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AN ANALYSIS OF A STRATEGIC RAIL CORRIDOR NETWORK (STRACNET) FOR--ETC(U)
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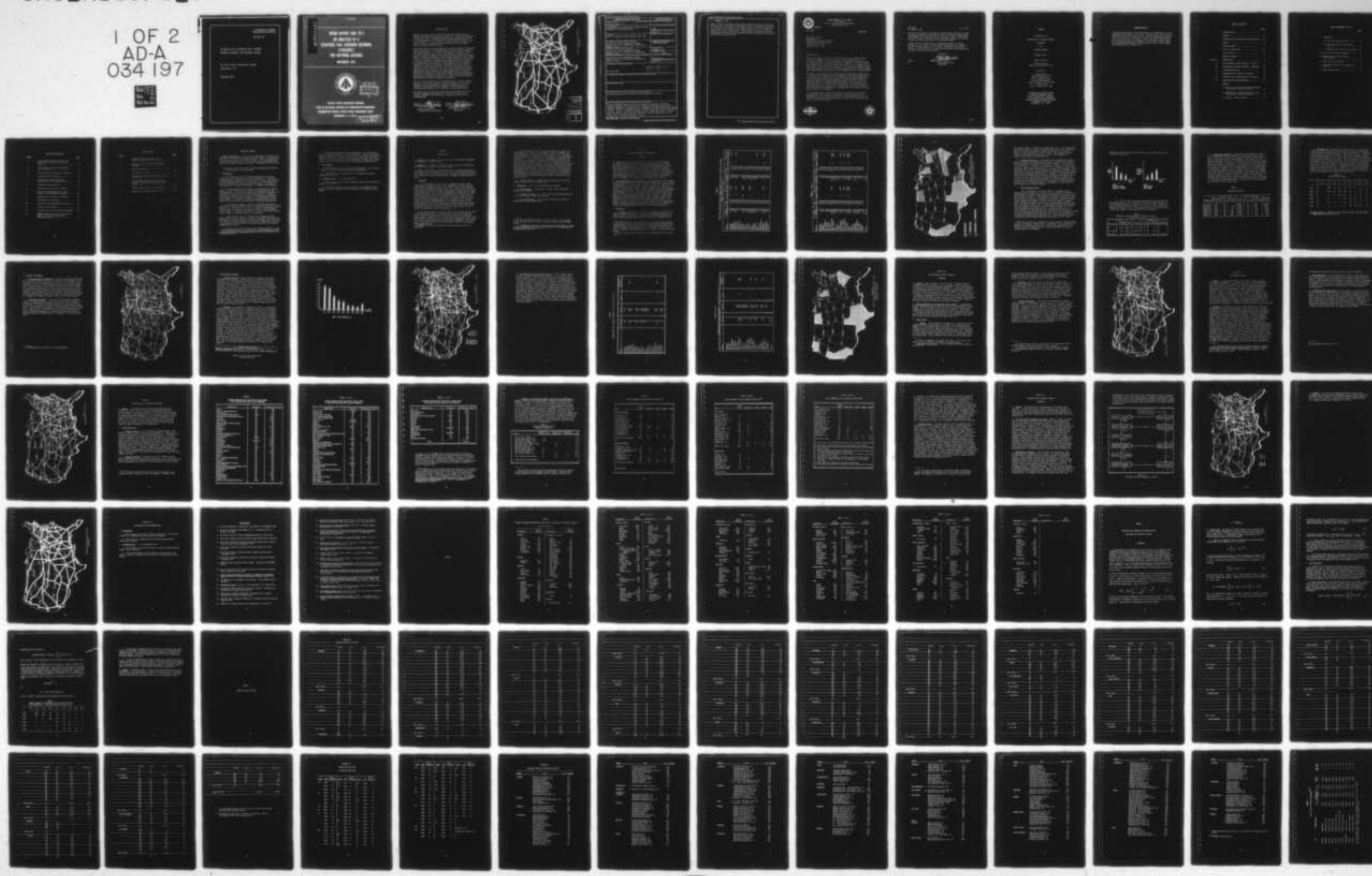


U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

AD-A034 197

AN ANALYSIS OF A STRATEGIC RAIL CORRIDOR NETWORK (STRACNET) FOR NATIONAL DEFENSE

Military Traffic Management Command
Washington, D.C.

November 1976

MTMC REPORT RND 76-1

AN ANALYSIS OF A STRATEGIC RAIL CORRIDOR NETWORK (STRACNET) FOR NATIONAL DEFENSE

NOVEMBER 1976

MILITARY TRAFFIC MANAGEMENT COMMAND
OFFICE OF THE SPECIAL ASSISTANT FOR TRANSPORTATION ENGINEERING
RAILROADS FOR NATIONAL DEFENSE PROJECT MANAGEMENT GROUP
WASHINGTON, D. C. 20315

AUTHENTICATION

Concern over the capability of the Nation's railroads to support defense requirements led the Deputy Secretary of Defense to designate the Military Traffic Management Command as his representative agency for the development of a Railroads for National Defense Program. The overall objective of the program is to ensure that the Nation's railroads are able to transport essential DOD supplies and equipment during both peacetime and wartime.

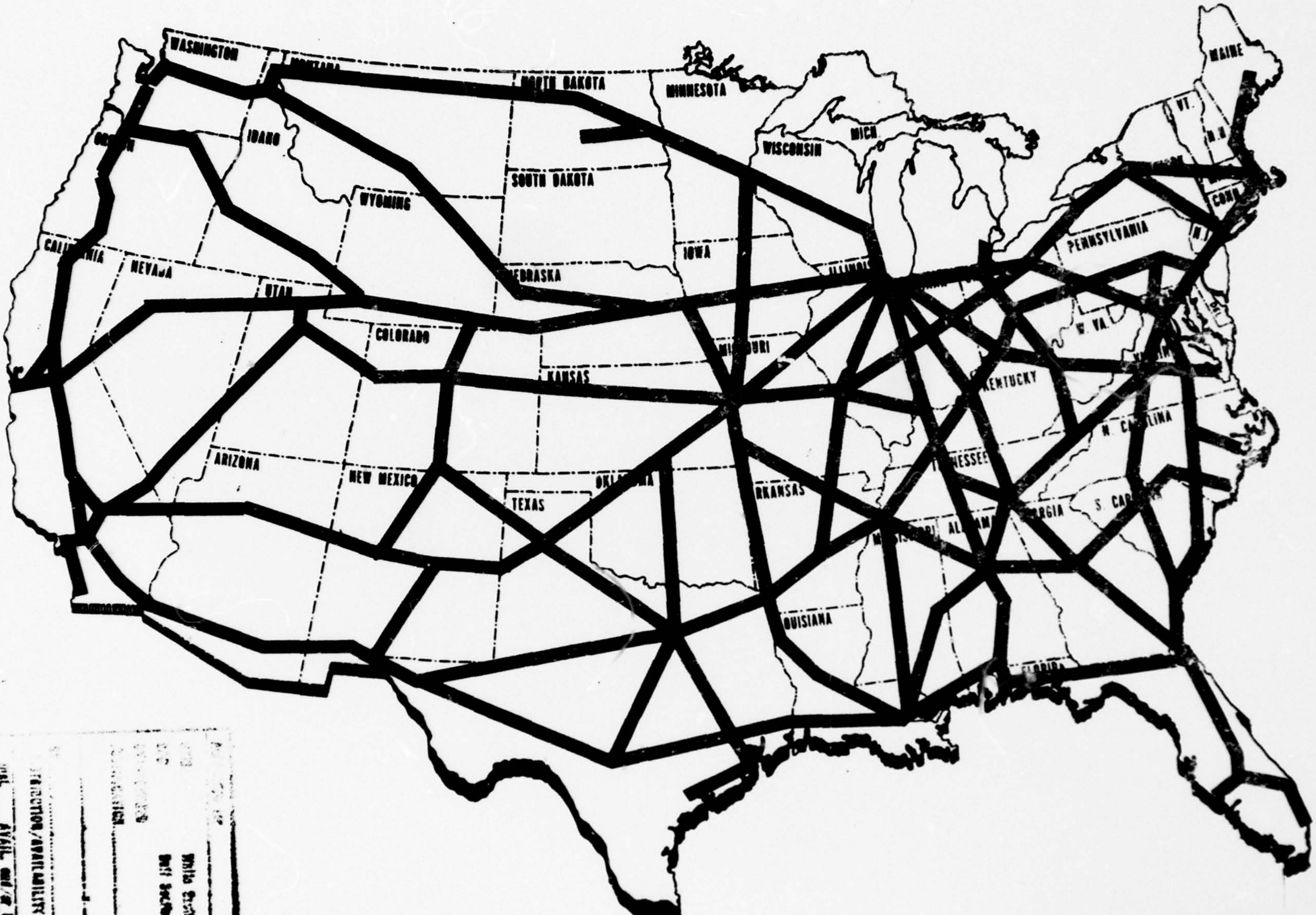
An initial effort in the development of a viable Railroads for National Defense Program must be the development of defense rail requirements. This study analyzes rail corridors determined strategically important to national defense. Its purpose is to identify a strategic rail corridor network (STRACNET) for peacetime and contingency rail requirements. An extensive analysis of defense peacetime rail carload traffic is made. This analysis resulted in a volume categorized corridor map. A clearance analysis is then made using combat tanks as an indicator for clearance shipments together with information from the Railway Industrial Clearance Association. Following the clearance analysis, contingency origin and destination pairs are examined but are not specific to a particular war plan. The volume, clearance and contingency analyses are merged by a corridor priority designation process. Subjective criteria required for system integration are integrity, defense and strategic rail needs, major population centers, seaports and airports of embarkation, services to major military installations and defense industries, transportation centers, and Federal Railroad Administration preliminary mainline designations.

The result of this study is an identification of a railroad corridor network. This corridor approach, rather than specific route determinations, has the advantage of presenting defense needs without advocacy of individual railroad companies. More importantly, it allows maximum flexibility in planning for defense requirements.

The final network of corridors represents the rail mainline system determined strategically important to national defense. This network, STRACNET, some 30,000 miles in extent, is shown on the following page.

Approval Recommended: A. J. DOWD
Special Assistant for Transportation Engineering

Command Approval: H. R. DEL MAR
Major General, USA
Commanding



Strategic Rail Corridor Network
(STRACNET)

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This study [redacted] analyzes rail corridors deemed strategically important to national defense. The objective is to identify a strategic rail corridor network (STRACNET) for peacetime and contingency rail requirements for national defense. First, an extensive analysis of defense peacetime rail carload traffic is made. Second, a clearance analysis is made using combat tanks, together with information from the Railway Industrial Clearance Association, as an indicator for clearance shipments. (Con't)

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20. ABSTRACT. (CON'T)

Third, contingency origin and destination pairs are examined but are not plan-specific. Subjective criteria such as interconnectivity and service are then applied to determine the final network. It has been found that a strategic rail corridor network somewhat analogous to the interstate highway system can be identified. This network is compatible with the preliminary classification of railroad mainlines identified by the Federal Railroad Administration (FRA).

DEPARTMENT OF THE ARMY
HEADQUARTERS
MILITARY TRAFFIC MANAGEMENT COMMAND
WASHINGTON, D.C. 20315

REPLY TO
ATTENTION OF:

MT-SA-RND

30 NOV 1976

Mr. Asaph H. Hall
Administrator
Federal Railroad Administration
Department of Transportation
400 7th Street, S. W.
Washington, DC 20590

Dear Mr. Hall:

Secretary Coleman, in his June 22, 1976 letter to Mr. Clements, Deputy Secretary of Defense, stated that the need for identification of a strategic network of rail lines important to the national defense can be met under the terms of Section 901(3) of the RRRR Act. He also indicated that defense rail access needs are already met, except for funding, by the provisions of Title VIII of the RRRR Act. To ensure that defense requirements are adequately addressed, he states that the Military Traffic Management Command should work directly with the Federal Railroad Administration.

On behalf of the Department of Defense, we have completed an Analysis of a Strategic Rail Corridor Network (STRACNET) for National Defense (Incl 1) to facilitate your identification of a national rail network essential to meet the needs of interstate commerce and the national defense. Our analysis identifies corridors rather than specific lines to allow you maximum flexibility in satisfying defense needs. This analysis is in consonance with our testimony before the Rail Services Planning Office of the Interstate Commerce Commission on 29 September 1976 that requested FRA to incorporate consideration of STRACNET into the reports for Sections 503 and 901(3) of the RRRR Act.

It is essential that quality rail lines be maintained in the corridors to ensure that rail movement is available to meet national defense requirements. The Department of Defense is heavily dependent upon rail service for movement of large quantities of cargo and in particular oversize or overweight equipment.

VANGUARD OF FREEDOM
BICENTENNIAL
UNITED STATES ARMY

AMERICAN REVOLUTION BICENTENNIAL
1776-1976

MT-SA-RND

Mr. Asaph H. Hall

30 NOV 1976

We are in the process of obtaining from the military services a listing of those installations requiring rail service. We will validate these requirements and furnish you with our rail access needs. These access lines are equally as important as the strategic corridors in assuring a total rail system responsive to the national defense.

I agree with Mr. Coleman that our organizations must work closely together to ensure that national defense requirements are included in the rail network essential to interstate commerce and the national defense. We look forward to a continued professional relationship with the Federal Railroad Administration.

Sincerely,

H. R. DEL MAR
Major General, USA
Commanding

1 Incl
as

CREDITS

AN ANALYSIS OF A

STRATEGIC RAIL CORRIDOR NETWORK

(STRACNET)

FOR

NATIONAL DEFENSE

November 1976

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ACKNOWLEDGEMENT

The following individuals and organizations are acknowledged for their invaluable contribution to this study: Charles E. Zell, LTC, USAR, for comments on the initial draft; Federal Railroad Administration, Department of Transportation, Washington, DC; Railroad Industrial Clearance Association, New York, NY; Military Traffic Management Command Transportation Engineering Agency (MTMCTEA), Newport News, VA; and support and operations directorates of Headquarters, Military Traffic Management Command (MTMC), Washington, DC.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

Page

LIST OF ILLUSTRATIONS

LIST OF TABLES

EXECUTIVE SUMMARY

1. Terms of Reference. This study is an outgrowth of concern by the Commander, Military Traffic Management Command (MTMC) for the Nation's rail system in supporting defense interests. It is an examination of strategically important rail corridors deemed vital to satisfy peacetime and contingency defense requirements. The objective of the study is:

> to identify a network of rail corridors strategically important to the defense of the United States.

2. Methodology.

a. The study first explores defense peacetime rail carload geographical distributions by origin and destination. An in-depth volume analysis of peacetime rail traffic is then made. This analysis includes sampling methods and the development of a base network map. Corridor routings are conducted through the network. The result of this analysis is a volume categorization of defense carload traffic.

b. The volume analysis is followed by a peacetime rail clearance analysis. This analysis uses the same network developed for the volume analysis. Clearance is determined by information obtained from the Railway Industrial Clearance Association (RICA) for clearance corridors in the Northeast and combat tank shipments as an indicator for clearance corridors in the remainder of the Continental United States (CONUS). A clearance corridor map is prepared from the RICA data and by routing combat tank shipments through the base network.

c. Contingencies relevant to specific origin/destination pairs are examined. These contingency pairs are not associated with a specific plan, nor are they exhaustive. They are, however, representative of a distribution of pairs for Department of Defense (DOD) contingency traffic flows. A contingency corridor map, using the identical network of the volume and clearance analysis, is developed.

d. Subjective criteria are considered in a separate section. These criteria focus on the area of system interconnectivity including discussion of network integrity, defense and strategic rail needs, major U.S. population centers, seaports and airports of embarkation, service to major military installations and defense industries, civil/defense transportation centers.

e. The study also evaluates the defense essential network in terms of the Preliminary Standards, Classification, and Designation of Lines of Class I Railroads in the United States reported by the Federal Railroad Administration.

f. The above subject areas are integrated into a strategic rail corridor network (STRACNET) for national defense. This is accomplished by first assigning a priority to each corridor link within the network based on the volume, clearance, and contingency analysis. The network with its assigned priority is then evaluated for its subjective considerations and compatibility with the FRA-identified mainline system.

3. Conclusions:

a. The strategic rail corridor network represents a rail mainline structure for supporting national defense requirements.

b. This network is compatible with the preliminary mainlines identified by the FRA.

4. Recommendations: It is recommended that:

a. The strategic rail corridor network be used as the DOD mainline system of rail corridors.

b. In the development of plans, programs, and standards of the Nation's railroads, consideration be given to the identified corridor system.

SECTION I

INTRODUCTION

1. Purpose. To establish a strategic rail corridor network (STRACNET) for Department of Defense (DOD).

2. Objective. To identify a network of rail corridors strategically important to the defense of the United States.

3. Scope. The strategic rail corridor network includes origin/destination pairs with sufficient traffic density and other priority requirements deemed vital to national defense. The study addresses a peacetime rail volume and clearance analysis, and contingency origin/destination pairs.

4. Background.

a. The Commander, Military Traffic Management Command (MTMC) established the special project group, Railroads for National Defense (RND) Project Management Group in July 1975[1/]. This group was created as a result of growing apprehension about the capability of the Nation's railroad system to support defense requirements in peace and war. Many factors contributed to this growing apprehension, including: (1) excessive transit time to move outsize equipment such as combat tanks, (2) United States Railway Association (USRA) forecasts of three to seven years to upgrade deteriorated mainlines, (3) military services reports on deteriorated and otherwise unsafe track conditions, (4) various studies of possible line abandonment, (5) imminent shutdown of major-system segments, and (6) the large number of tracks under "slow order." It was with these concerns that the RND group was assigned the mission to develop a program to assure that the rail system in the U.S. is capable of supporting defense requirements.

b. The initial thrust of the RND group was in response to the impact of the USRA reorganization of bankrupt rail lines in the northeast. USRA's Preliminary System Plan threatened rail service to eight DOD installations. Immediate action by the project group assured that, under USRA's Final System Plan, four of these eight installations would retain rail service from Consolidated Rail Corporation (CONRAIL). The remaining four installations were tentatively assured service through state rail planning agencies.

1/ Project Charter, Railroads for National Defense, 29 Jul 75, MTMC-C(SA).

c. Paralleling events surrounding the impact of reorganizing the bankrupt rail lines in the northeast was the development of a draft Department of Transportation (DOT) and DOD policy statement on rail planning and the subsequent development of relationships and procedures.[2/] It is intended that, in defense rail planning, MTMC will strive to integrate national defense railroad needs with the Federal railroad programs of the FRA, and, when appropriate, with state and local programs and with those of the American Association of Railroads (AAR) and of individual railroads. Cooperation and integration with DOT and FRA in matters pertaining to the Nation's railroad programs is essential. However, much of the initial support envisioned by DOD from FRA failed to materialize due to legislative mandates imposed on FRA by the Quad R Act of 1976. The Secretary of Transportation has published, in accordance with Section 503 of the Quad R Act, preliminary standards of Class I railroads in the United States.[3/]

d. The development of STRACNET gave consideration to the FRA report on Section 503 of the Quad R Act.

5. Assumptions. The following assumptions were made:

a. Rail Systems. The strategic corridor system lies within existing rail systems.

b. Access Rail Lines. Rail lines that tie origins/destinations to the corridors are adequate for DOD use.

c. Rail Capabilities. The current rail system's capability adequately fills DOD requirements.

2/ Ltr, HQ MTMC (MT-SA-RND), 3 Sep 75, subject: Joint DOT/DOD Policy Statement and Ltr, 30 Oct 75, subject: Revised Joint DOT/DOD Policy."

3/ Preliminary Standards, Classification, and Designation of Lines of Class I Railroads in the U. S., Vol I and II. U.S. Department of Transportation, Aug 1976.

SECTION II

DOD PEACETIME CORRIDOR ANALYSIS:

VOLUME

1. General. DOD contributes less than one-half of one percent of all peacetime rail carload traffic in the United States. However, DOD can be considered a large user of this commercial mode of transportation, moving approximately 100,000 rail carloads[4/] of traffic annually during peacetime. This analysis of peacetime defense rail traffic was made to determine the impact of the rail line classifications under the Quad R Act and the relationship of DOD rail traffic to the existing rail structure. The analysis includes a discussion of DOD origin/destination traffic, the data base, network development, traffic routings, and, intrastate vs interstate rail traffic.

2. Origin/Destination Carload Traffic. An investigation into originating and terminating DOD traffic was made to determine spatial patterns in the movement of defense cargo. Table 1 shows both originating and terminating rail carload traffic by state, percent, and rank, from 1 Aug 74 to 31 Jul 75. Figure 1 further shows the geographical distribution of origin traffic. Seven states originate more than 50 percent of all DOD goods, while the top 10 states account for nearly 60 percent. DOD destination traffic, like origin traffic, is shown in Table 1 and Figure 1. The seven shaded states in Figure 1 account for more than 50 percent of DOD terminating traffic. Five of these states are the same as five of the seven states originating the most traffic. No attempt was made to identify specific DOD activities having a given amount of traffic within states. However, Annex A does contain points either originating or terminating more than 50 carloads of DOD rail traffic for the year April 74 to Mar 75 which serve activity(s).

3. Data Base.

a. General. Analysis of routings for peacetime rail traffic was made for the period 1 Aug 74 to 31 Jul 75 by examining defense rail carload traffic[5/]. During this 12-month period 37,633 shipments were made, representing more than 75,700 rail carloads of defense goods.

4/ AR 55-39 defines carload as any rail freight shipment weighing 10,000 pounds or more. Also, any rail freight shipment weighing less than 10,000 pounds for which the bill of lading specifies tendered as carload, loaded to full visible capacity, indicates exclusive use of car, or otherwise indicates application of carload rates and/or minimum weight.

