China Street crossing in Rangoon. The intersection is one of the busiest in downtown Rangoon, and all possible impediments to smooth traffic flow should have been guarded against. This would not have been a difficult task. Instead, the combination of circumstances makes it one of the most chaotic crossings in the city, even at mid-day. A conscientious and competent traffic engineering group will be ever watchful of bad developments of this kind, and will see that the necessary preventive and regulatory police measures are taken.

Since the systematic planning and carrying out of municipal highway and street improvements will, at least for some years, be a departure from the present practice, the officials of the local communities will need assistance in gaining the experience that must go into this kind of study, planning and construction. As indicated in the recommendations, strengthening of the planning group in the Public Works Ministry is needed to carry the increased responsibilities that go with the rehabilitation program. For municipal improvements, the planning group will have to establish geometric standards, grades, drainage standards, minimum requirements for access and many other such factors in the design; will have to assist in the preparation, or prepare, the plans and specification for the work; and will then have to give guidance and counsel in the carrying out of the construction. With maintenance also a partial responsibility of the national government, maintenance programs and procedures will have to be set up, in order that the work done may be properly cared for, kept in a serviceable and useful condition, and not be permitted to deteriorate.

In planning for the rehabilitation of the highway system of Burma, it was found that a vital part of the improvement program must be local improvements in the towns and villages. In the past the growth of the smaller communities has been a haphazard and unplanned development, and this is characteristic of the routing of the national and district roads through these cities and towns, especially the latter. From the study that was made of the highway and traffic conditions in these urban areas, certain basic items developed as a common need of almost all of the communities, and these have been included in the recommendations of the Report.

The planning of a program of urban highway improvement for any particular city must be a cooperative enterprise between the national and district governments on the one hand, and the local authorities. One of the prime factors in the planning is the flow of traffic in the area, and since local traffic regulation and enforcement can either aid or impede this flow, it is necessary that the local police officials and other municipal authorities share in the over-all planning and carrying out of the improvement. Likewise, the municipal officials have an intimate and day by day knowledge of local problems, and what other improvements (such as housing, sewers, drainage) are in prospect and should be integrated with the highway and street program.

It has been found in the United States, where motor vehicle traffic is highly developed, that the effect of dense urban traffic extends, to a decreasing degree, some distance away from the center of the community, which is generally in the downtown business district. This effect is only general in nature, and no precise rules can be set down for its extent. However, studies of a large number of American communities indicate that the radius of effect of urban traffic begins to be appreciable at about these distances from cities and towns:

Population	*Radius of Effect** (*miles*)
300,000–1,000,000	25
100,000–300,000	15
50,000–100,000	12
25,000– 50,000	9
10,000– 25,000	6
5,000– 10,000	3

* Measured from downtown business section.

While the effect is not felt so strongly, nor for as great a distance, in the corresponding cities and towns in Burma, since the vehicle densities are much less, the relationship manifests itself in the same manner. Based on the field studies of urban traffic here, it is believed that the effect exists to an appreciable degree for a distance of $3\frac{1}{2}$ to 4 miles from cities of 10,000 to 25,000 population and 2 miles for towns in the 5,000 to 10,000 class. This means that in making improvements in a community the planning will have to consider developments within a circle of at least this radius, if the future growth of the community and its developing traffic are not to be adversely affected.

3. POPULATION FACTORS

a. General

In developing a long-range plan for highway development, one of the main influences upon traffic is found to be population, especially its distribution in urban areas. As population grows, so does traffic volume, and especially travel by public vehicles in urban areas, and between urban areas. Likewise, truck traffic between cities and towns increases, as the need to transport food and other commodities increases. The number and use of passenger cars, taxis and other types of motor vehicles increases correspondingly.

The increase in motor vehicle traffic may, in some

cases, be accompanied by significant shifting in the use and type of motor vehicles. As a community grows, the use of public transport becomes more and more necessary, if traffic congestion in closely built-up areas is to be avoided, or its results minimized.

As the population shifts within a local community it may also become necessary in the interest of proper civic development and of accommodation, both local and through traffic, to re-route the main highways through the community, and even to replan and relocate local streets to expedite the flow of traffic.

All of these operations are costly, in developed areas, both in construction and land acquisition, and the carrying out of the construction also results in major inconveniences to both the traveling public and the local residents and shopkeepers. In addition, in the larger communities, where there are extensive electrical, water, and other utility installations, there will be still further expense and inconvenience involved in the relocations which accompany the road and street modifications.

For all these reasons, then, it is necessary that the proper weight and consideration be given to the factors making the relocation and reconstruction necessary, one of the most important influences being that of population, its distribution, and trends.

b. Census of Urban Population, 1953

There was conducted in Burma, in 1953, and to the degree possible under conditions of insurgency and local unrest then prevailing, a population census of cities, towns and villages. The resulting figures may be summarized as follows:

242 cities, towns, and villages had a total population of 2,843,135.

