or Road Unit	Distance miles
37	0.30
3	0.15
24	0.15
37	0.10
39	0.35
25	0.35
27	0.30
8	0.30
21	0.30
33	0.50
23	0.10
15	0.40
6	0.10
Total	3.40

Segment No. 5

Trail or Road Unit	Distance miles
3	0.10
38	0.30
23	0.05
45	0.20
41	0.10
12	0.20
20	0.45
14	0.20
5	0.30
31	0.05
13	0.30
16	0.25
Total	2.70

Segment No. 6

Trail or Road Unit	Distance miles
3	0.15
29	0.55
17	0.10
11	0.15
53	0.15
40	0.10
24	0.35
37	0.05
Total	1.60

Segment No. 7

Trail or Road Unit	Distance miles
42	0.40
2	0.90
1	0.20
6	0.25
19	0.20
10	0.15
24	0.30
51	0.10
18	0.35
49	0.50
24	0.25
7	1.85
36	0.45
Total	5.00

NOTE: Total distance for all day course segments = 20.15 miles.

Table 5

Trail Unit Distances for Each Traverse Segment
Fort Knox Night Courses (FKNC)

Segment No. 8	
Trail or Road Unit	Distance miles
5	0.30
41	0.35
24	0.10
11	0.20
36	0.35
Total	1.30

Segment No. 9	
Trail or Road Unit	Distance miles
13	0.20
48	0.15
42	0.40
28	0.10
14	0.25
43	0.25
17	0.40
25	0.15
47	0.05
38	0.45
16	0.10
34	0.25
22	0.20
45	0.35
9	0.35
33	0.35
37	0.20
Total	4.25

Segment No. 10	
Trail or Road Unit	Distance miles
35	0.20
23	1.60
8	0.45
10	0.50
31	0.55
9	0.25
18	0.45
19	0.55
23	0.23
Total	4.80

Segment No. 11	
Trail or Road Unit	Distance miles
46	0.30
40	0.15
21	0.15
1	0.25
26	0.35
23	0.15
20	0.25
23	0.15
Total	1.75

Segment No. 12	
Trail or Road Unit	Distance miles
30	1.15
39	0.35
27	0.20
29	0.40
44	0.35
32	1.05
Total	3.50

Segment No. 13	
Trail or Road Unit	Distance miles
6	0.30
7	0.35
1	0.10
2	0.15
3	0.10
15	0.30
12	0.10
4	0.25
Total	1.65

NOTE: **Total distance for all night course segments = 17.25 miles.**

Table 6

Distribution of Factors Used to Describe FKDC and FKNC Factors in Fort Knox Day and Night Courses

Surface Type		Soil Strength		Slope		Surface Roughness		Visibility		Obstacle Approach Angle		Obstacle Height	
Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %
						FKDC							
1	90.4	1	100	3	34.6	2	59.9	1	49.6	1	64.1	1	69.4
2	9.6			4	28.8	3	20.1	2	39.6	8	14.3	2	14.8
				2	19.5	1	13.0	3	10.8	10	11.3	3	11.0
				1	12.3	4	7.0			13	5.3	4	2.5
				5	4.8					6	3.0	6	2.3
										12	2.0		
						FKNC							
1	88.6	1	100	3	38.8	4	36.2	1	67.0	8	36.5	1	43.5
2	11.4	1	100	2	27.3	2	25.8	2	29.3	1	32.2	3	22.6
				4	22.3	3	19.7	3	3.7	10	11.0	4	18.8
				1	10.4	1	11.0			6	10.1	2	13.0
				5	1.2	6	5.2			12	5.2	6	2.1
						5	2.1			14	3.2		
										13	1.2		
										4	0.6		

Obstacle Width		Obstacle Length		Obstacle Spacing		Obstacle Spacing Type	
Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %	Class No.	Test Course %
			FKDC				
1	78.2	6	100	1	83.2	2	100
4	8.5			2	10.5		
5	7.5			3	5.3		
3	5.8			4	1.0		
			FKNC				
1	51.0	6	100	1	72.5	2	100
3	36.8			2	24.3		
4	6.4			3	3.2		
5	5.8						

NOTE: No standing vegetation on trails.