5/ Rail carload traffic is Code K of the MTMC Freight and Routing File.

TABLE 1

ORIGIN AND DESTINATION RAIL CARLOAD TRAFFIC BY STATE, PERCENT, AND RANK
FROM 1 AUG 74 TO 31 JUL 75

State	Origin Carloads	Per Cent	Rank	Cum. Pct. by Rank	Destination Carloads	Per Cent	Rank	Cum. Pct. by Rank
Alabama	2,260	2.99	8	.5404	2,857	3.78	9	.6124
Arizona	295	0.39			546	0.72		
Arkansas	581	0.77			489	0.65		
California	4,515	5.96	3	.3358	6,485	8.58	3	.3672
Colorado	753	0.99			770	1.02		
Connecticut	34	0.04			59	0.08		
Delaware	75	0.10			6	0.01		
Florida	2,199	2.90	10	.5988	1,089	1.44		
Georgia	840	1.11			2,095	2.77		
Idaho	205	0.27			229	0.30		
Illinois	1,901	2.51			1,800	2.38		
Indiana	2,228	2.94	9	.5698	1,566	2.07		
Iowa	1,588	2.10			1,107	1.46		
Kansas	1,703	2.25			1,512	2.00		
Kentucky	1,328	1.75			1,396	1.85		
Louisiana	1,270	1.68			3,161	4.18	7	.5352
Maine	19	0.03			157	0.21		
Maryland	174	0.23			375	0.50		
Massachusetts	158	0.21			166	0.22		
Michigan	3,535	4.67	5	.4364	2,586	3.42	10	.6466
Minnesota	1,816	2.40			46	0.06		
Mississippi	446	0.59			404	0.53		
Missouri	867	0.15			653	0.86		

TABLE 1 - cont

State	Origin Carloads	Per Cent	Rank	Cum. Pct. by Rank	Destination Carloads	Per Cent	Rank	Cum. Pct. by Rank
Montana	30	0.04			87	0.12		
Nebraska	207	0.27			55	0.07		
Nevada	453	0.60			328	0.43		
New Hampshire	15	0.02			19	0.03		
New Jersey	355	0.47			842	1.11		
New Mexico	259	0.39			225	0.30		
New York	691	0.91			507	0.67		
North Carolina	11,836	15.63	1	.1563	13,765	18.21	1	.1821
North Dakota	1,939	2.56			3,182	4.21	4	.4093
Ohio	1,800	2.38			2,105	2.78		
Oklahoma	506	0.67			1,557	2.06		
Oregon	312	0.41			175	0.23		
Pennsylvania	3,238	4.28	6	.4792	3,174	4.20	6	.4934
Rhode Island	124	0.16			21	0.03		
South Carolina	2,370	3.13	7	.5105	2,979	3.94	8	.5746
South Dakota	69	0.09			116	0.15		
Tennessee	4,082	5.39	4	.3897	3,181	4.21	5	.4514
Texas	9,076	11.99	2	.2762	7,505	9.93	2	.2814
Utah	1,957	2.59			1,284	1.70		
Vermont	8	0.01			6	0.01		
Virginia	1,597	2.11			2,167	2.87		
Washington	1,978	2.61			2,045	2.71		
West Virginia	1,561	2.06			30	0.04		
Wisconsin	1,978	2.61			482	0.64		
Wyoming	96	0.13			117	0.15		
Canada	381	0.51			87	0.12		
Total	75,708				75,708			

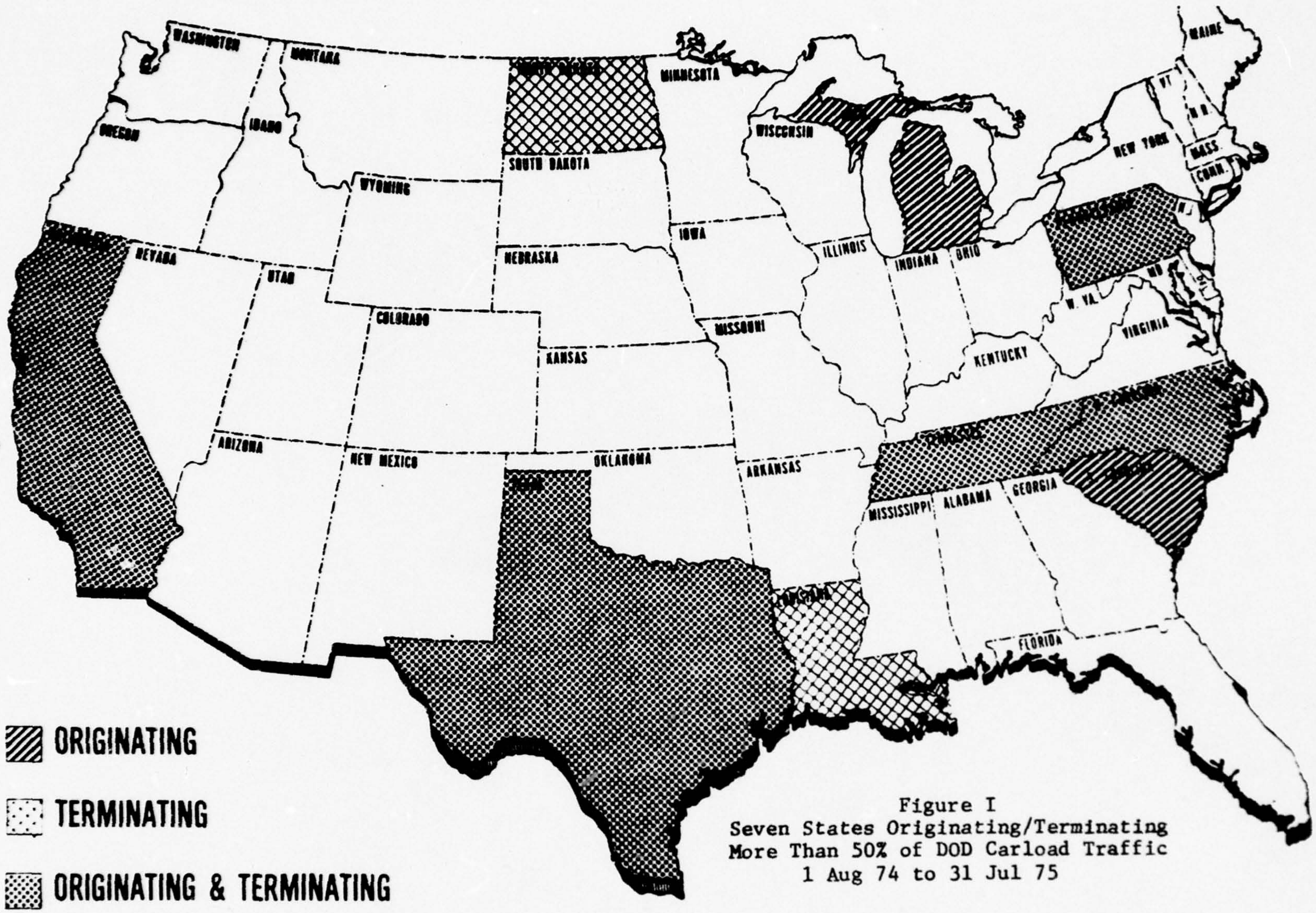

Figure I
Seven States Originating/Terminating
More Than 50% of DOD Carload Traffic
1 Aug 74 to 31 Jul 75

The average number of carloads per shipment was two. It was considered necessary to capture a large percentage of this traffic for routing purposes, in either an absolute or statistical sense, as an objective measure of the peacetime flow of DOD traffic. This section will discuss an initial analytical approach, a rail carload analysis, a sensitivity analysis, and link rejection.

b. Analytical Approach. Investigation into an appropriate sample size to be taken from the data base was made to determine the number of routings necessary to adequately describe the network. The analytical work in support of this effort is contained in Annex B. On strictly an 'a priori' basis, to obtain a root mean error of estimate of less than 20 percent given 37,633 Government bill of lading (GBL) records, a system containing 542 links, and an estimated 14 carload-link hits[6/] per record entry (two carloads per shipment with an average distance of seven links) would require examining 1,107 records. In general, a 10 percent reduction of the root mean error would require increasing the sample size by a factor of four. Even though a statistical sample was rejected in favor of a more straightforward approach, the initial inquiry produced a method for rejecting links when given the number of carload-link hits and the level of confidence desired. A discussion on link rejection will follow the rail carload analysis.

c. Rail Carload Analysis.

(1) A reduction of the large number of routings, without altering the data elements in the data base, was achieved by consolidating similar origins by state and city, destinations by state and city, rail carriers by carrier. This aggregation resulted in reducing 37,633 GBL records to 11,537, or a reduction of 69 percent. These new records, called "identical routings," increased the average number of carloads in the original data base from 2.0 to 6.5 for an identical routing. Next, identical routings of one and two carloads were examined to determine their impact on this total. A generalized frequency distribution for rail traffic with identical routes is shown in Figure 2a. Of the 11,537 consolidated routings, 8,242, or 71 percent, were of two or fewer carloads. Average carloads per routing increased from 6.5 to over 13 by dropping routings with only one carload. This average increased to nearly 20 carloads per routing when both one and two carloads per routing were dropped as shown in Figure 2b. Even by dropping carloads of one and two, the standard deviation was large at 133.97. This

6/ A carload-link hit is defined as a rail carload of defense traffic moving on or across a network link. For example, six carload-link hits could be one shipment carrying two carloads that crossed three links. A corridor link is a segment of rail corridor connecting two nodes or junction points in the system.

indicated that the distribution was skewed to the right, which led to a sensitivity analysis.

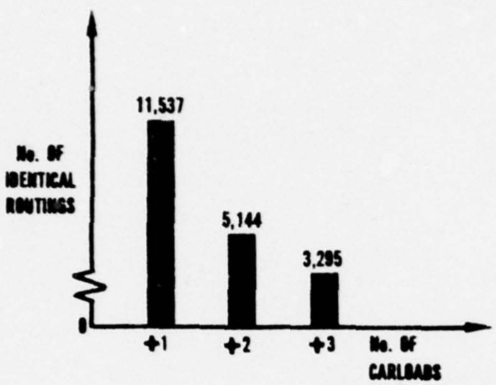

FIGURE 2 A
DISTRIBUTION OF IDENTICAL ROUTINGS BY No. of CARLOADS

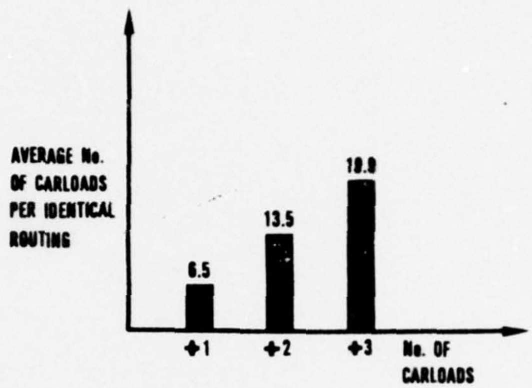

FIGURE 2 B
AVERAGE CARLOADS BY IDENTICAL ROUTING

(2) Table 2 shows the relationship between the data base and the sample selected. Use of identical routings of three carloads or more reduced the number of records from 11,537 to 3,295. These 3,295 records represent 65,611 carloads, or 87 percent of the 75,702 total carloads of defense traffic. All identical routings of three carloads or more were routed for the peacetime corridor analysis.

TABLE 2
ANALYSIS OF RAIL CARLOADS BY IDENTICAL ROUTINGS
1 Aug 74 to 31 Jul 75

Carloads	No of Identical Routings	Per-cent	No. of Carloads	Per-Cent	Average No of Carloads Per Routing	Standard Deviation
All	11,537	100	75,702	100	6.56	
2 or more	5,144	45	69,309	92	13.47	
3 or more	3,295	28	65,611	87	19.91	133.97

d. <u>Sensitivity Analysis</u>. As indicated in paragraph c(1) above, the carload distribution for identical routings was skewed to the right. Therefore, a sensitivity analysis was made by varying the carloads on the upper end of the distribution. The results of this analysis are shown in Table 3. By routing only the identical routings above 15 carloads, or 18 percent of the 3,295, more than 75 percent of the carload traffic is captured. The relatively few routings on the upper end of the distribution had little impact on the average number of carloads per shipment. For routings above 49, the average number of carloads per shipment was 4.0, compared with 2.4 for all routings above three carloads. A second advantage of the sensitivity analysis was that a better estimate of carload-link hits could be made for use in determining link rejection criteria. Original estimates used average carloads of 20 with a standard deviation of 133.97. Identical routings with a standard deviation no greater than the mean were used as a minimum objective with a goal of one-half this amount in estimating the number of rejectable links.

TABLE 3

CARLOAD SENSITIVITY

Carloads	Identical Routings	Percent of ID. Routings	ID. Routings Dropped	No. of Carloads	Percent of Carloads	Average Carloads per Routing	Standard Deviation
3 & Above	3295	100		65611	100	19.9	133.97
$3 \leq X \leq 300$	3276	99	19	41683	64	12.7	23.88
$3 \leq X \leq 200$	3263	99	32	38519	59	11.8	18.90
$3 \leq X \leq 99$	3230	98	65	33786	51	10.5	13.17
$3 \leq X \leq 49$	3132	95	163	27287	42	8.7	8.53
$3 \leq X \leq 25$	2947	89	348	20645	31	7.0	4.98
$3 \leq X \leq 15$	2690	82	605	15630	24	5.8	3.18

e. Link Rejection. The ability to reject a link or links within the network without seriously impairing the reliability of capturing a fixed percent of the peacetime rail traffic was desirable. Therefore, a link-rejection method was developed. (See para 2, Annex B.) Table 4 shows the maximum number of rejectable links for 80 percent coverage with varying confidence levels. This table is based on 259,514 carload-link hits and 536 links in the system. For the purposes of this analysis a confidence level of 90 was selected, with 72 carload-link hits for a given link. The maximum number of rejectable links at this confidence level was 161, while the number of actual links with carload-link hits equal to or less than 72 was 114. Therefore, 114 links, representing 27 percent of the network, could, if desired, be eliminated from the system. The impact of this link-rejection table on the volume analysis will be discussed in the traffic routing section.

TABLE 4
LINK REJECTION TABLE*

p \ N_0	70	72	74	75	80	85	90	95
0.95	148	78	43	33	10	4	2	1
0.90	304	161	89	68	20	7	3	2
0.85	---	--	138	104	30	11	5	3
0.80	---	--	--	143	42	16	7	4
0.70	---	--	--	229	67	25	11	6
0.60	---	--	--	---	96	36	16	9

*MAXIMUM NUMBER OF REJECTABLE LINKS FOR 80% COVERAGE WITH CONFIDENCE p, WHERE REJECTION CRITERION IS N_o.

4. Network Development.

a. Potential Rail Corridor Map. A network of links was developed for routing DOD traffic in CONUS. The primary input documents for the 536 links used in routing peacetime traffic were (1) portions of the mainline rail service between leading cities, as defined in the Rand McNally Railroad Atlas, (2) continuous interconnected links of major rail carriers contained in The Official Railway Guide, and (3) FRA's preliminary mainline analysis of lines carrying 20-million gross tons annually. The base network consists primarily of main-line railroad service between leading cities. Once selected, the links were plotted and coded by state and links within states on a CONUS map (see Figure 3.) Appendix A of Annex C contains a list of link codes by state.

b. Rail Junction Index. To quickly locate origins and destinations for routing purposes, a master rail junction index showing both origius and destinations was prepared by state from the following references: (1) Terminal Facilities Guides, (2) Rand McNally Highway Atlas, (3) Rand McNally Rail Atlas, (4) Official Railway Guide, (5) Map Book -- Major Military Installations, (6) US Transportation Zone Maps, and (7) FRA Junction Point File[7/]. This index proved invaluable in rapidly identifying geographical origins and destinations, which in turn made possible the large number of routings in a relatively short time.

7/ References are fully cited in the bibliography.

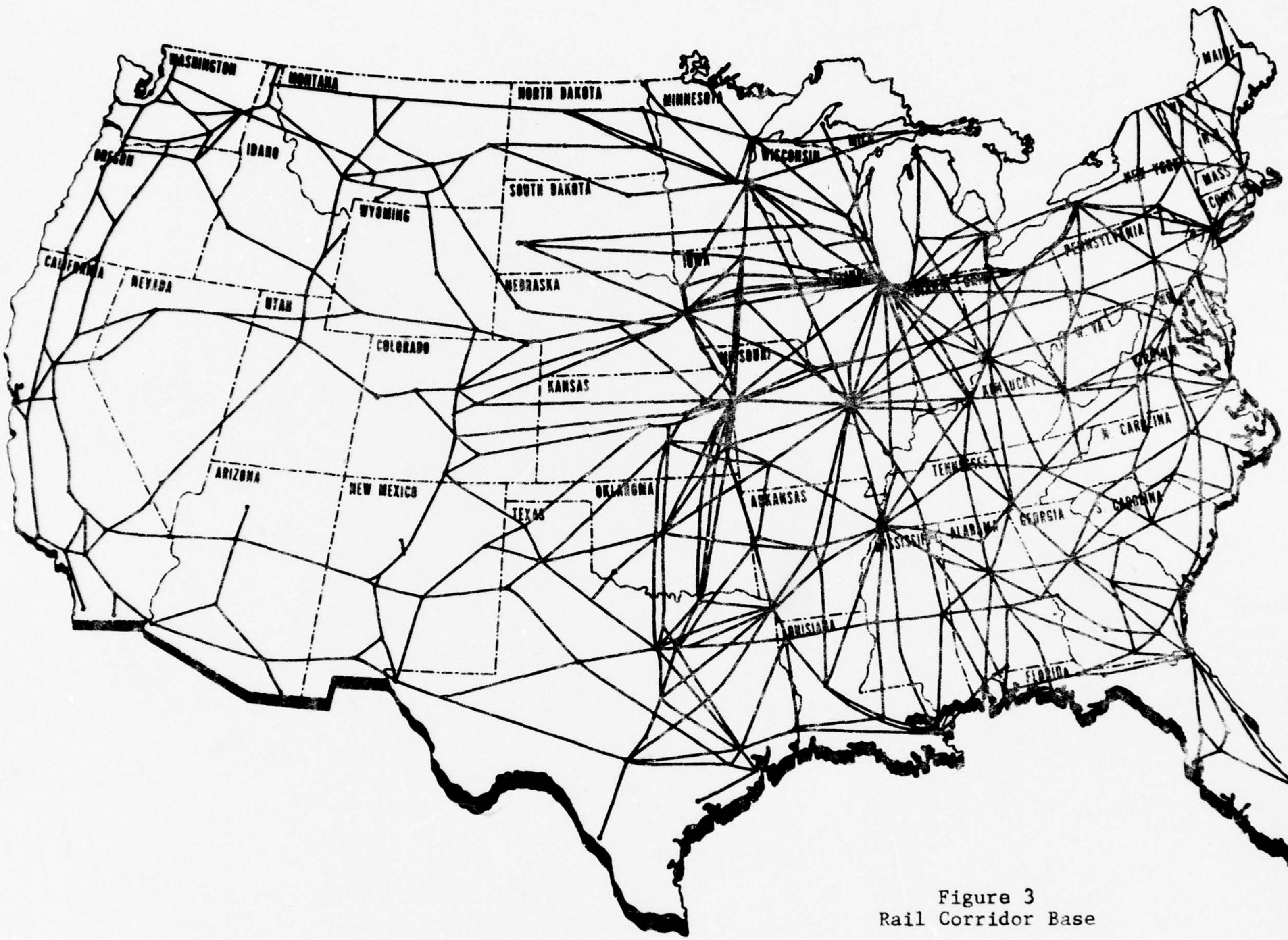

Figure 3
Rail Corridor Base

5. Rail Traffic Routings.

a. Routing Technique. Nearly 3,300 rail routings, reflecting approximately 87 percent of defense peacetime carload traffic were conducted. Traffic-originating points were located by state and by their proximity to corridor links. Carrier routings were then made to point of destination of the closest corridor link to the terminating point. In most cases, corridor links included all carriers whose route structure could be represented by the corridor link. In those cases where an identical routing had a carrier not listed for the corridor, the most convenient carrier available was selected. Actual junctions or interchange points were unknown. However, this factor had little impact on selecting transfer points from one carrier to another. These transfer points were predicated on the division of revenue concept, that is, a carrier would retain the traffic as long as possible before transferring it to the next carrier. From a list of carriers by carrier order and division of revenue, minimum path routings by junction point were made.

b. Routings. As discussed in paragraph 3c above, a consolidated report which contained identical routings with more than two carloads of traffic, was prepared from the freight and routing file on defense rail traffic between origins and destinations for the period 1 Aug 74 to 31 Jul 75. The report format, or record layout, used in conducting the routings is shown in Figure 4. The state codes in the Government bill of lading report were used to identify the state maps in the rail junction index, as well as the first two characters of the four digit codes assigned to the candidate corridor links. The second two characters identified the links within states. Figure 5 is a histogram of carload-link hits, by class interval, for the peacetime analysis. Approximately 27 percent, or 143, of the 536 links had 100 or fewer carloads of defense traffic, and only about six percent of the links had more than 1,500 carloads. Carload-link hits for all routings exceeded one-quarter million. An average link had more than 500 carload-link hits. A detailed listing of carload-link hits by state is given in Appendix A of Annex C. The link-rejection table was used to determine links having minimal impact on the volume analysis. For this analysis, links with fewer than 72 carload-link hits did not warrant further consideration. The 114 rejected links are contained in Appendix B of Annex C. The results of the volume analysis are shown by four categories in Figure 6.