Excluding the 22 villages enumerated for which the population was less than 1,000, 220 cities and towns had a total population of 2,826,991.

Of these, the five largest cities had a total population of 1,133,655 persons, divided as follows:

1. Rangoon (Town)	711,520	
2. Mandalay	182,367	
3. Moulmein	101,720	
4. Bassein	77,382	
5. Henzada	60,666	
		1,133,655

The remaining 215 cities and towns, each having a population less than 50,000, are distributed numerically as follows, for size:

8	30–50,000	14	8–10,000	30	3–4,000
13	20–30,000	15	6– 8,000	33	2–3,000
16	15–20,000	17	5– 6,000	36	1–2,000
12	10–15,000	21	4– 5,000		
				215	

For the purpose of this section of this Report, as relating to highway programs, classifications, etc., the communities will be classified as follows:

Major Cities	Population over	50,000	5
Other Cities	,,	20–50,000	21
Towns	,,	5–20,000	74
Villages	,,	1– 5,000	120
			220

c. Urban Densities

In planning the local improvement program, consideration was given to planning the street improvements in proper relationship to the population and areas of the communities involved. The relationship between population, developed area of the community and highway and street lengths within this area, is subject to variation from a number of factors. The more important factors are the population of the community, its basic nature, its stage of development, topography, barriers to expansion.

In developing the details of the local projects in the first stage of the highway rehabilitation and improvement program, it was found that with a few explainable exceptions, the population-area relationship was fairly consistent. The following cities will serve as examples:

	Density (persons per square mile)
Mandalay	10,200
Henzada	25,100
Prome	25,500
Myingyan	24,400
Chauk	28,400
Pyinmana	18,700
Meiktila	18,500
Shwebo	20,800
Thayetmyo	14,700

The density is based on the area of the developed portion of the city, as observed or established from local maps. These are very high densities, as compared to cities in the United States. Nine comparable American cities of populations between 40,000 and 220,000, based on the 1950 census, were compared to those above. It was found that the average density was approximately 7,700 persons per square mile; the figure varying from 6,200 to 9,800. The disparity between the cities in Burma and those in the United States, however, is not as great as the figures show, since the areas in the United States are those within the corporate limits. These are often somewhat beyond the limits of the present developed area. As a result it is believed that the average density value in the US would be approximately 9,000 to 10,000 persons per square mile, based on the developed area.

This compares to a reasonable average of 23,000 persons per square mile for the Burmese communities. This relatively high density produces no immediate problem, insofar as general traffic is concerned, due to the relatively small number of cars in most of the communities, as indicated in the vehicle registration figures in Table XVI–3A. It does point, however, to one serious current need, and this is borne out by common experience in and between a number of communities. The facilities provided for travel by bus are very inadequate, almost all vehicles in and between local communities are much overcrowded, and the service in general is not good.

As a long-range problem, the overcrowding of cities and towns will produce traffic congestion of a very serious nature, as the number of motor vehicles increases, and the use is intensified. For this reason careful planning of highway improvements is especially necessary. Many of the decisions taken in this direction will commit and influence the future development of the communities, and the long-range trends of population, community development and motor vehicle traffic.

d. Urban and Rural Population

It was necessary in establishing the basic trends of highway traffic, and its proper accommodation upon the highway network, both existing and as planned for future development, to establish the relative population, as between rural and urban areas, in the districts, divisions and the autonomous states of Burma.

Because of insurgency, no decennial census was made in 1951 in Burma. Based on the growth patterns indicated by the 1931 and 1941 censuses, and the much more rapid increase in the population of the urban areas, as revealed by a comparison of the 1941 and 1953 urban censuses, factors of increase were set up for the various parts of the nation. From these data, estimates were made of the rural, urban, and total population in each of the political subdivisions in Burma. These estimates are shown in Table XVI–7 (*see next page*). Also shown in the table are the estimated total populations of the divisions and of the eastern States. For the latter, no current figures are available as to urban population, and total estimates only could be made.

As shown in the table, the total population of Burma in 1951 is estimated to be 19,250,000, of which 2,940,000 (15·3%) are urban and 16,310,000 (84·7%) are rural residents. Almost half of the total population lives in the southerly three divisions (Pegu, Irrawaddy and Tenasserim) and if the Magwe and Mandalay Divisions are added, more than two thirds of the nation's population is accounted for.

The Pegu Division, which includes Rangoon, has an urban population which is 33·8% of the total. The urban percentages for other divisions are materially less, the second largest being the Mandalay Division, in which 18·5% of the population is urban. In four of the light divisions the urban population is less than 10% of the divisional total.

4. TREND AND ANTICIPATED TRAFFIC

The growth of motor vehicle traffic in Burma has been a sporadic and irregular matter, largely affected by extraneous influences for which no known experience factors can serve as a basis of estimate. Previous to World War II there were only a few motor vehicles in the whole Union. Military operations, and especially the transport and logistical problems created thereby, brought a great number of vehicles to Burma, but the majority were either for the haul and use of military equipment or for military personnel. Many of these vehicles remained here after the end of hostilities, and of these a considerable number—possibly 3,500—are now in use by the army of the Union. The vast majority, however, were immediately put to civilian use, either directly or after being converted. In this way, the number of trucks and buses in use became a very large proportion of the total number of registered vehicles.

Even so, there is a deficiency of vehicles in Burma, especially those for public hire and transport of passengers. The older vehicles now operating on the streets are from eight to ten years old, have been subjected to very severe operating conditions (as a result of the rough and otherwise maltreated and neglected pavements encountered since the war and insurrection) and cannot continue to operate much longer. Actually, at present, the loss due to "wearing out" is slightly greater than the increase each year due to import of cars.

Probably one of the most striking features of traffic in Burma, to the casual observer who has comparable experience elsewhere, is the persistent and almost complete overloading of hire vehicles, especially buses. On a recent field trip, for example, it was observed that a bus designed for 18 passengers, seated, was carrying a total of 46, including the two spare-men and three other passengers who were standing on the rear bumper of the bus and precariously clinging to the rear portion of the body. Such conditions are very common, and can be observed in every community and on the open, rural road as well. Buses so overloaded are a menace to the safety of the passengers, and to occupants of other motor vehicles as well.

The truck condition is scarcely better. Very heavy and bulky loads are often placed on the tops of truck bodies, thus raising the center of gravity of the loaded vehicle to an alarming degree. And more and more, of

TABLE XVI – 7

ESTIMATED POPULATION OF BURMA, 1951

(in thousands)

	Total 1951	*Division Total 1951*	*Urban 1951*		*Rural 1951*	
Arakan Division		1,350	(7·3%)		(92·7%)	
1. Akyab	866			68		798
2. Arakan Hill Tracts	39			6		33
3. Kyaukpyu	287			16		271
4. Sandoway	158			9		149
Pegu Division		3,470	(33·8%)		(66·2%)	
5. Rangoon Town	676·4			676·4		0
6. Pegu	663·6			158·6		505
7. Tharrawaddy	668			98		570
8. Hanthawaddy	523			50		473
9. Insein	441			112		329
10. Prome	498			81		417
Irrawaddy Division		3,030	(12·6%)		87·4%)	
11. Bassein	757			103		654
12. Henzada	790			91		699
13. Myaungmya	556			76		480
14. Maubin	488			48		440
15. Pyapon	439			64		375
Tenasserim Division		2,405	(15·5%)		(84·5%)	
16. Salween	65*			8*		57*
17. Thaton	676			70		606
18. Amherst	677			138		539
19. Tavoy	241			41		200
20. Mergui	206			39		167
21. Toungoo	540			77		463
Magwe Division		2,170	(8·7%)		(91·3%)	
22. Thayetmyo	338			39		299
23. Minbu	345			13		332
24. Magwe	638			73		565
25. Pakokku	637			45		592
26. Chin Hills	212			18		194
Mandalay Division		2,175	(18·5%)		(81·5%)	
27. } 28. } Mandalay incl. Town	466			222		244
29. Kyaukse	174			15·5		158·5
30. Meiktila	392			37		355
31. Myingyan	614			71·5		542·5
32. Yamethin	529			57		472
Sagaing Division		2,630	(6·8%)		(93·2%)	
33. Bhamo	147			9·5		138·5
34. Myitkyina	340			14·5		325·5
35. Shwebo	547			42·5		504·5
36. Sagaing	441			32·5		408·5
37. Katha	332			18		314
38. Lower Chindwin	488			40		448
39. Upper Chindwin	239			13		226
40. Naga Hills	96*			8*		88*

TABLE XVI – 7 (*continued*)

	Total 1951	*Division Total 1951*	*Urban 1951*	*Rural 1951*
Eastern States		2,020	(7%*)	(93%*)
North Shan States	788			
South Shan States	1,058			
Karenni	80			
Wa	94			
Total Estimated Population, Burma, 1951		19,250	2,940	16,310
Per cent of Total Population			15·3	84·7

Notes: Urban: Includes all communities of 1,000 or more.
Rural: Includes rural and all communities less than 1,000.
* Estimated.

late, the overcrowding of the buses has caused truck operators to engage, on the side, in the bus transport business. Many loaded and nearly loaded trucks are observed to be carrying two to five passengers, in addition to the working crew. This unregulated and illegal practice should be stopped at once, as it also creates a dangerous condition in traffic.