Origin		Destination		Participating Carriers							Shipments	Carloads	Wt
St	City	St	City	Car #1	Car #2	Car #3	Car #4	Car #5	Car #6	Car #7			

Figure 4, Record Layout Extracted from the GBL File

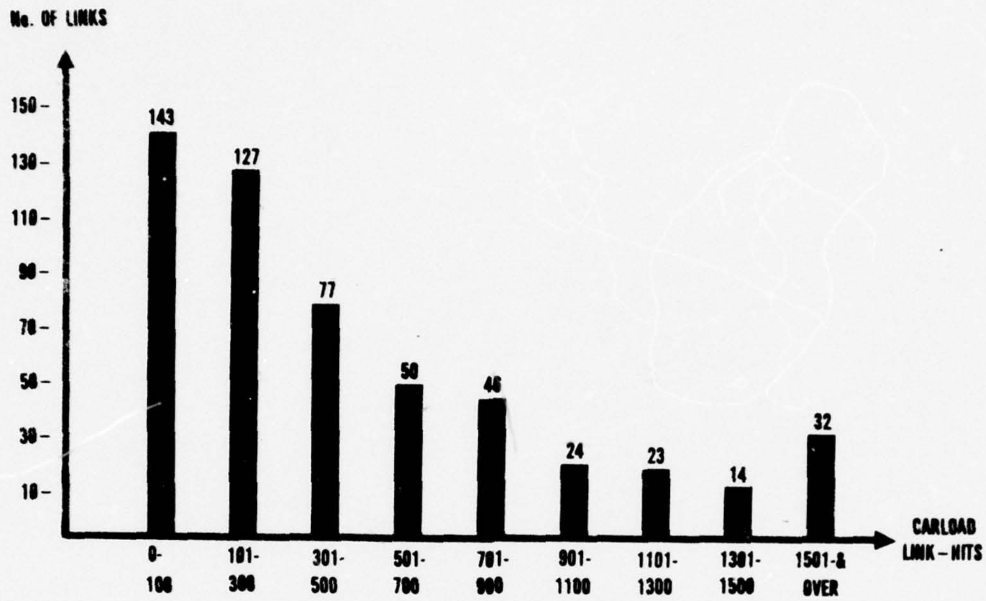

FIGURE 5 LINKS BY CARLOAD-LINK-HIT

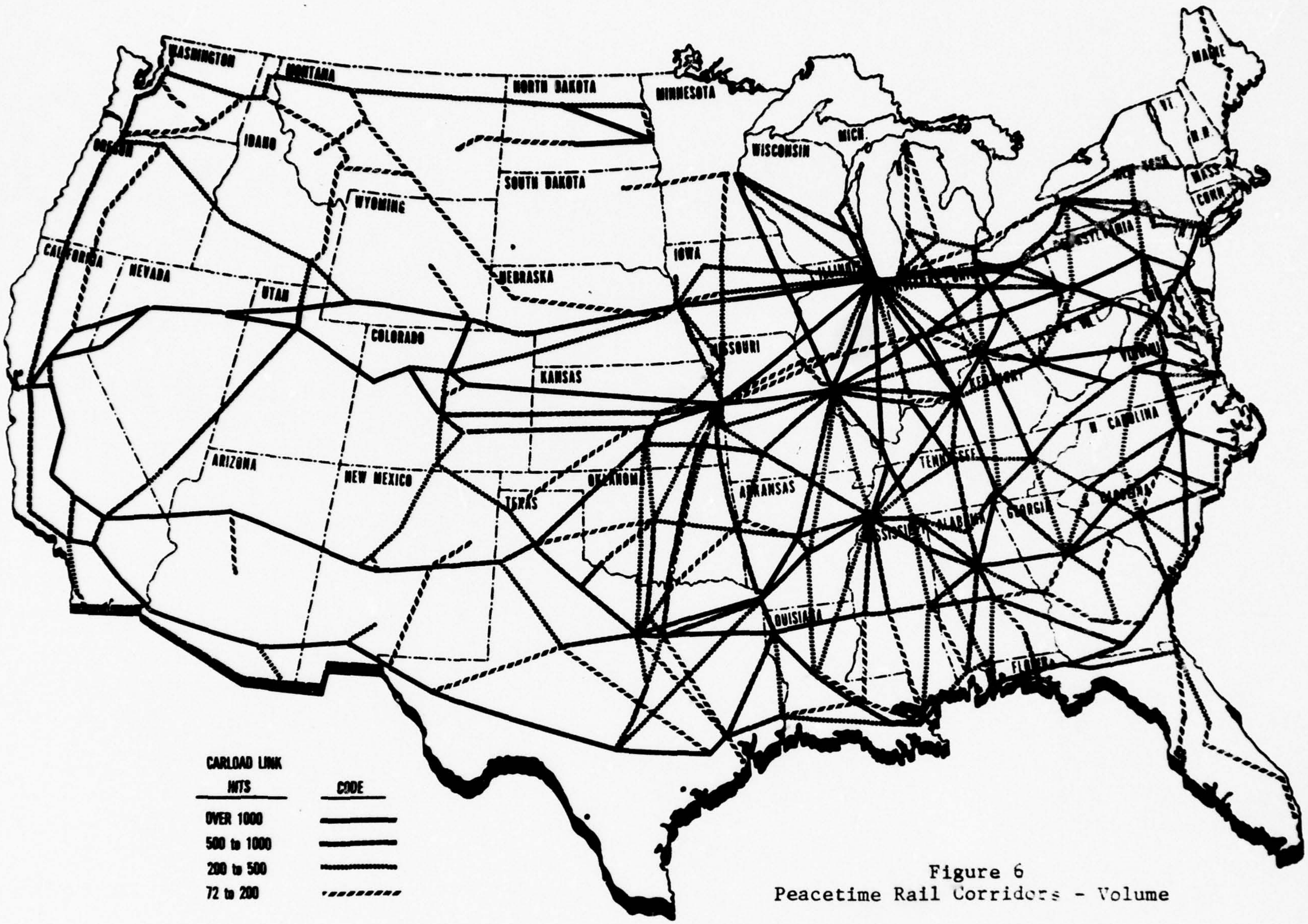

Figure 6
Peacetime Rail Corridors - Volume

6. Intrastate vs Interstate Rail Traffic. It was observed during the rail routings that a significant amount of rail traffic was moving intrastate. Therefore, an analysis of intrastate vs interstate traffic was made. Of the 3,295 identical routings, 305, or less than 10 percent were intrastate. However, these 305 identical routings accounted for approximately 40 percent of all carload traffic. The average number of carloads for an intrastate move was 84 for an identical routing, compared with an average interstate routing of 13. This would indicate that, in general, higher density routes are used over shorter line-haul distances. An examination of intrastate records revealed that almost all moves are made by not more than two carriers. Table 5 shows the intrastate rail carload traffic by state, percent, and rank. Twenty-five states had fewer than 25 carloads of defense goods moving within the state. Figure 7 illustrates that 90 percent of all intrastate traffic occurs in seven states. Five of these seven states are identical to the seven states originating the most traffic, as shown in Figure 1.

TABLE 5

INTRASTATE RAIL CARLOAD TRAFFIC 1 AUG 74 TO 31 JUL 75

State	Carloads	Percent	Rank	Cumulative Percent
Alabama	436	.017		
Arizona	0			
Arkansas		0		
California	828	.032	7	.887
Colorado	73	.003		
Connecticut	0			
Delaware	0			
Florida	582	.023		
Georgia	14	.001		
Idaho	0			
Illinois	155	.006		
Indiana	50	.002		
Iowa	235	.009		
Kansas	9	.000		
Kentucky	73	.003		
Louisiana	0			
Maine	0			
Maryland	0			
Massachusetts	12	.001		
Michigan	2,150	.084	3	.666
Minnesota	0			
Mississippi	47	.002		
Missouri	70	.003		

TABLE 5 (cont.)

INTRASTATE RAIL CARLOAD TRAFFIC - 1 AUG 74 TO 31 JUL 75

State	Carloads	Percent	Rank	Cumulative Percent
Montana	0			
Nebraska	0			
Nevada	0			
New Hampshire	0			
New Jersey	0			
New Mexico	0			
New York	4	.000		
North Carolina	10,524	.409	1	.409
North Dakota	1,831	.071	5	.809
Ohio	341	.013		
Oklahoma	51	.002		
Oregon	11	.000		
Pennsylvania	129	.005		
Rhode Island	0			
South Carolina	1,840	.072	4	.738
South Dakota	37	.001		
Tennessee	446	.017		
Texas	4,448	.173	2	.582
Utah	37	.001		
Vermont	0			
Virginia	96	.004		
Washington	1,173	.046	6	.855
West Virginia	0			
Wisconsin	4	.000		
Wyoming	0			
TOTAL	25,706			

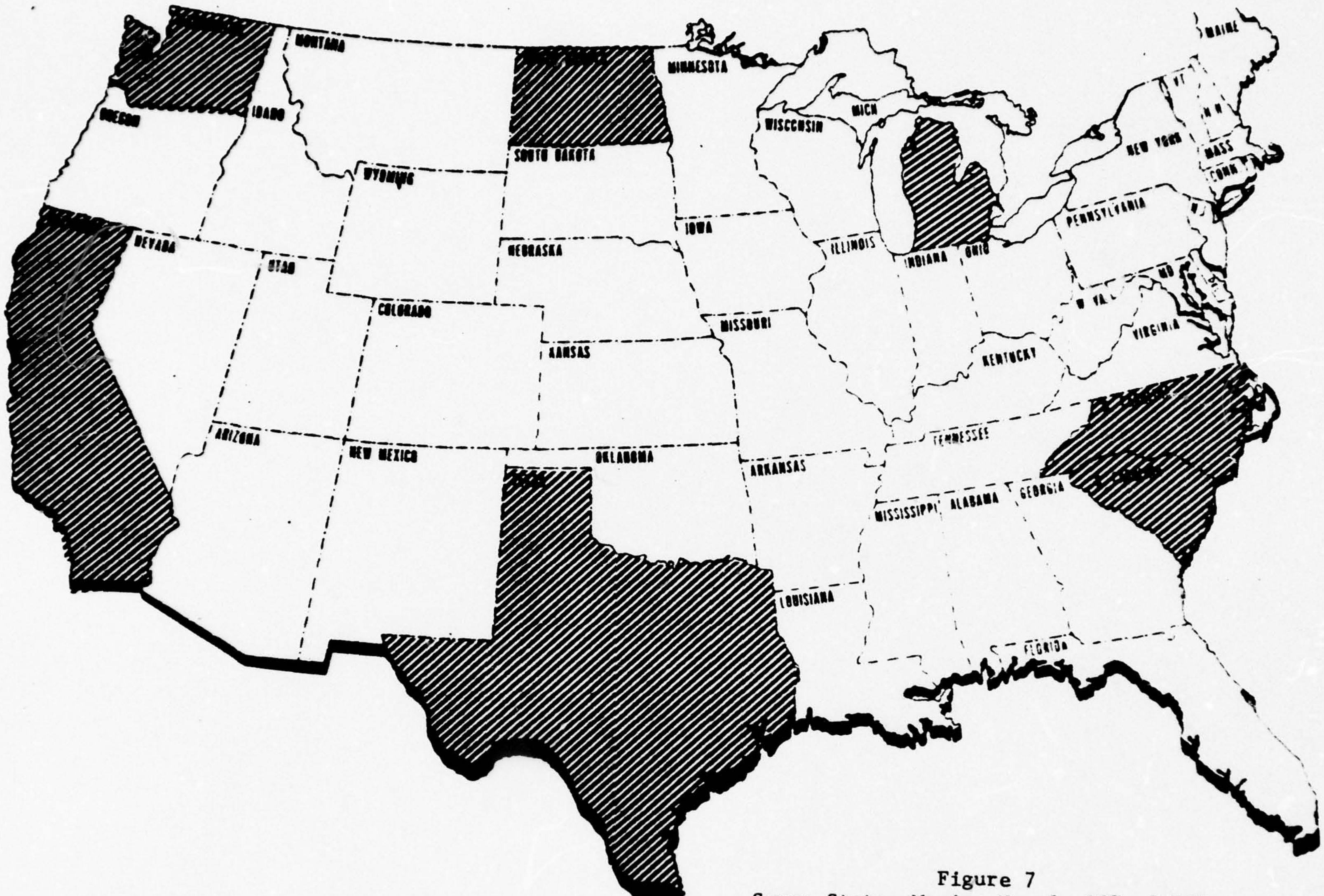

Figure 7
Seven States Moving Nearly 90% of DOD
Intrastate Carloads
1 Aug 74 to 1 Jul 75

SECTION III

DOD PEACETIME CORRIDOR ANALYSIS:

CLEARANCE

1. General. Rail movements of outsize and/or overweight items of equipment represent a special area of interest. Annex D contains a listing of rail outsize/overweight equipment[8/]. The accepted procedure for handling out-size/overweight shipments is by exception through the routing authority issuance of DD Form 1085, Domestic Freight Request and Order. With the reorganization of rail lines in the northeast, the retention of clearance routes became an issue. It was in this climate of change and abandonment that the Railway Industrial Clearance Association (RICA) identified clearance routes in the northeast. This information was used in conjunction with clearance data on tractor tanks to establish clearance corridors in the network analysis.

2. Railway Industrial Clearance Association (RICA). A map prepared by RICA showed historical clearance routes in the northeastern United States. This map originally was used as a basis for comparing rail abandonments to the loss of rail clearance capability. The routes conform to or exceed the requirements set forth on clearance plate "C" of the AAR.[9/] This map was incorporated into our potential rail corridor map, which shows both the RICA information and clearance routes relating to combat tanks discussed below (see Figure 9.)

3. Combat Tanks.

a. General. Combat tanks were selected as a unique item in DOD's inventory because they represent (1) a high priority sophisticated weapon, (2) an overweight item of equipment, (3) an outsized item of equipment for rail due to their excessive width, and (4) because they have been shown to require excessive transit movement time. Shipments of combat tanks were traced by extracting from the freight and routing file two uniform freight classifications (UFCs) on combat tanks with and without guns. This information was taken from the same data base

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8/ Items of equipment that exceed 128" width or 137" height (44" above rail) or 26 STON are considered overweight/outsize.

9/ Railway Line Clearance, National Railway Publication Company, June 1975, XI.

as the peacetime volume analysis. Combat tank routings proved advantageous in that they represent a broad geographical distribution pattern of potential clearance corridors in CONUS and, therefore, act as a proxy for clearance corridors in general.

b. Routings. As in the case of volume analysis, combat tank records were aggregated into identical routings by origin, state, and city; destination, state, and city; and carriers by carrier. This reduced the number of records from 1,995 to approximately 400 identical routings, moving 2,668 carloads of rail traffic. In addition to the information derived from the data base, standard point location codes (SPLCs) were identified for the rail carrier interchange points.[10/] The inclusion of interchange points greatly enhanced the reliability of a given routing, more accurately reflecting the true route. Clearance corridors for combat tank routings are shown in Figure 9.

c. Future Developments. Even though the information on combat tanks was useful in obtaining a clearance structure for specific routes, a general model for describing clearance routes was considered highly desirable. In support of this requirement a defense traffic route analysis model (DTRAM) was developed.[11/] This model will be programed and tested by the Federal Railroad Administration, using DOD combat tank information developed in paragraph b above. The model, based on a historical file of origins, junctions, and destinations, is designed to give all possible combinations of routes. The model can be modified by both macro and micro constraints. A system view of the model is contained in Annex E. Critical to the development of this model is a mileage, or trip, table for all origins, destinations, and junction points which is currently being developed by FRA.

10/ Standard point location codes (SPLCs) for interchange points were provided by the Freight Traffic Division, HQ MTMC.

11/ Defense traffic route analysis model (DTRAM) was developed by Lt. Thomas Bouvé (USNR), Mobilization Designee (MOBDES), HQMTMC, Jun 1976.

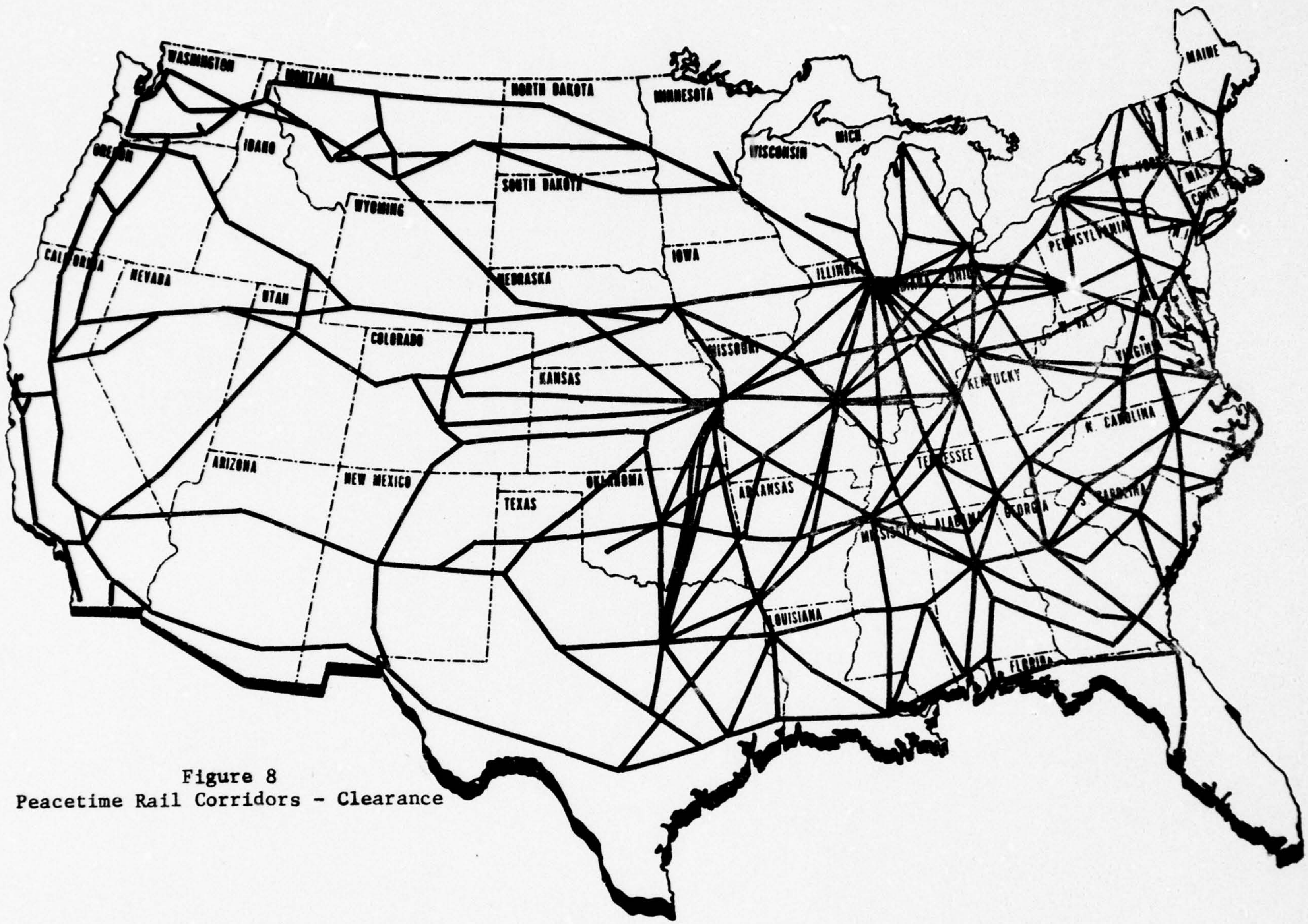

Figure 8
Peacetime Rail Corridors - Clearance

SECTION IV

CONTINGENCY ANALYSIS

1. General. The DOD relies heavily on the rail system to support contingency requirements. To assess rail needs, origin/destination pairs were obtained from the Mobility Plans Division, Directorate of Plans and Operations, HQ MTMC. While these origin/destination pairs were not associated with any specific plan, they were considered representative of DOD requirements. These requirements were not examined in terms of volume of traffic, but rather in terms of corridors of access to ports of embarkation (POEs). The capability of the rail corridors to accommodate surges of DOD traffic during contingencies was assumed to be adequate, that is, other bottlenecks would develop in the logistics chain, such as daily throughput capacities at seaports of embarkation (SPOEs), would break down before rail. The rail system's capability is, however, discussed in terms of a post-nuclear rail environment as portrayed by another study in the literature.[12/]

2. Analysis. To determine corridor-network requirements, over 700 origin/destination pairs were examined. The potential rail corridor map used for the peacetime clearance analysis was used also to develop a contingency overlay. Unlike the peacetime analysis, the contingency analysis did not include actual rail carriers. Therefore, rules were established to govern the hypothetical movement of traffic between pairs. Since corridors represent carrier(s) in a broad geographical sense, carrier retention for similar directional flows was viewed as practical and efficient. Carrier retention also conforms to the division of revenue concept, under which the railroads operate, and thereby better depicts the actual flow of goods. Given these constraints on the routings, the contingency analysis covered minimum distance paths for the pairs. The completion of routings based on carrier retention was determined necessary but not sufficient. Therefore, where practicable, alternate routes were built into the system, allowing a certain level of redundancy in the contingency network. Redundancy or circuitous routing has a functional value as well: by utilizing a storage in motion concept, export shipments can become inventories in motion. This concept was developed during the Vietnam crisis, with the red, white, and blue routes for ammunition shipments. Figure 10 shows the results of contingency routings. An overlay was developed to be used in conjunction with the

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12/ A System Analysis of the Effects of Nuclear Attack on Railroad Transportation in the Continental United States, by Harvey L. Dixon, Dan G. Naney, and Paul S. Jones, Stanford Research Institute, Menlo Park, California, April 1960.

peacetime and clearance overlays for further network refinement.

3. Force Deployment. The rapid deployment of major combat forces and the role rail plays in their deployment is essential in strategic planning. Key posts, camps, and stations, were identified and are listed in Annex G. These installations are expected to generate surges of equipment and supplies during the initial phases of deployments. Even though the capability of the rail system is assumed to be adequate, it is critical to recognize the importance of responsiveness to DOD requirements in force deployment.

4. Post-Nuclear Rail Environment. The potential for a nuclear attack against military and population centers represents the worst case contingency. An important study conducted by the Stanford Research Institute showed that, in their transportation model, service between the east and west coasts would be completely destroyed.13/ Annex F contains the study's applicable conclusions and a diagram showing the impact of a post-1965 nuclear attack on military and population centers. The Stanford transportation model was compared with the strategic rail corridor network to identify deficiencies relevant to contingencies. The network, as shown in the Stanford model, is compatible with STRACNET.

13/ Dixon, Naney, and Jones, op. cit.

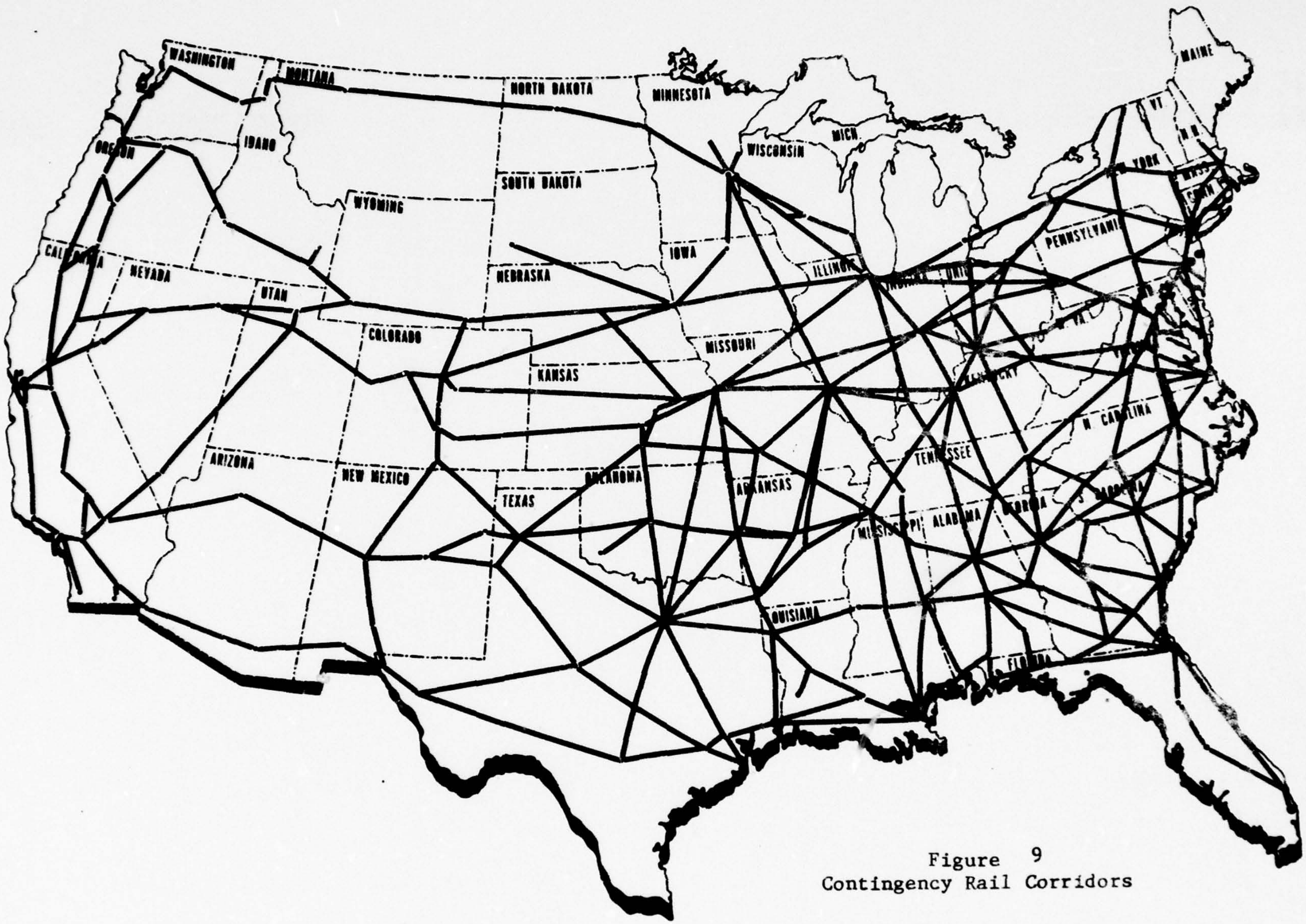


Figure 9
Contingency Rail Corridors

SECTION V

CONSIDERATION OF SUBJECTIVE CRITERIA

1. General. The preceeding three sections discussed objective measures of the strategic rail corridor network through a rail traffic analysis for volume, clearance, and desired traffic patterns for contingency origin/destination pairs. It is not enough, however, to examine these three dimensions of the network without also considering those explicit attributes that are not only intrinsic to the system, but also essential for network integrity from a strategic point of view. These attributes, interconnectivity, service, and strategic requirements, were incorporated into the final corridor design and will be discussed in this section.

2. Interconnectivity.

a. Network Integrity. The geographical cohesiveness of a rail system is essential in maintaining network integrity. Therefore, an interconnected network was considered desirable for the efficient and effective transport of military materiel and personnel. An inter connected network in this sense does not mean that a junction point must be connected by more than one other junction, but that all junction points must be connected to the system by at least one link. The network must connect population centers as well as yield access to ports. Population centers and ports are discussed below. General Pershing has been quoted as saying: "The basic elements of a transportation system are contained not only in unity of form and harmonious symmetry, but also by spatial completeness with respect to the present and future needs of the services." The concept of interconnectivity then and today remains the same.

b. Population Centers. The ability of a rail system to serve major population centers was considered essential. Major population centers were defined as Standard Metropolitan Statistical Areas (SMSAs) 14/ which contained more than one-third million persons. Table 6 contains

14/ Standard Metropolitan Statistical Areas, prepared by the Statistical Policy Division, Office of Management and Budget, 1975.

TABLE 6

STANDARD METROPOLITAN STATISTICAL AREAS (SMSA)
WITH MORE THAN ONE THIRD MILLION PERSONS

SMSA Title	State(s)	Population (000's)
Akron	OH	679
Albany-Schenectady-Troy	NY	778
Albuquerque	NM	333
Allentown-Bethlehem-Easton	PA-NJ	594
Anaheim-Santa Ana-Garden Grove	CA	1,420
Atlanta	GA	1,598
Baltimore	MD	2,070
Baton Rogue	LA	376
Beaumont-Port Arthur-Orange	TX	346
Birmingham	AL	767
Boston	MA	2,899
Bridgeport	CT	402
Buffalo	NY	1,349
Canton	OH	394
Charleston-North Charleston	SC	336
Charlotte-Gastonia	NC	558
Chattanooga	TN-GA	370
Chicago	IL	6,979
Cincinnati	OH-KY-IN	1,385
Cleveland	OH	2,064
Columbus	OH	1,018
Dallas-Fort Worth	TX	2,378
Davenport-Rock Island-Moline	IA-IL	363
Dayton	OH	850
Denver-Boulder	CO	1,237
Detroit	MI	4,431
El Paso	TX	359
Flint	MI	507
Fort Lauderdale-Hollywood	FL	620
Fort Wayne	IN	362
Fresno	CA	413
Gary-Hammond-East Chicago	IN	633
Grand Rapids	MI	539
Greensboro-Winston-Salem-High Point	NC	723
Greenville-Spartanburg	SC	473
Harrisburg	PA	411
Hartford	CT	721
Houston	TX	1,999
Indianapolis	IN	1,110
Jacksonville	FL	622
Jersey City	NJ	609
Johnson City-Kingsport-Bristol	TN-VA	373

TABLE 6 (cont.)

STANDARD METROPOLITAN STATISTICAL AREAS (SMSA)
WITH MORE THAN ONE THIRD MILLION PERSONS

SMSA Title	State(s)	Population (000's)
Kansas City	MO-KS	1,272
Knoxville	TN	409
Lansing-East Lansing	MI	424
Los Angeles-Long Beach	CA	7,032
Long Branch-Asbury Park	NJ	459
Louisville	KY-IN	867
Memphis	TN-AR-MS	834
Miami	FL	1,268
Milwaukee	WI	1,404
Minneapolis-St. Paul	MN-WI	1,965
Mobile	AL	377
Nashville-Davidson	TN	699
Nassau-Suffolk	NY	2,553
New Brunswich-Perth Amboy-Sayreville	NJ	584
New Haven-West Haven	CT	411
New Orleans	LA	1,046
New York	NY-NJ	9,974
Newark	NJ	2,055
Newport News-Hampton	VA	333
Norfolk-Virginia Beach-Portsmouth	VA-NC	733
Northeast Pennsylvania	PA	622
Oklahoma City	OK	698
Omaha	NE-IA	540
Orlando	FL	453
Oxnard-Simi Valley-Ventura	CA	376
Paterson-Clifton-Passaic	NJ	461
Peoria	IL	342
Philadelphia	PA-NJ	4,818
Phoenix	AZ	968
Pittsburg	PA	2,401
Portland	OR-WA	1,009
Providence-Warwick-Pawtucket	RI-MA	906
Raleigh-Durham	NC	419
Richmond	VA	542
Riverside-San Bernardino-Ontario	CA	1,143
Rochester	NY	961
Sacramento	CA	801
St. Louis	MO-IL	2,410
Salt Lake City-Ogden	UT	705
San Antonio	TX	888
San Diego	CA	1,358
San Francisco-Oakland	CA	3,110

TABLE 6 (cont.)

STANDARD METROPOLITAN STATISTICAL AREAS (SMSA)
WITH MORE THAN ONE-THIRD MILLION PERSONS

SMSA Titles	State(s)	Population (000's)
San Jose	CA	1,065
Seattle-Everett	WA	1,422
Shreveport	LA	335
Springfield-Chicopee-Holyoke	MA-CT	542
Syracuse	NY	637
Tacoma	WA	411
Toledo	OH-MI	763
Tucson	AZ	352
Tulsa	OK	551
Utica-Rome	NY	341
Washington	DC-MD-VA	2,909
West Palm Beach-Boca Raton	FL	349
Wichita	KS	389
Wilmington	DE-NJ-MD	499
Worchester	MA	37[illegible]
York	PA	330
Youngstown-Warren	OH	536
TOTAL		118,881

a listing of over 100 CONUS SMSAs representing nearly 120 million people.15/ The rail system acts as one primary method of moving cargo and people during times of national emergency. Because of the unique characteristics of rail transportation logistical support by rail cannot, in many cases, be duplicated by other modes of transportation. Rail adds an extra dimension to a multi-mode support requirement in times of critical need.

15/ While only the 100 largest SMSAs were examined, it is estimated that the preliminary mainline system developed by the Federal Railroad Administration serves 35 percent, or 169, of the 486 United States Transportation Zones. These zones include SMSAs and other counties aggregated into zones for the remainder of the country. See, Preliminary Standards, Classification, and Designation of Lines of Class I Railroads in the United States, Vol. I & II, US Department of Transportation, 3 Aug 76.

c. Seaports of Embarkation (SPOEs) and Airports of Embarkation (APOEs). Ports serve as the gateways through which defense materials must flow. Military controlled ports are shown by both type and capability in Table 7. A total of 64 berths are available at these ten military ports. Table 8 is a list of CONUS commercial ports and berths by type strategic for mobility planning[16/]. These 61 ports have a total of 1,072 berths consisting of break-bulk, container, Roll-on/Roll-off (RORO) and barge. Important commercial and military ports were included in the strategic corridor network. Airports of embarkation, like seaports of embarkation, are necessary for the rapid deployment of military forces. The lift capability of the C-5A Galaxy and the C-141A Starlifter, plus the capability of commercial aircraft from the Civil Reserve Air Fleet (CRAF), demands a total integrated logistics system for peacetime as well as for contingencies.

TABLE 7
MILITARY CONTROLLED PORT*
BERTHING CAPABILITY

Port	Break-bulk (General Cargo)	Break-bulk (Ammunition)	Container (Ammunition)	Total
Gulf Outport (MTMC), LA	3			3
MOT Bay Area (MTMC), CA	3			3
MOT Bayonne (MTMC), NJ [1/]	19[2/]			19
MOT Kings Bay (MTMC), CA		2		2
MOT Sunny Point (MTMC), NC [3/]		5	1	6
NAD Earle (USN), NJ		6		6
NCBC Hueneme (USN), CA	5			5
NSC San Diego (USN), CA	2			2
NSC Norfolk (USN), VA	12			12
NWS Concord (USA), CA		6		6
Total Military Controlled	44	19	1	64

*See Table 8 for footnotes.

16/ Military controlled ports and commercial ports are contained in the Military Traffic Management Command (MTMC) - Pamphlet 700-1, Logistics Handbook for Strategic Mobility Planning, February 1971.

TABLE 8

CONUS COMMERCIAL PORT BERTHING CAPABILITY[4/]

Port	Break-bulk	Container	RO/RO	Barge	Total
North Atlantic					
Baltimore, MD	53	7	2	5	67
Boston, MA	14	3			17
Bridgeport, CT	2				2
Falls River, MA	3				3
New Haven, CT	3				3
New London, CT	2				2
New York/New Jersey	112	22	3		137
Philadelphia, PA	41	10	2		53
Portland, ME	3		1		4
Providence, RI	7				7
Searsport, ME	2				2
Wilmington, DE	4				4
Total North Atlantic	246	42	8	5	301
South Atlantic					
Brunswick, GA	2	1			3
Charleston, SC[1/]	8	2		1	11
Hampton Roads/Norfolk [5/]	24	8		10	42
Jacksonville, FL	8	4			12
Miami, FL	11		10		21
Morehead City, NC	5			1	6
Savannah, GA	25	2			27
Wilmington, NC	9	5			14
Total South Atlantic	92	22	10	12	136

(Continued)

TABLE 8 (cont.)

CONUS COMMERCIAL PORT BERTHING CAPABILITY 4/

Port	Break-bulk	Container	RO/RO	Barge	Total
Gulf Coast					
Baton Rouge, LA	5				5
Beaumont, TX	9			2	11
Brownsville, TX	7				7
Corpus Christi, TX	7				7
Freeport, TX	3				3
Galveston, TX	25	2		2	29
Gulfport, MS	7				7
Houston, TX	35	11			46
Lake Charles, LA	9				9
Mobile, AL	24	2			26
New Orleans, LA	75	2	4	4	85
Pascagula, MS	2	4			6
Pensacola, FL 6/	4				4
Port Arthur, TX	3	3			6
Port Isabel, TX	1				1
Tampa, FL	3				3
Texas City, TX	1	1			2
Total Gulf Coast	220	25	4	8	257
West Coast					
Alameda, CA	10	1			11
Anacortes, WA	2				2
Astoria, OR	4	1			5
Bellington, WA	3	1			4
Coos Bay, OR	2				2
Eureka, CA	9			4	13
Everette, WA	9				9
Grays Harbor, WA	4	2			6
Long Beach, CA 7/	35	10		2	47

(Continued)

TABLE 8 (cont.)

CONUS COMMERCIAL PORT BERTHING CAPABILITY[4/]

Port	Break-bulk	Container	RO/RO	Barge	Total
West Coast (cont.)					
Los Angeles, CA	41	8		2	51
Newport, OR	1				1
Oakland, CA[1/]	11	1	1		24
Olympia, WA	4				4
Port Angeles, WA	3				3
Portland, OR	9	3	1		13
Redwood City, CA	2				2
Richmond, CA	5				5
Sacramento, CA	3				3
San Diego, CA	15	4			19
San Francisco, CA	55	4			59
Seattle, WA[7/,1/]	32	18	7		57
Stockton, CA	8	4	1		
Tacoma, WA	18	2			
Vancouver, WA	5				5
Total West Coast	290	70	10	8	378

1/ Ports that can best handle a large quantity of helicopters.
2/ Nine berths are in poor condition and would require major repairs prior to use.
3/ Only six berths available for ammunition use at any one time due to quantity-distance safety restrictions.
4/ All berths have a minimum low water depth of 29 feet, and a minimum length of 500 feet.
5/ Consists of four container handling terminals (Norfolk International (2), Newport News (2), Portsmouth (2), and Lambert Point (2).
6/ Two berths are required for military operations.
7/ Seven Container berths can accommodate side loading RORO vessels.

3. <u>Service</u>. The physical relationship between the rail line and the defense activity is not under investigation since this is assumed to be adequate. Service is used here to describe the capability of the corridor network to support defense requirements. As previously stated, DOD's annual carload traffic is only a small fraction of the Nation's total peacetime traffic. The important question is whether DOD can be served effectively during contingencies. Historically, the answer has been an unqualified yes. With the current levels of deferred maintenance, track abandonments, slow orders, and capital shortages in the rail industry, the answer becomes less self-evident. Contingencies create surges of traffic, sometimes 6 to 20 times greater than defense peacetime flows, over relative short periods of time. These traffic surges are concentrated on a smaller number of corridors depending on the location of the contingency. For this reason, alternate corridors for contingencies are built into the system to insure service retention.

4. <u>Strategic Aspects</u>. Strategic aspects of the rail network will be discussed only in the context of topical areas of concern and their implication for a sound defense posture, rather than an attempt to make a definitive analysis. The logistics support required during the first few days of a conflict must not be understated. Major depots, acting as inventory storage areas, must be assured adequate rail support. A list of major defense depots is contained in Annex H. Of special interest are ammunition storage and manufacturing points, since on-hand inventories are readily exhaustible and the resupply function is felt immediately. A complete analysis of rail service requirements would include a review of the key facilities list maintained by the Defense Supply Agency (DSA) as well as the essential facilities list maintained by the Federal Preparedness Agency (FPA) in cooperation with the Office of Emergency Transportation (OET) in DOT.[17] CONUS topographical features, like key facilities, draw attention to critical corridors. For example, both the number and capacity of rail bridges crossing the Mississippi River and the number of rail lines crossing the Rocky Mountains are strategically important. Rail corridors are retained or added if they represent limited access avenues internal to the rail system or warrant inclusion because activities are dependent upon them.

<u>17/</u> The American Association of Railroads (AAR) is currently updating the Essential Facilities List for the Federal Preparedness Agency. This update is scheduled to be completed by January 1977.

SECTION VI

STRATEGIC RAIL CORRIDOR NETWORK

(STRACNET)

1. General. This section is an integration of the previous four sections. It describes how the volume, clearance, and contingency analysis, as well as subjective criteria, were brought together. The final network includes consideration of the FRA preliminary mainline designations, since they represent the most active railroad lines in the United States.

2. Corridor Priority Designation Process. Based on volume, clearance, and the contingency analysis, a rail corridor priority designation process was designed to assign relative merit to each corridor link. This designation process is shown in Figure 10. A corridor link was assigned a number 1 priority if it contained more than 1000 carload-link hits or from 501 to 1000 link hits and had been identified as having a contingency and clearance requirement. A priority 2 designation was given to links with 201 but not more than 500 carload-link hits and either a contingency or a clearance requirement. Links with 501 to 1000 carload-link hits not assigned a priority 1 designation were assigned to the second priority. A priority 3 was given to links with between 72 and 200 carload-link hits and having either a contingency or a clearance requirement. Links with 201 to 500 carload-link hits not assigned a priority 2 were automatically assigned the third priority. The purpose of this designation process was to insure that those links with a relatively high defense priority would be given proper consideration when the total network was reduced to the minimum essential for national defense. The defense priority links are shown in Figure 11.

3. Application of Criteria. Once corridors on the potential rail corridor map were assigned priority ratings, the network development was undertaken by applying both the priority ratings and subjective criteria. This procedure included the consideration of the FRA preliminary mainline system, defense priority, interconnectivity, and node retention to meet service and strategic requirements. A defense identified priority 1 line would not necessarily retain its priority. For instance, the corridor between Wells, NV and Salt Lake City, UT, carried a priority 1 defense requirement. This line was not included in STRACNET because an alternate acceptable corridor was found compatible to the FRA preliminary mainline system. Where interconnectivity was a deciding factor, an attempt was made to reconcile the corridor link with a FRA mainline. For example, the corridor between Fargo, ND, and

Minneapolis/St. Paul, MN, area was not considered a priority 3 defense requirement. This corridor was needed for purposes of interconnectivity and had no conflict with a FRA mainline connecting these nodes. In most cases, there was no conflict between the strategic rail corridor network and the United States mainline system identified by the Federal Railroad Administration.

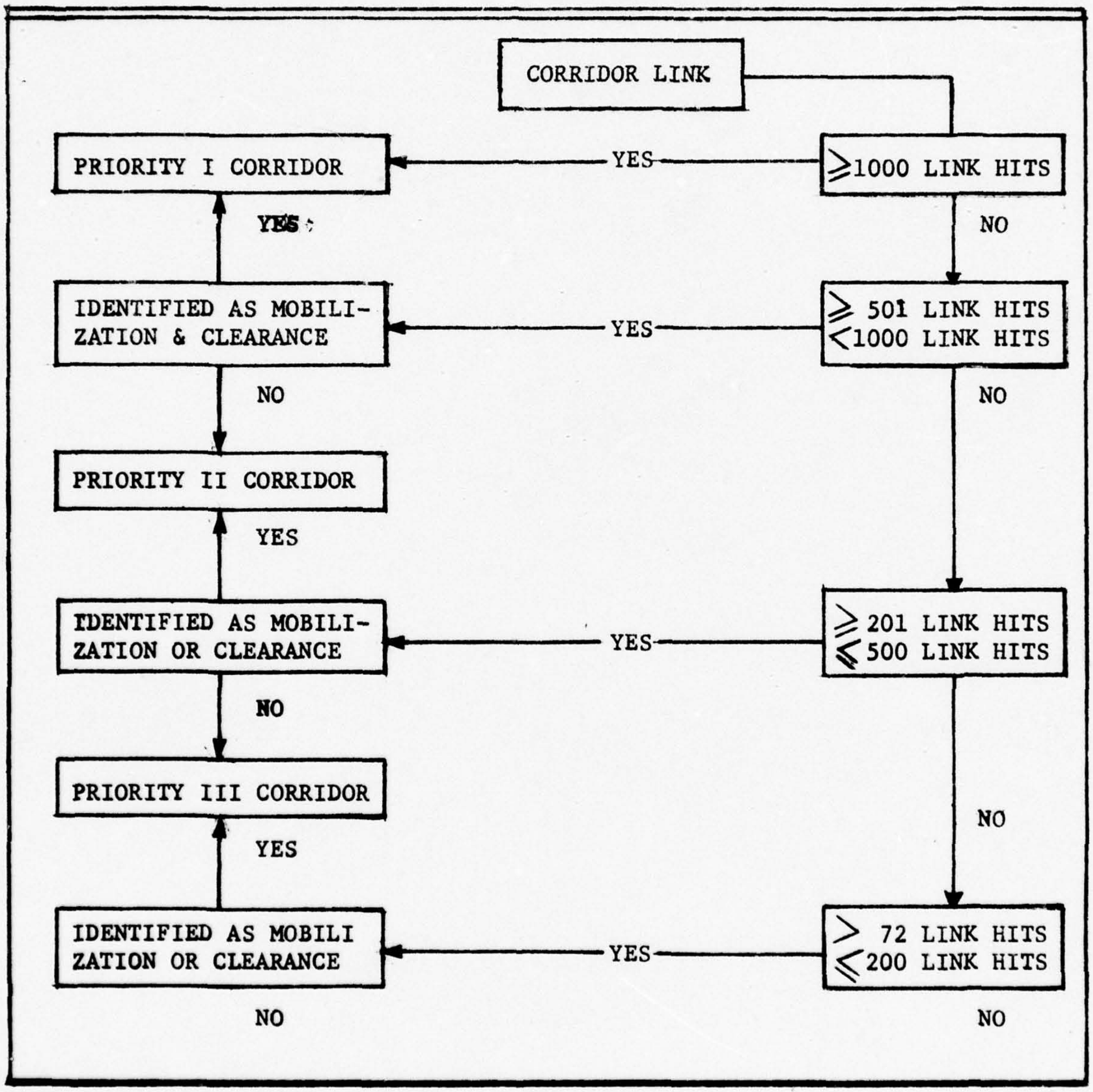


Figure 10
Corridor Priority Designation Process

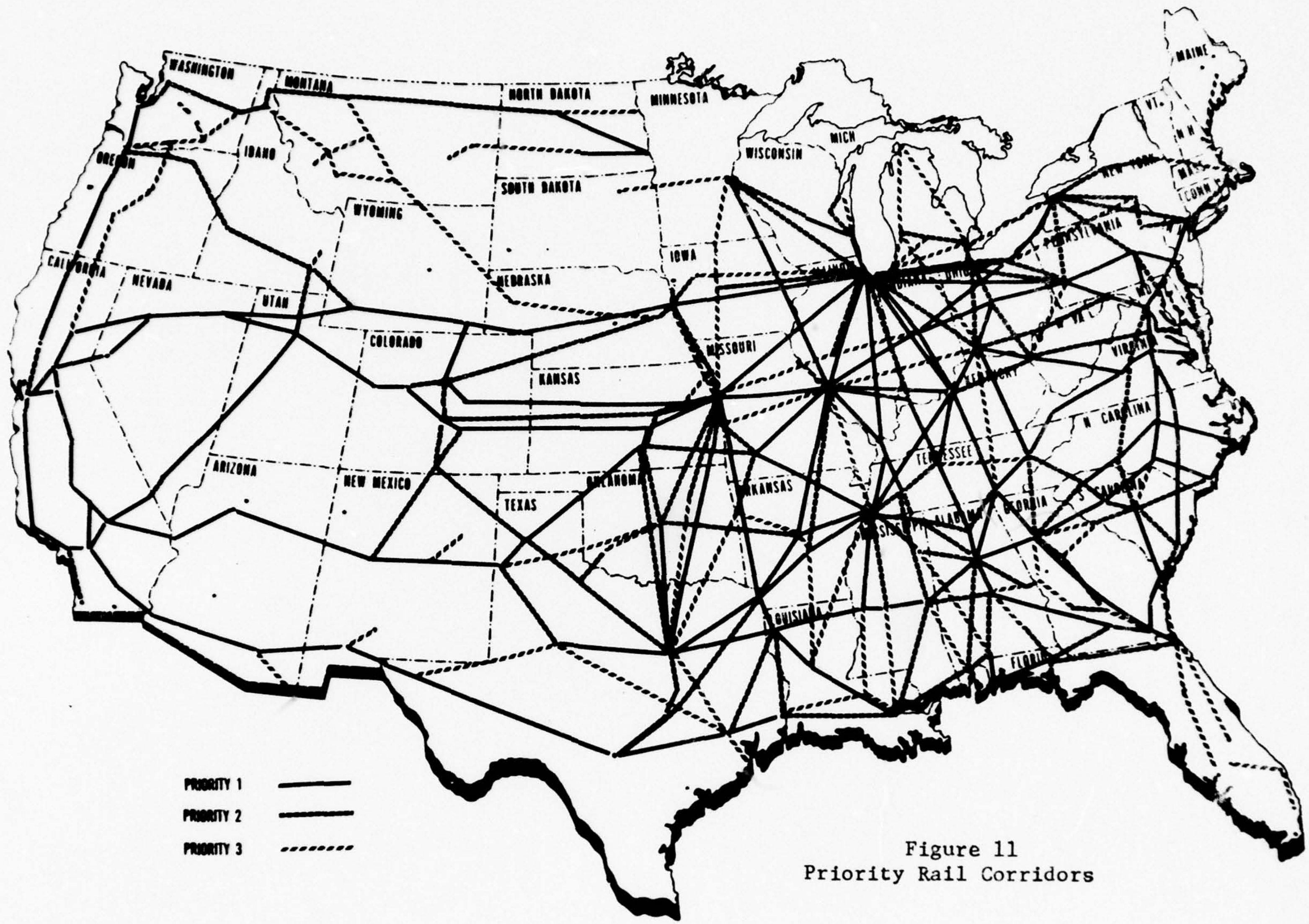
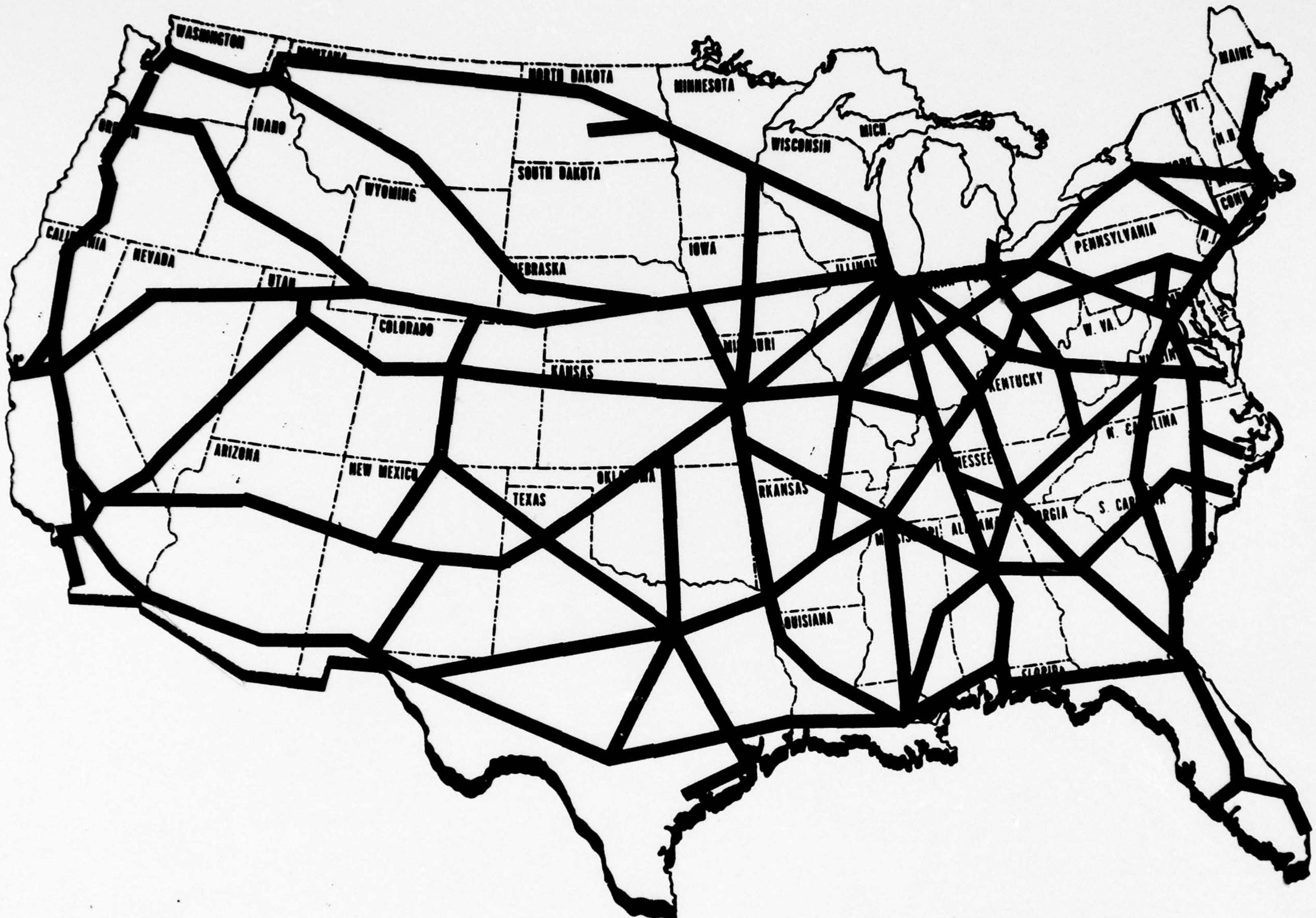


Figure 11
Priority Rail Corridors

4. STRACNET. The result of applying the above criteria is the strategic rail corridor network (STRACNET) which is shown in Figure 12. The final network consists of approximately 30,000 corridor miles. A list of the strategic rail corridor links, showing connecting nodes and mileage is contained in Appendix c of Annex C.



Strategic Rail Corridor Network
(STRACNET)

SECTION VII

CONCLUSIONS AND RECOMMENDATIONS

1. Conclusions.

a. The strategic rail corridor network represents a rail mainline structure for supporting national defense requirements.

b. This network is compatible with the preliminary mainlines identified by the FRA.

2. Recommendations: It is recommended that:

a. The strategic rail corridor network be used as the DOD mainline system of rail corridors.

b. In the development of plans, programs, and standards of the Nation's railroads, consideration be given to the identified corridor system.

BIBLIOGRAPHY

1. AR 55-16, Movement of Cargo by Air and Surface, 18 September 1968.

2. AR 55-39, Statistical Processing on U. S. Government Bill of Lading, June 1968.

3. AR 55-355, Military Traffic Management Regulation, March 1969.

4. AR 55-357, Terminal Facilities Guide United States Army, June 1972.

5. AR 55-358, Terminal Facilities Guide United States Navy, Marine C Corps and Coast Guard, September, 1975.

6. AR 55-365, Terminal Facilities Guide United States Air Force, July 1972.

7. AR 55-365, Terminal Facilities Guide, Commercial Contractors, 1 September 1965.

8. DOD Directive 5160.54, Industrial Facilities Protection Program, 13 October 1973.

9. DOT/FRA Letter, 30 October 1975, subject: Revised Joint DOT/DOD Policy.

10. FRA, Calcomp Printouts on Selected States: "20 Million Gross-Ton Miles," received 17 May 1976.

11. General Rules Governing the Loading of Commodities on Open-Top Cars, Association of American Railroads, Chicago, January 1976.

12. HQ MTMC Letter, 3 September 1975, subject: Joint DOT/DOD Policy Statement.

13. Information Letter, AAR, No. 2193, Washington, DC, 26 May 1976.

14. Information Paper, DALO-TSM, 5 May 1975, subject: Capability of US Railroads to Support Mobilization.

15. Memorandum for Record, MT-SA-RND, 17 November 1975, subject: Railroads for National Defense Program.

16. MTMC-PAM 700-1, Logistics Handbook for Strategic Mobility Planning, February 1971.

17. MTMSR 55-1, Inland Freight Traffic Regulation, 1 June 1973.

18. The Official Railway Guide, North America Freight Service Edition, New York: Intermodal Publishing Company, Ltd., May-June 1976.

19. Official Railway Equipment Register, New York: National Railway Publication Co., July 1975

20. Preliminary Standards, Classification,and Designation of Lines of Class I Railroads in the U. S., Vol I and II, US Department of Transportation, August 1976.

21. Project Charter, Railroads for National Defense, MTMC-C, 29 July 1975.

22. Railway Line Clearances, No. 185, New York: National Railway Publication Company, June 1975, p. XI.

23. Rand McNally Handy Railroad Atlas of the United States, Rand McNally and Company, 1973.

24. SECDEF Letter, 26 April 1976, subject: Railroads for National Defense Legislation.

25. SECDOT Letter, 22 June 1976, subject: Sponsorship of Railroads for National DefenseLegislation.

26. Standard Metropolitan Statistical Areas, (Revised edition 1975), Office of Management and Budget, Statistical Policy Division, Washington, DC: Government Printing Office

27. State Maps of Military Installations and Industrial Facilities, DOD, OASD (Comptroller), Directorate for Information Operations, 30 June 1974.

28. A System Analysis of the Effects of Nuclear Attack on Railroad Transportation in the Continental United States, by Harvey L. Dixon, Dan G. Naney, and Paul S. Jones, Stanford Research Institute, Menlo Park, California, April 1960.

29. Final System Plan, United States Railway Association, Washington, DC: Government Printing Office, 1 December 1975.

30. Preliminary System Plan, United States Railway Association, Washington, DC: Government Printing Office, May 1975.

31. United States Transportation Zone Map, US Dept. of Transportation, Federal Railroad Administration, Washington, DC: Government Printing Office.

ANNEXES

ANNEX A

POINTS ORIGINATING/TERMINATING MORE THAN 50 CARLOADS OF DOD RAIL TRAFFIC

Apr 74 to Mar 75

State/City	Rail Carloads	State/City	Rail Carloads
ALABAMA		CALIFORNIA (cont.)	
Alamet	266	McKay	54
Anniston	251	Merced	55
Birmingham	55	National City	151
Bynum	2,516	Oakland	562
Goodway	212	Planehaven	57
Maxwell AFB	114	Polk	489
Mobile	931	Port Chicago	3,250
Sylacauga	191	Port Hueneme	151
Tuscaloosa	264	Ranch House	162
		Richmond	50
		Riverbend	203
ARIZONA		Sacramento	69
		Santa Clara	201
Bellemont	362	San Diego	229
Wilmot	166	San Francisco	125
		San Jose	157
ARKANSAS		San Pedro	60
		Stockton	235
Baldwin	475	Tangair	51
Calico Rock	55	Vallejo	97
Conway	79	Vernon	646
Pine Bluff	295	Westminster	58
		W. Yermo	400
CALIFORNIA			
		COLORADO	
Alameda	180		
Bagdad	55	Avondale	1,321
City of Industry	150	Kelker	254
Clyde	400	Oak Creek	187
El Monte	226		
Herlong	733		
Kaiser	53	CONNECTICUT	
Lathrop	499		
Long Beach	249	Groton	69
Los Angeles	179		
Lyoth	952	FLORIDA	
Manix	66		
		Jacksonville	551

State/City	Rail Carloads
FLORIDA (cont.)	
Lynn Haven	1,023
Miami	142
Milton	445
Mossy Head	77
Naranja	57
Orlando	66
Pensacola	465
Tampa	75
Yukon	78
GEORGIA	
Albany	179
Atlanta Army Depot	312
Fort Benning (Benning Junction)	90
Doraville	50
Dosaga	313
Homerville	133
Lockair	140
Moody Field	1,021
Warner Robins (Robins AFB)	346
Sandhill	82
Valdosta	200
Vogel	51
Walthourville	236
IDAHO	
Boise	169
Mountain Home AFB	155
Pocatello	65
ILLINOIS	
Chicago	177
Decatur	66
Joliet	2,228
Joliet Arsenal Area	119
Proving Ground	419
Rock Island	621
Savanna	81
Wood River	181

State/City	Rail Carloads
INDIANA	
Austin	93
Bunker Hill	101
Charlestown	1,323
Crane	1,852
Dana	154
Evansville	56
Ft. Wayne (Wayne)	52
Grissom AFB	80
South Bend	497
Terre Haute	132
Whiting	195
IOWA	
Council Bluffs	274
Sergeant Bluff	265
Waterloo	299
West Burlington	2,550
KANSAS	
Kansas City	241
Parsons	3,292
Riley	126
KENTUCKY	
Avon	302
Caney Creek	495
Edgoten	219
Estill	139
Fort Estill	1,283
Fort Knox	335
Leatherwood	137
Louisville	80
Peyler	200
Tilford	80
LOUISIANA	
Alexandria	109
Barksdale AFB	368
Bossier City	79
Doyline	1,337

ANNEX A (cont.)

State/City	Rail Carloads
LOUISIANA (cont.)	
Fort Polk	197
New Orleans	1,397
Rapides	539
Shreveport	884
MAINE	
Limestone	100
MARYLAND	
Aberdeen	124
Baltimore	242
Indian Head Jct	130
Landover	76
MASSACHUSETTS	
New Bedford	53
Otis AFB	96
MICHIGAN	
Bay City	2,182
Center Line	361
Grand Rapids	160
Hart	58
Lansing	605
Manistee	62
Milan	65
Skeel Spur	2,206
Warren	137
MINNESOTA	
Fridley	52
Moorhead	736
New Brighton	417
Ripley	66
St. Louis	132

State/City	Rail Carloads
MISSISSIPPI	
Gulfport	302
Jackson	132
Shelby	190
MISSOURI	
Independence	65
Lake City	767
Newburg	367
St. Louis	242
West Plains	98
MONTANA	
Malmstrom AFB	63
NEBRASKA	
Omaha	62
NEVADA	
Hawthorne Ammo Depot	120
Henderson	83
Thorne	1,115
NEW JERSEY	
Bayonne	804
Earle Ammo Depot	214
NEW MEXICO	
Alamagordo	80
McCune	594
NEW YORK	
Brooklyn	169

ANNEX A (cont.)

State/City	Rail Carloads
NEW YORK (cont.)	
Calcium	112
Kendaia	484
Little Falls	70
West Point	80
NORTH CAROLINA	
Beaufort	10,203
Bryson City	71
Camp LeJeune	419
Cherry Point	2,509
Durham	90
Edenton	59
Fayetteville	972
Fort Bragg	2,571
Goldsboro	312
Jacksonville	556
Leland	3,739
Millers	5,679
Winston-Salem	55
NORTH DAKOTA	
Grand Forks (AFB)	858
Mandan	1,766
Minot (AFB)	302
Tatman	2,158
Williston	296
OHIO	
Akron	162
Atlas	256
Cincinnati	579
Columbus	653
Dayton	54
Fairborn	145
Lima	73
Lockbourne	449
Mansfield	132

State/City	Rail Carloads
OHIO (cont'd)	
Patterson	824
Rickenbacker AFB	62
St. Mary's	299
OKLAHOMA	
Altus	502
Ft. Sill	338
Haywood	719
McAlester Ammo Depot	63
Midwest City	61
Savanna	904
Stringtown	55
Tinker AFB	59
OREGON	
Klamath Falls	78
Ordnance	269
Portland	115
Riddle	73
PENNSYLVANIA	
Berwick	72
Bethlehem	54
Chambersburg	85
Cornwells Heights	108
Culbertson	861
Indiantown Gap (Military Reservation)	105
Johnstown	56
Lemoyne	136
Letterkenny Army Depot	602
McKees Rocks	143
Mechanicsburg	1,796
New Cumberland Army Depot	1,087
Parkesburg	105
Philadelphia	171

State/City	Rail Carloads
PENNSYLVANIA (cont.)	
Scranton	636
Tobyhanna (Army Depot)	271
York	639
RHODE ISLAND	
Davisville	130
SOUTH CAROLINA	
Cane Savannah	271
Charbulk	1,704
Charleston	884
Inness	239
Jackson	168
Miller	110
Mullins	206
North Charleston	100
Sumter	1,489
SOUTH DAKOTA	
Sioux Falls	215
TENNESSEE	
Bruceton	56
Greenville	75
Holston	648
Kingsport	666
Memphis	2,853
Milan	2,458
Tyner	599
TEXAS	
Atlanta	267
Baytown	243
Beaumont	291
Benbrook	1,864
Cadet	67

State/City	Rail Carloads
TEXAS (cont.)	
Carswell AFB	62
Defense	3,304
Fort Bliss	177
Fort Hood	116
Fort Worth	4,696
Garland	262
Houston	120
Karnack	155
Kelly AFB	68
Killeen	445
Mountain Creek	736
Olcott	325
Pasadena	911
San Antonio	213
Sheppard AFB	220
Texarkana	89
Texas City	53
UTAH	
Arsenal	57
Bacchus	162
Hiawatha	216
Hill AFB	601
Ogden	581
Thiokol	104
Tooele (Army Depot)	83
Warner	2,038
VIRGINIA	
Bellbluff	884
Blacksburg	127
Camp A. P. Hill (Milford)	82
Danville	78
Dublin	285
Lee Hall	142
Lynchburg	62
Newington	56
Newport News	95
Norfolk	941

ANNEX A (cont.)

State/City	Rail Carloads	State/City	Rail Carloads
VIRGINIA (cont.)			
Pepper	387		
Portsmouth	186		
Quantico	52		
Wysor	66		
WASHINGTON			
Bangor	65		
Bremerton	216		
Fairchild	1,071		
Fort Lewis	173		
Mobase	112		
Mukilteo	1,364		
Pomona	137		
Seattle	411		
Tacoma	136		
Vancouver	102		
WEST VIRGINIA			
Stone Coal	128		
Stonecoal Yard	62		
WISCONSIN			
Camp McCoy	184		
Douglas	60		
Eau Claire	2,145		
Janesville	75		
Marinette	160		
Merrimac	222		
North Madison	199		
Sparta	51		
Waukesha	53		
WYOMING			
Cheyenne	225		

ANNEX B

SAMPLING FOR CORRIDOR DETERMINATION FOR RAILROADS FOR NATIONAL DEFENSE

I. Problem.

1. We consider given a network of M links (where M is an integer) which represents either a rectilinear grid placed on the United States or a system of rail corridors through the country which is considered to be exhaustive. Also given is a bin, B, of information from which samples may be drawn, each bin record giving the link location of one rail carload. We will refer to this notional record as a "carload-link hit". Further, suppose that p_i is the probability that a random carload-link hit is on link i, where i=1,...,M, and suppose the events of hitting various links are independent. Thus, p_i is the relative frequency of use of link i, and if N records are extracted randomly from B, one would expect Np_i of them to hit link i.

2. We are interested in drawing a sample of size N from B and estimating Pi by $\hat{P}_i = N_i/N$, where N_i is the observed number of carload-link hits on link i. Under the assumptions of paragraph 1 above, the observed N_i are multinomially distributed with parameters p_i, so that the probability of observing the M-tuple $(N_1,\ldots,N_M)$ is given by

$$p(N_1,\ldots,N_M) = \binom{N}{N_1 \cdots N_M} P_1^{N_1} \cdots P_M^{N_M} \qquad (1)$$

and the $\hat{p}_i$ are unbiased estimators of the population values. It is desired to determine a "reasonable" sample size N for estimating the p_i to a required precision. This problem is considered in Section II below.

II. Analysis.

1. Sample size. The number of records which can be extracted from bin B is sharply limited by the labor required to process each one. On the other hand, the larger the sample, the more certain one is of the estimates of p_i. A "reasonable" sample size should strike a balance between these conflicting demands.

a. Under the assumption that the observed N_i are multinomially distributed with parameters p_i, the quantity

$$Q = \sum_{i=1}^{M} (N_i - Np_i)^2/Np_i$$

is distributed approximately as χ^2 with M-1 degrees of freedom. Let us state a measure of the closeness of the estimated $\hat{p}_i$ and the true P_i thus: the observed N_i and the expected Np_i are ε-close for $\varepsilon>0$ provided

$$\sum_{i=1}^{M} (N_i - Np_i)^2 < \varepsilon^2. \qquad (2)$$

This means that $(N_1,\ldots,N_M)$ is in an ε-neighborhood of $(Np_1,\ldots,Np_M)$ in R^M (real M-dimensional space). Note that we can force (2) by requiring $Q < \varepsilon^2/N$, since

$$Q \geq (1/\max(Np_i)) \sum_{i=1}^{M} (N_i - Np_i)^2 \geq (1/N) \sum_{i=1}^{M} (N_i - Np_i)^2.$$

Let ${}_\rho\chi^2(\nu)$ denote that value of χ^2, with ν degrees of freedom, such that the probability of $\chi^2 < {}_\rho\chi^2(\nu)$ is ρ. Then we can be $100\cdot\rho$ percent confident that (2) holds, provided

$${}_\rho\chi^2(\nu) < \varepsilon^2/N. \qquad (3)$$

We choose $\varepsilon=0.2N$. If (2) holds for this value of ε, we can say that the root mean error of estimate of the frequencies p_i is less than 20% with $100 \cdot \rho$-% confidence. With this value, (3) becomes

$$_{\rho}\chi^2(\nu) < 0.04N. \qquad (4)$$

The required sample size is then known when we specify ν and ρ. Take $\rho=0.99$ and $\nu=M-1=541$. Then $_{.99}\chi^2\ (541) \simeq 619.82$ and $N > 15{,}496$.

b. Previous work has shown we can expect about 14 carload-link hits per Government Bill of Lading (GBL) file record, so the number of GBL records to be examined is 1,107. If we desire a closer bound on the root mean error of estimate, the sample size must balloon rapidly. To lower this error to 10% would require examination of 4,428 GBL records, and in general, to double the precision requires four times as many records.

c. The final sample taken was considerably larger than that required for a 99% confidence of root mean square (RMS) error less than 20%. In fact, 252,650 link-hits were observed. The expected RMS error of estimate is therefore less than about 5%, at the 99% confidence level.

2. Link rejection.

a. While it is of interest to estimate the probabilities p_i, it would also be useful to have a criterion by which to decide than an observed link usage is so low that it can be withdrawn from the initial corridor network. Such a criterion is available; however, it must be applied with great caution. Note that, using the sample size derived in paragraph II.1. above, the best one can say about a given link i is that $|P_i - (N_i/N)| < 0.2$. This degree of precision generally permits no rejection whatever; even if $N_i=0$, the link must be retained.

b. Some improvement in the situation can be made as follows. Suppose we consider only one link of the net. Suppose, too, that any frequency p for this link is as likely as any other. A simple application of Bayes' Theorem yields the following distribution for the frequency p given the observed number of successes, S, is below some value, N_o, in N attempts:

$$\text{prob}(p \mid S \leq N_o) = ((N+1)/(N_o+1)) \sum_{i=0}^{N_o} \binom{N}{i} p^i (1-p)^{N-i} \qquad (5)$$

Integrating this, we obtain

$$\text{prob}(p<\alpha|S\leq N_o) = (1/(N_o+1)) \sum_{i=0}^{N_o} I_\alpha(i+1,N-i+1),$$

where $I_\alpha(m,n)$ is the incomplete beta distribution with parameters m and n.

Denote the probability computed in (6) by $p(\alpha,N_o)$. Suppose we would like to be $100\cdot\rho$ percent confident that all rejected links account for less than $100\cdot\beta$ percent of the traffic flow. Assume that the same sample of 252,650 link-hits provides adequate data for evaluation of each link. (While this is definitely not correct, the number of rejectable links is generally so low that the error introduced should not be serious.) Then N_r, the maximum number of rejectable links, using N_o as a rejection criterion, is found from

$$[p(\alpha,N_o)]^{N_r} = \rho$$

or

$$N_r = \text{int}[\ (\log\ \rho)/p(\alpha,N_o)],$$

with $\alpha = \beta/542$. Taking $\beta=0.2$, this computation yields Table 1.

TABLE 1
MAXIMUM NUMBER OF REJECTABLE LINKS FOR 80% COVERAGE WITH CONFIDENCE ρ, WHERE REJECTION CRITERION IS N_o.

ρ \ N_o	70	72	74	75	80	85	90	95
0.95	148	78	43	33	10	4	2	1
0.90	304	161	89	68	20	7	3	2
0.85	---	---	138	104	30	11	5	3
0.80	---	---	---	143	42	16	7	4
0.70	---	---	---	229	67	25	11	6
0.60	---	---	---	---	96	36	16	9

c. In choosing a reasonably good link rejection criterion, one would desire a high number of rejectable links, and a level of rejection not so conservative as to be essentially useless in modifying the initial rail corridor network. With these considerations, 72, 74, or 75 seem to be excellent numbers to choose.

d. It must be emphasized that Table 1 represents essentially rules of thumb. On the one hand, we have ignored the declining value of the sample information for successive link evaluations. On the other hand, the choice of α is excessively strict when the maximum number of rejectable links is under 20% of the total. The net effect is probably conservative.

3. Caveat. The analysis above is based on the assumption that the link frequencies p_i are independent. It should be noted that this is probably true only for relatively separated links. It is likely that, if a given link has high activity, the same will be true of the adjacent links.

ANNEX C

NETWORK LINKS AND NODES

APPENDIX A

CARLOAD-LINK-HITS BY STATE*

	STATE	LINK	CL(S)	DETAILS**
ALABAMA	01	01	490	43
	01	02	456	40
	01	03	606	45
	01	04	723	59
	01	05	1650	93
	01	06	547	61
	01	07	2602	158
	01	08	342	36
	01	09	822	57
	01	10	714	16
	01	11	526	43
	01	12	309	18
	01	13	386	29
	01	14	912	70
	01	15	139	13
	01	16	112	9
	01	17	248	22
	01	18	440	39
	01	19	739	40
	01	20	192	3
SUB TOTAL	01		12955	894
ARIZONA	04	01	1756	77
	04	02	1	1
	04	03	1817	92
	04	04	74	7
	04	05	39	7
	04	06	26	3
	04	07	1203	48
	04	08	1205	50
	04	09	246	3
SUB TOTAL	04		6367	288
ARKANSAS	05	01	209	15
	05	02	643	63
	05	03	352	53
	05	04	162	24
	05	05	980	91
	05	06	1033	71
	05	07	1344	116
	05	08	1022	67
	05	09	215	14
	05	10	384	27
SUB TOTAL	05		6344	541
CALIFORNIA	06	01	486	29
	06	02	41	6

	STATE	LINK	CL(S)	DETAILS
CALIFORNIA	06	03	559	38
	06	04	168	22
	06	05	1166	96
	06	06	1841	123
	06	07	1976	92
	06	08	1369	140
	06	09	437	16
	06	10	1596	102
	06	11	20	4
	06	12	745	67
	06	13	2315	142
	06	14	642	62
	06	15	1801	108
	06	16	1812	108
	06	17	644	64
	06	18	718	61
	06	19	1371	65
	06	20	521	40
	06	21	1851	82
	06	22	984	54
	06	23	2582	133
	06	24	436	40
	06	25	1288	54
	06	26	72	9
	06	27	1	1
	06	28	1226	46
	06	29	1	1
SUB TOTAL	06		28684	1806
COLORADO	08	01	1015	99
	08	02	258	36
	08	03	1171	134
	08	04	14	3
	08	05	1079	84
	08	06	395	46
	08	07	1073	112
	08	08	90	8
	08	09	659	68
	08	10	766	77
	08	11	429	33
	08	12	407	33
SUB TOTAL	08		7358	733
CONNECTICUT	09	01	31	6
	09	02	207	13
SUB TOTAL	09		238	19
FLORIDA	12	01	618	30

	STATE	LINK	CL(S)	DETAILS
FLORIDA	12	02	863	41
	12	03	256	31
	12	04	269	34
	12	05	127	17
	12	06	277	29
	12	07	21	4
	12	08	97	13
	12	09	12	2
	12	10	184	18
	12	11	21	4
	12	12	17	1
	12	13	168	14
	12	14	171	15
	12	15	15	4
	12	16	632	3
SUB TOTAL	12		3748	260
GEORGIA	13	01	707	58
	13	02	292	25
	13	03	448	40
	13	04	1751	89
	13	05	112	9
	13	06	235	24
	13	07	343	42
	13	08	154	16
	13	09	237	27
	13	10	58	4
	13	11	55	7
	13	12	617	65
	13	13	269	27
	13	14	36	5
	13	15	86	12
	13	16	1415	59
	13	17	763	58
	13	18	574	4
	13	19	26	3
	13	20	129	24
	13	21	46	9
	13	22	178	13
	13	23	601	5
	13	24	1	1
SUB TOTAL	13		9133	626
IDAHO	16	01	3	1
	16	02	467	34
	16	03	466	32
	16	04	338	19
	16	05	187	17
	16	06	223	26

	STATE	LINK	CL(S)	DETAILS
	16	07	1	1
SUB TOTAL	16		1685	130
ILLINOIS	17	01	1154	83
	17	02	246	23
	17	03	1074	62
	17	04	1141	41
	17	05	243	15
	17	06	81	9
	17	07	172	21
	17	08	50	5
	17	09	1152	137
	17	10	258	28
	17	11	695	60
	17	12	985	50
	17	13	880	79
SUB TOTAL	17		8131	613
INDIANA	18	01	1409	67
	18	02	763	40
	18	03	272	17
	18	04	489	33
	18	05	17	3
	18	06	1116	68
	18	07	141	20
	18	09	133	11
SUB TOTAL	18		4342	259
IOWA	19	01	27	4
	19	02	10	3
	19	03	346	15
	19	04	3	1
	19	05	10	2
	19	06	225	34
	19	07	247	4
	19	08	447	33
	19	09	69	13
	19	10	77	12
	19	11	283	24
	19	12	1541	68
	19	13	438	41
	19	14	58	3
SUB TOTAL	19		3781	257
KANSAS	20	01	1216	130
	20	02	12	2
	20	03	1163	129

	STATE	LINK	CL(S)	DETAILS
KANSAS	20	04	890	90
	20	05	283	41
	20	06	928	91
	20	07	380	48
	20	08	834	73
	20	09	555	51
	20	10	72	12
	20	11	614	69
	20	12	733	67
	20	13	40	10
	20	14	289	31
	20	15	390	21
	20	16	791	31
	20	17	274	40
	20	18	443	30
	20	19	3	1
	20	20	1	1
SUB TOTAL	20		9911	968
KENTUCKY	21	01	1214	63
	21	02	650	36
	21	03	1095	74
	21	04	1129	58
	21	05	383	15
	21	06	1104	75
	21	07	297	22
	21	08	1628	44
	21	09	497	46
SUB TOTAL	21		7997	433
LOUISIANA	22	01	1465	112
	22	02	1341	58
	22	03	1048	45
	22	04	175	21
	22	05	533	24
	22	06	159	8
	22	07	305	40
	22	08	183	19
SUB TOTAL	22		5209	327
MAINE	23	01	96	1
	23	02	3	1
	23	03	1	1
	23	04	3	1
	23	05	96	1
	23	06	102	3
	23	07	106	5
SUB TOTAL	23		409	13

	STATE	LINK	CL(S)	DETAILS
MARYLAND	24	01	1400	112
	24	02	896	38
	24	03	874	65
	24	04	280	26
SUB TOTAL	24		3450	241
MASSACHUSETTS	25	01	199	13
	25	02	107	6
	25	03	20	3
SUB TOTAL	25		326	22
MICHIGAN	26	01	6	2
	26	02	7	2
	26	03	98	11
	26	04	95	14
	26	05	138	10
	26	06	284	12
	26	07	1	1
	26	08	492	4
	26	09	259	14
	26	10	149	19
	26	11	1	1
	26	12	165	10
	26	13	621	30
	26	14	36	7
SUB TOTAL	26		2352	137
MINNESOTA	27	01	11	1
	27	02	3	1
	27	03	40	6
	27	04	3	1
	27	05	20	3
	27	06	100	5
	27	08	1194	42
	27	09	126	7
	27	10	56	4
SUB TOTAL	27		1553	70
MISSISSIPPI	28	01	218	2
	28	02	782	33
	28	03	599	30
	28	04	860	79
	28	05	465	21
	28	06	729	34
	28	07	511	44
	28	08	153	11
	28	09	478	40

	STATE	LINK	CL(S)	DETAILS
MISSISSIPPI	28	10	79	6
	28	11	189	17
	28	12	375	38
SUB TOTAL	28		5438	355
MISSOURI	29	01	205	21
	29	02	34	4
	29	03	233	8
	29	04	52	10
	29	05	376	46
	29	06	186	21
	29	07	73	3
	29	08	1746	182
	29	09	472	34
	29	10	276	40
	29	11	843	22
	29	12	780	37
	29	13	67	11
	29	14	633	79
	29	15	252	14
	29	16	170	19
SUB TOTAL	29		6398	551
MONTANA	30	01	327	18
	30	02	327	18
	30	03	317	13
	30	04	143	16
	30	05	160	16
	30	06	43	6
	30	07	139	15
	30	08	47	7
	30	09	103	6
	30	10	72	4
	30	11	75	4
	30	12	133	14
	30	13	43	5
	30	14	32	4
	30	15	127	13
	30	16	151	17
	30	17	1	1
	30	18	43	5
	30	19	96	13
	30	20	165	18
	30	21	76	12
	30	22	138	12
	30	23	26	5
	30	24	55	6
	30	25	75	9
SUB TOTAL	30		2914	257

	STATE	LINK	CL(S)	DETAILS
NEBRASKA	31	01	164	19
	31	02	604	89
	31	03	240	31
	31	04	482	54
SUB TOTAL	31		1490	193
NEVADA	32	01	1151	91
	32	02	1967	138
	32	03	2347	210
	32	04	474	39
	32	05	667	60
SUB TOTAL	32		6606	538
NEW HAMPSHIRE	33	01	1	1
	33	02	1	1
	33	03	10	2
SUB TOTAL	33		12	4
NEW JERSEY	34	01	1151	93
	34	02	35	8
SUB TOTAL	34		1186	101
NEW MEXICO	35	01	419	28
	35	02	993	62
	35	03	79	14
	35	04	474	38
	35	06	5	1
	35	07	429	34
	35	08	260	25
	35	09	52	10
	35	10	105	13
	35	11	1009	69
	35	12	759	64
	35	13	60	7
	35	14	115	13
	35	15	239	3
	35	16	1349	54
	35	17	63	8
SUB TOTAL	35		6410	443
NEW YORK	36	01	298	25
	36	02	34	5
	36	03	18	5
	36	04	262	21
	36	05	624	11
	36	06	365	26

	STATE	LINK	CL(S)	DETAILS
NEW YORK	36	07	18	4
	36	08	39	5
	36	09	14	2
	36	10	20	3
SUB TOTAL	36		1692	107
NORTH CAROLINA	37	01	377	35
	37	02	550	46
	37	03	708	57
	37	04	876	61
	37	05	162	23
	37	06	1802	30
	37	07	2627	115
	37	08	610	11
	37	09	1	1
SUB TOTAL	37		7713	379
NORTH DAKOTA	38	01	326	7
	38	02	79	4
	38	03	28	3
	38	04	35	9
	38	05	88	7
	38	06	37	5
	38	07	88	6
SUB TOTAL	38		681	41
OHIO	39	01	832	39
	39	02	344	12
	39	03	1588	99
	39	04	323	11
	39	05	687	58
	39	06	700	53
	39	07	37	6
	39	08	392	17
	39	09	362	22
	39	10	846	116
	39	11	384	6
	39	12	1828	59
	39	13	260	21
	39	14	439	33
	39	15	1553	135
SUB TOTAL	39		10575	687
OKLAHOMA	40	01	155	17
	40	02	326	38
	40	03	387	26
	40	04	245	11

	STATE	LINK	CL(S)	DETAILS
ODLAHOMA	40	05	22	4
	40	06	82	3
	40	07	612	34
	40	08	148	12
	40	09	935	45
	40	10	19	5
	40	11	457	45
	40	12	29	8
	40	13	173	12
	40	14	951	96
SUB TOTAL	40		4551	356
OREGON	41	01	477	30
	41	02	213	14
	41	03	197	24
	41	04	234	20
	41	05	244	23
	41	06	433	27
	41	07	504	34
	41	08	511	31
	41	09	198	23
	41	10	18	4
	41	11	179	21
	41	12	197	25
SUB TOTAL	41		3405	276
PENNSYLVANIA	42	01	256	26
	42	02	213	10
	42	03	215	20
	42	04	479	50
	42	05	746	26
	42	06	233	32
	42	07	2594	221
	42	08	893	79
	42	09	531	24
	42	10	1162	94
	42	11	590	32
	42	12	1	1
SUB TOTAL	42		7913	615
SOUTH CAROLINA	45	01	598	51
	45	02	225	21
	45	03	1781	90
	45	04	278	7
	45	05	165	24
	45	06	1973	86
	45	07	160	16
	45	08	344	24

	STATE	LINK	CL(S)	DETAILS
SOUTH CAROLINA	45	09	523	30
	45	10	264	9
	45	11	419	49
	45	12	794	42
SUB TOTAL	45		7524	449
SOUTH DAKOTA	46	01	4	1
	46	02	6	2
	46	03	14	4
SUB TOTAL	46		24	7
TENNESSEE	47	01	1400	64
	47	02	2089	125
	47	03	633	57
	47	04	324	40
	47	05	327	37
	47	06	883	51
	47	07	553	47
	47	08	296	24
	47	09	253	18
	47	10	1105	52
	47	11	1015	56
	47	12	886	65
SUB TOTAL	47		9766	636
TEXAS	48	01	259	25
	48	02	61	5
	48	03	637	43
	48	04	634	46
	48	05	923	30
	48	06	385	30
	48	07	1493	74
	48	08	141	18
	48	09	1320	53
	48	10	726	43
	48	11	179	23
	48	12	329	23
	48	13	295	24
	48	14	522	22
	48	15	1320	69
	48	16	2429	43
	48	17	713	43
	48	18	1545	35
	48	19	360	38
	48	20	146	17
	48	21	390	11
	48	22	86	8

	STATE	LINK	CL(S)	DETAILS
TEXAS	48	23	53	5
	48	24	201	25
	48	25	634	53
	48	26	449	13
	48	27	579	34
	48	29	224	10
	48	30	409	15
	48	31	70	7
	48	32	1003	46
	48	33	1	1
	48	34	1099	53
	48	35	3	1
	48	36	98	14
	48	37	880	65
	48	38	491	15
	48	39	43	4
	48	40	500	4
	48	41	16	1
SUB TOTAL	48		21653	1090
UTAH	49	01	1200	120
	49	02	419	22
	49	03	1556	188
	49	04	1195	100
	49	05	1901	160
	49	06	1452	112
SUB TOTAL	49		7723	702
VERMONT	50	01	1	1
	50	02	1	1
	50	03	1	1
	50	04	1	1
	50	05	1	1
SUB TOTAL	50		5	5
VIRGINIA	51	01	937	36
	51	02	727	48
	51	03	323	20
	51	04	338	19
	51	05	618	55
	51	06	834	43
	51	07	954	94
	51	08	575	29
	51	09	772	51
	51	10	210	26
	51	11	412	22
	51	12	391	24
	51	13	674	34

	STATE	LINK	CL(S)	DETAILS
VIRGINIA	51	14	1	1
	51	15	1	1
SUB TOTAL	51		7767	503
WASHINGTON	53	01	151	6
	53	02	215	25
	53	03	347	25
	53	04	574	39
	53	05	26	5
	53	06	575	45
	53	07	1	1
	53	08	604	45
	53	09	104	7
	53	10	96	11
	53	11	46	7
	53	12	36	5
	53	13	87	11
	53	14	127	18
	53	15	1	1
	53	16	179	21
	53	17	92	13
	53	18	24	3
SUB TOTAL	53		3285	288
WEST VIRGINIA	54	01	213	11
	54	02	251	22
	54	03	490	14
	54	04	758	33
	54	05	1136	57
	54	06	14	2
SUB TOTAL	54		2862	139
WISCONSIN	55	01	3	1
	55	02	56	2
	55	03	32	3
	55	04	921	13
	55	05	16	3
	55	06	805	18
	55	07	246	23
	55	08	893	31
	55	09	231	11
	55	10	53	7
	55	11	835	7
	55	12	1262	55
	55	13	1	1
SUB TOTAL	55		5354	175

	STATE	LINK	CL(S)	DETAILS
WYOMING	56	01	66	7
	56	02	142	17
	56	03	74	7
	56	04	547	84
	56	05	1765	212
	56	05	1765	212
SUB TOTAL	56		2594	327
GRAND TOTAL			259514	17861

* For programing reasons an entry of one (1) in the CL(s) column means the link received no hits.

** The Details column shows the number of identical routings contributed to the CL(s) column entries.

APPENDIX B

LINKS WITH LESS THAN

72 CARLOAD LINK HITS

STATE	LINK	NO OF CARLOADS	STATE	LINK	NO OF CARLOADS	STATE	LINK	NO OF CARLOADS
AZ	0402	0	GA	1324	0	MI	2601	6
	0405	39	ID	1601	3		2602	7
	0406	26		1607	0		2607	0
CA	0602	41	IL	1708	50		2611	0
	0611	20	IN	1805	17		2614	36
	0627	0	IA	1901	27	MN	2701	11
	0629	0		1902	10		2702	2
CO	0804	14		1904	3		2703	40
CT	0901	31		1905	10		2704	3
FL	1207	21		1909	69		2705	20
	1209	12		1914	58		2710	56
	1211	21	KS	2002	12	MO	2902	34
	1212	17		2013	40		2904	52
	1215	15		2019	3		2913	67
GA	1310	58		2020	0	MT	3006	43
	1311	55	ME	2302	3		3008	47
	1314	36		2303	0		3013	43
	1319	26		2304	3		3014	32
	1321	46	MA	2503	20		3017	0

STATE	LINK	NO OF CARLOADS	STATE	LINK	NO OF CARLOADS	STATE	LINK	NO OF CARLOADS
MT	3018	43	OH	3907	37	VA	5114	0
	3023	26	OK	4005	22		5115	0
	3024	55		4010	19	WA	5305	26
NH	3301	0		4012	29		5307	0
	3302	0	OR	4110	18		5311	46
	3303	10	PA	4212	0		5312	36
NJ	3402	35	SD	4601	4		5315	0
NM	3506	5		4602	6		5318	24
	3509	52		4603	14	WV	5406	14
	3513	60	TX	4802	61	WI	5501	3
	3517	63		4823	53		5503	32
NY	3602	34		4831	70		5505	16
	3603	18		4833	0		5510	53
	3607	18		4835	3		5513	0
	3608	39		4839	43	WY	5601	66
	3609	14		4841	16			
	3610	20	VT	5001	0			
NC	3709	0		5002	0			
ND	3803	28		5003	0			
	3804	35		5004	0			
	3806	37		5005	0			

TOTAL NO. OF
REJECTIBLE LINKS = 114

APPENDIX C

STRACNET LINKS AND CORRIDOR MILEAGE**

STATE	LINK	APP. MILEAGE
ALABAMA	Mobile-New Orleans, LA	137
	Flomation-Pensacola, FL	47
	Flomation-Mobile	50
	Flomation-Montgomery	125
	Montgomery-Birmingham	90
	Birmingham-Atlanta, GA	143
	Birmingham-Meridian, MS	149
	Birmingham-Amory, MS	112
	Birmingham-Decatur	80
	Decatur-Nashville, TN	112
	Birmingham-Chattanooga, TN	156
ARIZONA	Williams-Barstow, CA	278
	Williams-Dalies/Isleta/Belen, NM	320
	Yuma-Tucson	223
	Tucson-Demming, NM	191
ARKANSAS	Pine Bluff-Texarkana, TX	133
	Pine Bluff-Memphis, TN	130
	Pine Bluff-St. Louis, MO	300
	* Springfield, MO-Memphis, TN	250
CALIFORNIA	Stockton-Fresno	125
	Fresno-Bakersfield	115
	Bakersfield-Mojave	52
	Mojave-Barstow	75
	Mojave-Colton	90
	Los Angeles-Colton	50
	Los Angeles-San Diego	125
	Barstow-Colton	48
	Colton-Niland	98
	Niland-Yuma, AZ	63
	Barstow-Las Vegas, NV	133
	Klamath Falls, OR-Black Butte, CA	52
	Black Butte-Sacramento	205
	Sacramento-Oakland	70
	Oakland-Stockton	53
	San Francisco-Oakland	7
	Sacramento-Reno, NV	112
	Barstow-Williams, AZ	278

STATE		LINK	APP. MILEAGE
COLORADO		Trinidad-Dalies/Isleta/Belen	215
		Trinidad-Amarillo, TX	213
		Grand Junction-Salt Lake City, UT	225
		Grand Junction-Dotsero	100
		Dotsero-Denver	120
		Denver-Cheyenne, WY	98
		Denver-Colorado Springs	74
		Colorado Springs-Pueblo	48
		Pueblo-Trinidad	83
		Denver-Kansas City, KS	575
CONNECTICUT	*	Providence, RI-New York, NY	167
DELAWARE	*	Baltimore, MD-Philadelphia, PA	91
DISTRICT OF COLUMBIA		Washington-Richmond, VA	112
		Washington-Baltimore, MD	40
		Washington-Lynchburg, VA	160
		Washington-Shenandoah Jct, WV	50
FLORIDA		Pensacola-Flomation, AL	47
		Jacksonville-Pensacola	343
		Jacksonville-Atlanta, GA	183
		Jacksonville-Savannah, GA	130
		Jacksonville-Orlando	125
		Orlando-Auburndale	48
		Auburndale-Tampa	39
		Auburndale-West Palm Beach	151
		West Palm Beach-Miami	68
GEORGIA		Atlanta-Birmingham, AL	143
		Atlanta-Chattanooga, TN	112
		Atlanta-Hamlet, NC	275
		Atlanta-Jacksonville, FL	183
		Savannah-Columbia, SC	152
		Savannah-Charleston, SC	90
		Savannah-Jacksonville, FL	130
IDAHO		Boise-Hinkle, OR	220
		Boise-Pocatello	197
		Pocatello-Granger, WY	156
		Sandpoint-Spokane, WA	61
		Sandpoint-Bonners Ferry	32
		Sandpoint-Billings, MT	415
		Bonners Ferry-Shelby, MT	107

STATE		LINK	APP. MILEAGE
ILLINOIS		Chicago-Milwaukee, WI	78
		Chicago-Omaha, NE	456
		Chicago-Kansas City, KS	430
		Chicago-St. Louis, MO	276
		Chicago-Evansville, IN	284
		Chicago-Indianapolis, IN	198
		Chicago-Cincinnati, OH	260
		Chicago-Toledo, OH	225
	*	St. Louis, MO-Indianapolis, IN	254
	*	St. Louis, MO-Evansville, IN	160
INDIANA		Indianapolis-Louisville, KY	112
		Indianapolis-Chicago, IL	198
		Indianapolis-Cleveland, OH	271
		Indianapolis-St. Louis, MO	254
		Evansville-Nashville, TN	140
		Evansville-St. Louis, MO	160
		Evansville-Chicago, IL	284
	*	Chicago, IL-Cincinnati, OH	260
IOWA	*	St. Paul, MN-Kansas City, MO	425
	*	Chicago, IL-Omaha, NE	456
KANSAS		Kansas City-St. Louis, MO	250
		Kansas City-Denver, CO	575
		Kansas City-St. Paul, MN	425
		Kansas City-Wichita, KS	198
		Kansas City-Omaha, NE	175
		Kansas City-Fort Scott	105
		Fort Scott-Texarkana, TX	312
		Fort Scott-Springfield, MO	92
		Wichita-Amarillo, TX	313
		Wichita-Oklahoma City, Ok	160
KENTUCKY		Louisville-Memphis	333
		Louisville-Cincinnati, OH	100
		Louisville-Chattanooga, TN	231
		Louisville-Indianapolis,IN	112
LOUISIANA		New Orleans-Mobile, AL	50
		New Orleans-Baton Rouge	163
		Baton Rouge-Alexandria	103
		Alexandria-Shreveport	122
		New Orleans-Meridian, MS	200

STATE	LINK	APP. MILEAGE
MAINE	Portland-Bangor	117
	Portland-Boston	103
MARYLAND	Baltimore-Washington	40
	Baltimore-Philadelphia, PA	91
	Cumberland-Pittsburg, PA	98
MASSACHUSETTS	Boston-Providence	61
	Boston-Portland, ME	103
	Boston-Albany, NY	140
MICHIGAN	Detroit-Toledo	68
MINNESOTA	Minneapolis/St. Paul-Milwaukee, WI	315
	Minneapolis/St. Paul-Minot, ND	460
	Minneapolis/St. Paul-Kansas City, MO	425
MISSISSIPPI	Meridian-New Orleans, LA	200
	Jackson-Memphis, TN	208
	Jackson-New Orleans, LA	163
	Amory-Memphis, TN	115
	Amory-Birmingham, AL	112
	Meridian-Birmingham, AL	149
MISSOURI	Kansas City-Fort Scott, KS	105
	Kansas City-St. Paul, MN	425
	Kansas City-Wichita, KS	198
	Kansas City-Denver, CO	575
	Kansas City-Omaha, NE	175
	Springfield-Fort Scott, KS	92
	Springfield-Memphis, TN	250
	St. Louis-Pine Bluff, AR	300
	St. Louis-Kansas City	250
	St. Louis-Chicago, IL	276
	St. Louis-Indianapolis, IN	254
	St. Louis-Evansville, IN	160
MONTANA	Shelby-Bonners Ferry, ID	107
	Billings-Sand Point, ID	415
	Shelby-Minot, ND	487
	Billings-Alliance, KS	393

STATE		LINK	APP. MILEAGE
NEBRASKA		Omaha-Kansas City, KS	175
		Omaha-Cheyenne, WY	475
		Omaha-Chicago, IL	456
		Omaha-Alliance, KS	370
	*	Alliance, KS - Billings, MT	393
NEVADA		Reno-Sacramento, CA	112
		Reno-Winnemuca	154
		Winnemucca-Wells	142
		Wells-Ogden, UT	157
		Las Vegas-Barstow, CA	133
		Las Vegas-Salt Lake City, UT	375
NEW HAMPSHIRE	*	Portland, ME-Boston, MA	103
NEW JERSEY	*	Philadelphia, PA-New York, NY	83
	*	Buffalo, NY-New York, NY	290
NEW MEXICO		Demming-Tucson, AZ	191
		Demming-El Paso TX	83
		Dalies/Isleta/Belen-Williams, AZ	320
		Dalies/Isleta/Belen-Trinidad, CO	215
		Dalies/Isleta/Belen-Vaughn	100
		Vaughn-Farwell, TX	87
		Vaughn-El Paso, TX	214
NEW YORK		Buffalo-Cleveland, OH	183
		Buffalo-Albany	268
		Buffalo-New York	290
		Albany-Boston	140
		Albany-New York	149
		New York-Providence, RI	167
NORTH CAROLINA		Hamlet-Atlanta, GA	275
		Hamlet-Wilmington	119
		Charlotte-Columbia, SC	98
		Charlotte-Lynchburg, VA	193
		Selma-Charleston, SC	230
		Selma-Morehead City	118
		Selma-Petersburg, VA	125
	*	Johnson City, TN-Roanoke, VA	161
NORTH DAKOTA		Minot-Shelby, MO	487
		Minot-Minneapolis/St. Paul, MN	460

STATE	LINK	APP. MILEAGE
OHIO	Toledo-Columbus	140
	Toledo-Cleveland	94
	Toledo-Detroit, MI	68
	Toledo-Chicago, IL	225
	Columbus-Cincinnati	105
	Columbus-Huntington/Kenova, WV	125
	Columbus-Pittsburgh, PA	173
	Cleveland-Buffalo, NY	183
	Cleveland-Pittsburgh, PA	138
	Cleveland-Indianapolis, IN	271
	Cincinnati-Chicago, IL	260
	Cincinnati-Huntington/Kenova, WV	133
	Cincinnati-Louisville, KY	100
OKLAHOMA	Oklahoma City-Wichita, KS	160
	Oklahoma City-Dallas/Ft. Worth, TX	188
	* Amarillo, TX-Wichita, KS	313
OREGON	Portland-Vancouver, WA	10
	Portland-Hinkle, ID	165
	Portland-Salem	46
	Salem-Eugene	69
	Eugene-Chemult	91
	Chemult-Klamath Falls	77
	Klamath Falls-Black Butte, CA	52
	Hinkle-Boise, ID	220
PENNSYLVANIA	Pittsburgh-Cleveland, OH	138
	Pittsburgh-Columbus, OH	173
	Pittsburgh-Harrisburg	175
	Pittsburgh-Cumberland, MD	98
	Harrisburg-Shennandoah Jct, WV	100
	Harrisburg-Philadelphia	102
	Philadelphia-Baltimore, MD	91
	* Buffalo, NY-New York, NY	167
RHODE ISLAND	Providence-Boston, MA	61
	Providence-New York, NY	167
SOUTH CAROLINA	Charleston-Selma, NC	230
	Charleston-Savannah, GA	90
	Columbia-Charlotte, NC	98
	Columbia-Savannah, GA	152
	* Atlanta, GA-Hamlet, NC	275

STATE	LINK	APP. MILEAGE
TENNESSEE	Chattanooga-Atlanta, GA	112
	Chattanooga-Nashville	125
	Chattanooga-Louisville, KY	231
	Chattanooga-Birmingham, AL	156
	Chattanooga-Knoxville	114
	Nashville-Evansville, IN	140
	Nashville-Decatur, AL	112
	Memphis-Pine Bluff, AR	130
	Memphis-Jackson, MS	208
	Memphis-Springfield, MO	250
	Memphis-Amory, AL	115
	Memphis-Louisville, KY	333
	Knoxville-Johnson City	82
	Johnson City-Roanoke, VA	161
	Johnson City-Huntington/Kenova, WV	153
TEXAS	El Paso-Demming, NM	83
	El Paso-Vaughn, NM	214
	El Paso-Sierra Blanca	81
	Sierra Blanca-San Antonio	460
	Sierra Blanca-Dallas/Ft. Worth	515
	San Antonio-Houston	200
	Houston-Beaumont	81
	Houston-Dallas/Ft. Worth	241
	Houston-Galveston	53
	Galveston-Corpus Christi	119
	Dallas/Ft. Worth-Oklahoma City, OK	188
	Dallas/Ft. Worth-Texarkana	180
	Dallas/Ft. Worth-Amarillo	325
	Dallas/Ft. Worth-San Antonio	252
	Farwell-Vaughn, NM	133
	Amarillo-Trinidad, CO	213
	Amarillo-Wichita, KS	313
	Beaumont-New Orleans, LA	250
	Texarkana-Fort Scott, KS	312
	Texarkana-Shreveport, LA	76
	Texarkana-Pine Bluff, AR	133
UTAH	Ogden-Wells, NV	157
	Ogden-Granger, WY	106
	Ogden-Salt Lake City	36
	Salt Lake City-Las Vegas, NV	375
	Salt Lake City-Grand Junction, CO	225

STATE	LINK	APP. MILEAGE
VIRGINIA	Petersburg-Salem, NC	125
	Petersburg-Richmond	25
	Lynchburg-Huntington/Kenova, WV	184
	Lynchburg-Roanoke	50
	Lynchburg-Washington DC	160
	Lynchburg-Charlotte, NC	193
	Richmond-Washington, DC	112
	Lynchburg-Petersburg	106
	Petersburg-Norfolk	68
	Roanoke-Johnson City, TN	161
WASHINGTON	Everett-Spokane	225
	Everett-Seattle	22
	Seattle-Auburn	21
	Auburn-Olympia	35
	Olympia-Vancouver	98
	Vancouver-Portland, OR	10
	Spokane-Sand Point, ID	61
WEST VIRGINIA	Huntington/Kenova-Columbus, OH	125
	Huntington/Kenova-Cincinnati, OH	133
	Huntington/Kenova-Johnson City, TN	153
	Huntington/Kenova-Lynchburg, VA	184
	Shenandoah Jct-Washington, DC	50
	Shenandoah Jct-Harrisburg, PA	100
	Shenandoach Jct-Cumberland, MD	66
WISCONSIN	Milwaukee-Minneapolis/St. Paul, MN	315
	Milwaukee-Chicago, IL	78
WYOMING	Granger-Ogden, UT	106
	Granger-Pocatello, ID	156
	Granger-Cheyenne	280
	Cheyenne-Omaha, NE	475
	Cheyenne-Denver, CO	98
	* Billings, MT-Alliance KS	393

* Links which cross states but do not originate or terminate in that state.

** Mileage is not additive.

ANNEX D

LIST OF RAIL OUTSIZE EQUIPMENT a/b/

LIN	NOMENCLATURE	DIMENSIONS IN INCHES			WEIGHT LBS	ITEM PER RAIL CAR
		L	W	H		
A64869	Angledozer	168.0	132.0	48.0	5000	3 - 57'
A81439	Antenna Tlr Mtd	256.0	103.0	142.5	12890	2 - 57'
A81576	Antenna Tlr Mtd	256.3	103.3	143.0	12765	2 - 57'
A81713	Antenna Tlr Mtd	256.3	103.3	143.0	12830	2 - 57'
C22469	Bridge Ferry End Bay	507.5	144.0	124.0	51600	1 - 57'
C22606	Bridge Ferry Interior Bay	507.5	144.0	109.0	46700	1 - 57'
C25620	Bridge Float Mbl Aslt	506.0	144.0	114.0	33875	1 - 57'
(Component)	Interior Bay	300.0	144.0	28.0	14295	2 - 57'
C35415	Bldzer Earth Moving	102.5	136.5	44.5	3920	6 - 57'
C35826	Bldzer Earth Moving	105.8	136.5	45.3	5380	6 - 57'

a/ Item exceeds 128" (width) or 137" (height) (44" above rail) or 26 STON.
b/ Preferred model, reduced dimensions TB 55-46-1.

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AN ANALYSIS OF A STRATEGIC RAIL CORRIDOR NETWORK (STRACNET) FOR--ETC(U)
NOV 76 W E BANKS, R BARCLAY

UNCLASSIFIED MTMC-RND-76-1 NL

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LIN	NOMENCLATURE	DIMENSIONS IN INCHES			WEIGHT	ITEM PER
		L	W	H	LBS	RAIL CAR
E56577	Cbt Eng Veh FTRAC	287.8	145.0	127.5	108080	1 - 80 TON
(Component)	Moldboard Assy	146.3	37.5	14.3	2480	c/
E56578	Cbt Eng Veh FTRAC	287.8	145.0	127.5	108080	1 - 80 TON
(Component)	Moldboard Assy	146.3	37.5	14.3	2480	c/
F39378	Crane Whl 20T W/Boom	344.0	126.5	149.0	57380	1 - 57'
(Component)	Boom Point Section	197.0	32.3	30.3	1480	c/
(Component)	Boom Foot Section	183.5	45.1	30.3	2000	c/
F39926	Crane-Shovel Cwl Mtd	215.0	136.1	142.6	76620	2 - 80 TON
(Component)	Counterweight	128.0	28.5	18.5	4380	c/
F40063	Crane-Shovel Cwl Mtd	238.5	154.0	144.5	96320	1 - 80 TON
(Component)	Counterweight	116.5	25.3	20.5	4380	c/
F40200	Crane-Shovel Cwl Mtd	239.0	136.5	141.0	97100	1 - 80 TON

c/ These items are not rail outsize and will be consolidated with other unit equipment shipped by rail

LIN	NOMENCLATURE	DIMENSIONS IN INCHES L	W	H	WEIGHT LBS	ITEM PER RAIL CAR
(Component)	Counterweight	126.0	25.8	15.5	3600	c/
F40337	Crane-Shovel Cwl Mtd	236.0	136.0	153.0	92000	1 - 80 TON
F40474	Crane Cwl Mtd 40T W/Boom	222.0	135.5	152.0	84330	1 - 80 TON
(Component)	Boom Foot Section	300.0	65.0	44.5	2980	c/
(Component)	Boom Point Section	317.8	47.3	44.5	3940	c/
F40611	Crane-Shovel Cwl Mtd	252.0	148.0	148.0	132000	1 - 80 TON
F43414	Crane Trk 20T W/Boom	340.8	122.5	149.5	52965	1 - 57'
(Component)	Boom Foot Section	183.0	39.0	30.3	1045	c/
(Component)	Boom Point Section	194.0	32.3	30.3	1220	c/
F50221	Crush Screen & Wash	480.0	124.0	144.0	65000	1 - 57'
F50721	Crush Jaw Whl Mtd	410.0	108.0	144.0	72030	1 - 57'
F50858	Crush Jaw Whl Mtd	441.0	119.0	160.0	72120	1 - 57'

c/ See page 79 for note.

LIN	NOMENCLATURE	DIMENSIONS IN INCHES			WEIGHT LBS	ITEM PER RAIL CAR
		L	W	H		
F51132	Crush Roll Whl Mtd	495.0	118.0	143.0	61450	1 - 57'
F51632	Crushing & Screening Unit	352.0	126.0	156.5	50990	1 - 57'
G29976	Ditch Mach Cwl Mtd	294.0	132.0	135.0	30000	2 - 57'
G52994	Drier Aggr Tlr Mtd	468.0	127.3	145.0	38300	1 - 57'
G53131	Drier Aggr Tlr Mtd	413.8	125.3	147.5	36200	1 - 57'
H36465	Feeder Aggr Stlr Mtd	390.5	119.0	152.5	15930	1 - 57'
J74215	Grader Control Unit	341.8	122.1	155.3	29380	1 - 57'
J97093	Gun FA Sp 155MM	402.0	141.0	140.0	96000	1 - 80 TON
K56981	Howitzer SP 8-Inch	264.8	124.0	107.8	57630	2 - 57'
L37030	Landing Veh Tracked	477.3	152.5	128.5	82750	1 - 57'
L43390	Lchr Bridge Tk Mtd	323.0	144.0	118.0	95600	2 - 100 TON
L43364	Lchr Bridge Tk Mtd	340.0	144.0	112.0	87700	2 - 100 TON

LIN	NOMENCLATURE	DIMENSIONS IN INCHES			WEIGHT LBS	ITEM PER RAIL CAR
		L	W	H		
L45534	Lchr Rkt 762MM Trk Mtd	513.0	120.0	147.5	42680	1 - 57'
L75803	Loader Bucket	234.0	117.0	222.0	20500	2 - 57'
L75940	Loader Bucket	234.0	117.0	222.0	20500	2 - 57'
L81406	Logging Tractor	158.4	121.8	150.5	11136	3 - 57'
M53877	Mixer Bitum Tlr Mtd	251.8	119.5	140.0	31400	2 - 57'
N74624	Paver Concrete Cwl Mtd	849.5	121.3	139.8	62500	1 - 85'
N75124	Paving Machine Cwl Mtd	199.3	133.6	88.5	23058	3 - 57'
R11462	Ramp Loading Veh	506.0	144.0	114.0	33875	1 - 57'
(Component)	End Bay	360.0	144.0	52.0	20245	1 - 57'
R50681	Recovery Veh FTRAC	321.0	135.0	117.3	107600	1 - 80 TON
S12712	Roller Twd Sheepft	182.1	175.0	55.0	8480	3 - 57'
(Component)	Draw Bar	132.0	90.0	16.8	590	c/

c/ See page 79 for note.

LIN	NOMENCLATURE	--------DIMENSIONS-------- --------IN INCHES--------			WEIGHT LBS	ITEM PER RAIL CAR
		L	W	H		
(Component)	Tie Bar	130.0	27.3	78.5	630	c/
(Component)	Drum	79.5	57.8	55.0	2420	c/
S60133	Screen Unit Aggr Whl Mtd	508.0	106.0	164,0	29650	1 - 57'
S61907	Scrubber & Washer	306.0	117.0	162.0	24970	2 - 57'
S71476	Stlr Reefer 7-1/2 Ton	386.0	96.3	149.0	10380	1 - 57'
S73942	Stlr Van Ca-go 12 Ton	362.5	96.0	146.5	7380	1 - 57'
S74079	Stlr Van Cargo 12 Ton	346.3	98.3	145.3	15850	1 - 57'
S74096	Stlr Van Cargo 20 Ton	432.0	97.0	156.0	27500	1 - 57'
S74764	Stlr Van Office 6 Ton	293.0	97.3	144.0	12000	2 - 57'
S75175	Stlr Van Supply 12 Ton	345.5	97.3	142.0	15110	1 - 57'
U58875	Superstructure End Bay MAB	284.6	145.0	54.5	19500	2 - 57'
U58878	Superstructure Interior Bay MAB	395.5	144.0	27.0	14000	1 - 57'
U58881	Superstructure Transporter	509.5	144.0	114.5	31905	1 - 57'

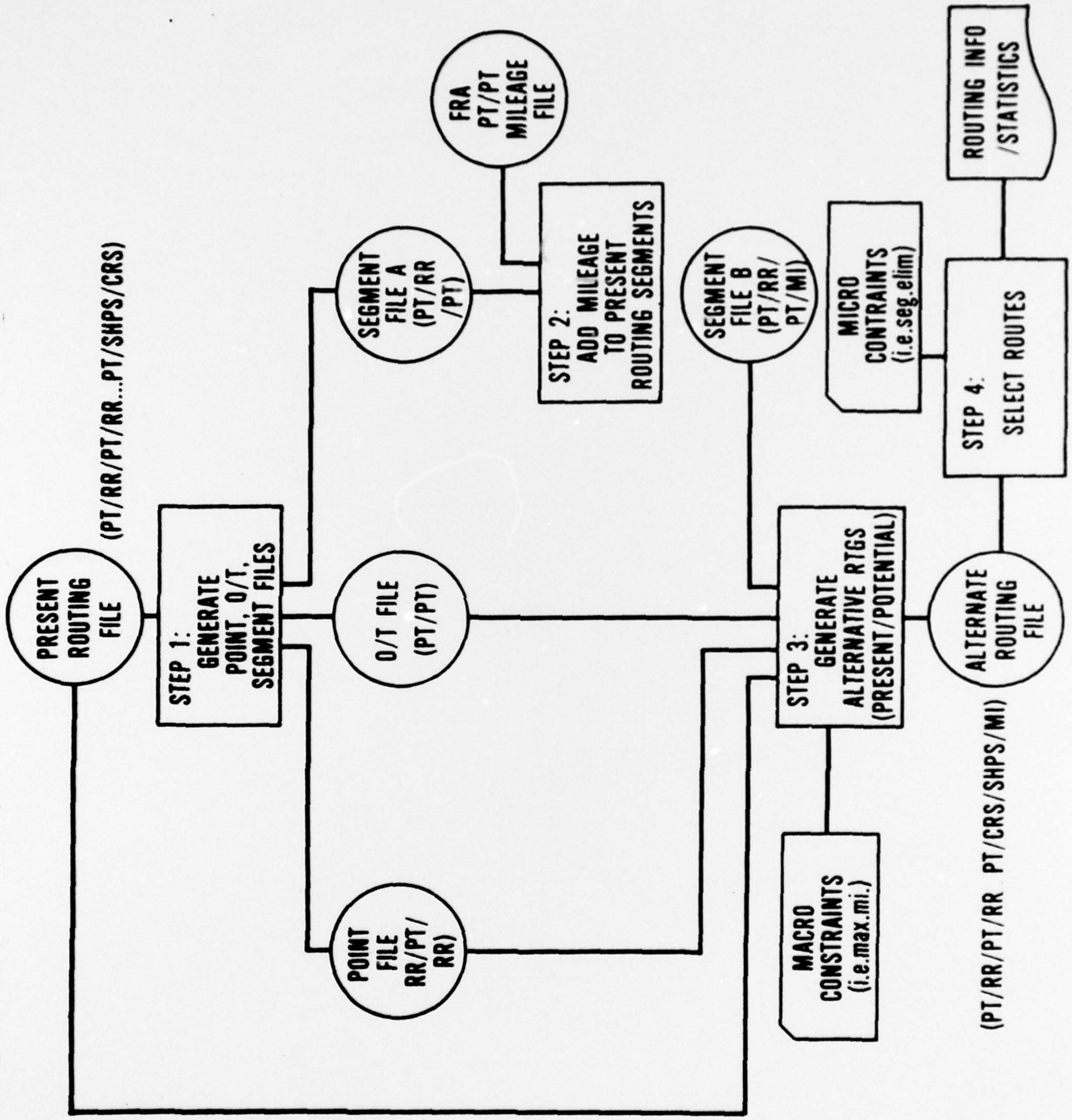
c/ See page 79 for note.

LIN	NOMENCLATURE	DIMENSIONS IN INCHES L	W	H	WEIGHT LBS	ITEM PER RAIL CAR
V12964	Tank Cbt FTRAC 90MM					
	Model M47	280.3	138.3	120.3	95083	2 - 100 TON
	Model M48	283.0	143.5	114.5	93100	2 - 100 TON
	Model M48C	292.5	143.0	107.5	83400	2 - 100 TON
	Model M48A1	285.6	144.0	118.8	98210	2 - 100 TON
	Model M48A2	285.6	145.0	118.8	97949	2 - 100 TON
	Model M48A2C	286.5	144.0	116.3	95300	2 - 100 TON
	Model M48A3	281.5	143.5	117.0	99500	2 - 100 TON
V13101	Tank Cbt FTRAC 105MM					
	Model M60	320.0	144.0	126.3	95300	2 - 100 TON
	Model M60A1	325.0	144.0	128.3	97000	2 - 100 TON
V13237	Tank Cbt FTRAC 120 MM					
	Model M103	400.5	143.0	128.8	117000	1 - 80 TON
	Model M103A1	400.5	143.0	128.8	117000	1 - 80 TON
	Model M103A2	400.5	143.0	128.8	117000	1 - 80 TON
V13270	Tank Cbt FTRAC 152 MM	275.5	143.5	129.8	109980	1 - 80 TON
W76679	Tractor FTRAC	267.8	130.8	102.0	44780	2 - 57'
W77501	Tractor FTRAC	228.0	136.0	125.0	48088	2 - 57'
W91064	Tractor Whld	290.0	136.0	137.0	52200	2 - 57'

LIN	NOMENCLATURE	DIMENSIONS IN INCHES			WEIGHT LBS	ITEM PER RAIL CAR
		L	W	H		
W97592	Trailer Low Bed 60 Ton	445.0	136.0	76.3	21570	1 - 57'
X00696	Trainer Tank 90MM	259.5	170.0	98.5	27429	2 - 57'
X52750	Truck Lift Fork	192.0	92.8	152.9	18430	3 - 57'
YA0022	Crush & Screening Unit	387.0	102.0	159.0	45000	1 - 57'
Y30013	Wash & Screen Unit Whl Mtd	439.3	119.3	171.5	38430	1 - 57'
(Component)	Screen Vibrator	170.8	94.3	76.0	8880	c/
(Component)	Washer	146.3	80.5	81.3	8700	c/
(Component)	Piping Equipment	378.3	54.8	5.8	11710	c/

c/ See page 79 for note.

ANNEX E
DEFENSE TRAFFIC ROUTE ANALYSIS MODEL
(DTRAM)



ANNEX F

POST-NUCLEAR ENVIRONMENT

A study by the Stanford Research Institute entitled, A System Analysis of the Effects of Nuclear Attack on Railroad Transportation in the Continental United States, contained the following conclusions concerning the nation's rail system in a post-nuclear environment:

- For the entire range of attacks considered, the post-attack railroad transportation system would have enough resources surviving blast and fallout (e.g., rolling stock, track, personnel) to provide the long-haul transportation service needed in the early post-attack period to most areas in the country now served by railroad transportation.

- No single component of the railroad transportation system appears to be limiting for all situations. In some geographical areas classification yards would limit system capability; in other areas, the rail lines would be the limiting factor. For some situations, train crews would be the limiting part of the system, but for others, freight cars would be.

- In estimating the capability of the post attack rail transportation system, it is not enough to consider only the quantities of components that would be available. The environment in which the system must operate and the pattern of operation also have significant effects on system capability.

- The capability of the system is sensitive to the manner in which the rolling stock is managed. Therefore, unless provisions are made to assure efficient management in the post-attack period, the capability of the railroad system might be greatly reduced.

These conclusions cover a post-1965 military and population attack on bomber bases; missile bases, naval bases, air defense bases, and cities. Total weapons were 2,300 and total megatons delivered were

23,000. Figure 13 depicts the damage assessment of their transportation model on this level of attack. While the rail system is expected to be able to function adequately during the post-attack period, service between east and west CONUS will be completely destroyed. Thus, as the rail system becomes smaller and smaller, links within the system become more critical.

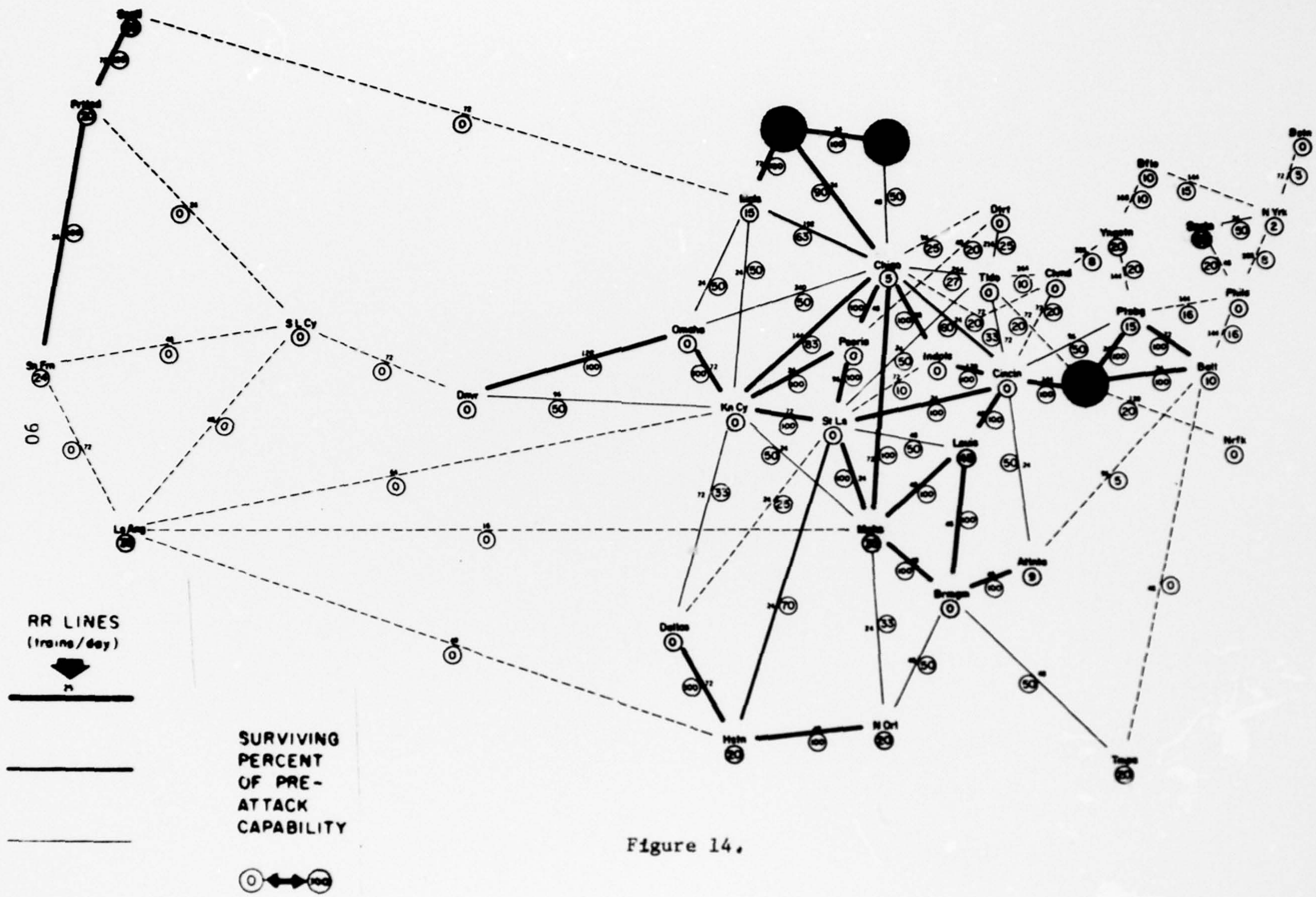


Figure 14.

SOURCE: Stanford Research Institute.

DAMAGE ASSESSMENT OF RAIL TRANSPORTATION MODEL FOR POST-1965 MILITARY AND POPULATION ATTACK

ANNEX G

KEY ARMY AND MARINE POSTS, CAMPS, AND STATIONS

ARMY

Aberdeen Proving Ground, MD
Camp Grayling, MI
Camp Ripley, MN
Camp Roberts, CA
Camp Shelby, MS
Fort Belvoir, VA
Fort Benning, GA
Fort Bliss, TX
Fort Bragg, NC
Fort Campbell, KY
Fort Carson, CO
Fort Chaffee, AR
Fort Devens, MA
Fort Dix, NJ
Fort Drum, NY
Fort Eustis, VA
Fort Gordon, GA
Fort Benjamin Harrison, IN
Fort A. P. Hill, VA
Fort Hood, TX
Fort S. Houston, TX
Fort Huachuca, AZ
Fort Indiantown Gap, PA
Fort Irwin, CA
Fort Jackson, SC
Fort Knox, KY
Fort Leavenworth, KS
Fort Lee, VA
Fort Lewis, WA
Fort Hunter Liggett, CA
Fort MacArthur, CA
Fort McClellan, AL
Fort McCoy, WI
Fort McNair, WASH DC
Fort Meade, MD
Fort Monmouth, NJ

ARMY (cont.)

Fort Ord, CA
Fort Pickett, VA
Fort Polk, LA
Fort Riley, KS
Fort Ritchie, MD
Fort Rucker, AL
Fort Sheridan, IL
Fort Sill, OK
Fort Stewart, GA
Fort Leonard Wood, MO
Gowan Field, ID
Hunter Army Airfield, GA
Presidio of San Francisco, CA

MARINE CORPS

Marine Corps Air Station, Cherry Point, NC
Marine Corps Base, Twenty-Nine Palms, CA
Camp LeJeune, NC
Camp Pendleton, GA

ANNEX H

MAJOR DEFENSE DEPOTS

Air Force Depots

San Bernadino Air Materiel Area	Norton AFB, California
Oklahoma City Air Materiel Area	Tinker AFB, Oklahoma
San Antonio Air Materiel Area	Kelly AFB, Texas
Ogden Air Materiel Area	Hill AFB, Utah
Warner Robbins Air Materiel Area	Robbins AFB, Georgia

Defense Supply Agency

Defense Depot Ogden	Ogden, Utah
Defense Depot Tracy	Lyoth, California
Defense Depot Memphis	Memphis, Tennessee
Defense Depot Mechanicsburg	Mechanicsburg, Pennsylvania
Defense General Supply Center	Richmond, Virginia
Defense Construction Supply Center	Columbus, Ohio

Army

Red River Army Depot	Texarkana, Texas
Anniston Army Depot	Bynum, Alabama
Sierra Army Depot	Herlong, California
Tooele Army Depot	Tooele, Utah
Lexington-Blue Grass Army Depot	Ft. Estill, Kentucky
Atlanta Army Depot	Forest Park, Georgia
Pueblo Army Depot	Avondale, Colorado
Letterkenny Army Depot	Chambersburg, Pennsylvania
Seneca Army Depot	Romulus, New York
New Cumberland Army Depot	Harrisburg, Pennsylvania
Umatilla Army Depot	Ordnance, Oregon
Tobyhanna Army Depot	Tobyhanna, Pennsylvania
Navajo Army Depot	Flagstaff, Arizona
Savanna Army Depot	Savanna, Illinois
Sharpe Army Depot	Stockton, California

Marine Corps Depots

Marine Supply Center Barstow	Nebo, California
Marine Supply Center	Albany, GA
Marine Supply Center	Philadelphia, PA

ANNEX H (cont.)

MAJOR DEFENSE DEPOTS

Navy

Naval Ammunition Depot Crane	Crane, Indiana
Naval Ammunition Depot McAlester	Savanna, Oklahoma
Naval Ammunition Depot Hawthorne	Thorne, Nevada
Naval Supply Center Norfolk	Norfolk, Virginia
Naval Supply Center San Diego	San Diego, California
Naval Supply Center Charleston	Charleston, South Carolina
Naval Supply Center Oakland	Oakland, California
Naval Supply Center Puget Sound	Bremerton, Washington