With a demonstrated shortage of vehicles for the passengers and goods now desiring to be carried by public transport, the Government should exercise every effort to improve the conditions for the import of vehicles, to take the place of those worn out and no longer on the highways, and additional vehicles, especially trucks and buses, to serve the increased traffic already desiring such service.

As to the rate at which the traffic will increase, the answer is difficult to make. Total registrations in countries where the vehicle population is low can increase more rapidly than ones in which the number of cars and trucks is already substantial and somewhat stabilized. On this basis, and if there were no import restrictions to impede the process, it seems possible that the vehicle population in Burma, and thus the total traffic, could double in the next five years. However, the import exchange obstacles cannot be completely removed even if the recommendations are effectively put into force. On the basis of experience in evaluating factors of this nature, it is estimated that the vehicle registration in the Union will increase by one third in the next five-year period. Thus, by 1958, the vehicle population of Burma would be approximately 35,000. It is suggested that the highway planning and expenditures be geared to that level of growth.

Betterment of the conditions of the Union roads, especially the national system as recommended below, will bring about an increased use by vehicles of all roads, and this increased road usage will also be an important growth factor.

5. THE OX CART

One of the problems that has plagued the Department of Building and Roads, and its predecessor bodies, is that of the accommodation of the ox cart upon highways with mixed traffic, traveling at differing speeds.

Based on the best available data on agriculture, in 1948–49, it can be demonstrated that there are 1,500,000–1,700,000 ox teams in Burma at the present time. While the larger figure is subject to some qualification, there are certainly not less than one and one half million teams in service, and occasionally using the public highways of the Union. On the basis that these bullock teams are in use by the owner-cultivators, for plowing and other farm duties, at least half the time, and possibly two thirds, the ox-team population represents a net total of say 700,000 vehicle units on the local, and occasionally on the main roads. As a consequence of this number, as compared to the total motor vehicles in use at present, and the wide disparity in their respective speeds and behavior in traffic, the ox cart is important as a traffic factor in rural areas and smaller communities.

The vehicle is important for another reason as well. On narrow pavement surfaces, such as exist now in all parts of Burma, a motor vehicle which overtakes a cart going in the same direction or meets an approaching one, causes the animal-drawn vehicle to turn off the pavement surface and on to the shoulder. This process, since almost all of the carts have narrow band

steel tires, is destructive to the edges of pavements, especially bituminous surfaces. The condition is especially damaging in recent times, for the lack of adequate highway maintenance has permitted the surface of the shoulder to become depressed, adjacent to the edge of the roadway surface. This step, which is bumped over twice each time a cart leaves the paved way and then returns to it, is sometimes six to eight inches in height, and hardly ever, except immediately after the visit of the road gang, less than two inches. A great deal of the raveling and ragged-toothed edges of the present pavements is due to this cause.

As examples of the destructive effect of "turning off," see Plate 1, in Section C of this chapter.

In the case of gravel and earth roads, the result of the turning-off process by carts is to produce ruts in the road surface. These are dangerous to other traffic and costly to eliminate by maintenance.

The problem has several solutions:

(*a*) The development of a pneumatic-tired cart, to avoid damage to the pavement edges, and to reduce rutting on gravel and earth roads.

(*b*) The insistence, by the traffic regulatory agencies, that the present narrow (in some cases as little as one-inch width) steel-band tires be replaced by wider tires, to reduce the high unit pressure on the pavement immediately under the tire as it goes off or comes on to the pavement surface, and to reduce the effect of rutting on gravel and earth roads.

(*c*) To force the carts to use only the shoulders, or other berm roads.

(*d*) To reconstruct the road surfaces with sufficient width to eliminate, or at least drastically reduce, the "turning-off" process. This scheme will only be completely successful if it is accompanied by a major improvement in the quality of shoulder maintenance, for the surfaces immediately adjacent to the pavement must be well kept, and at the same elevation as the surface of the latter.

(*e*) To surface the shoulders, to provide on them a surface of sufficient strength to carry the cart loads, even with narrow tires.

It is the consultant's view that a combination of solutions (*d*) and (*e*) is the preferable answer to the problem. Strong recommendations as to road maintenance and especially that on shoulders, are made in this Report. The recommendations for roadway sections on the national roads, district roads and farm-to-market roads, as more fully described elsewhere and shown on Plates 6–9, provide treated shoulder surfaces, of sufficient width to accommodate mixed traffic with a minimum necessity to leave the pavement.

In several countries, and especially in the Phillipines, the governments have been fairly successful in obtaining the use of wider cart tires by having wheels with such tires made by prison labor and sold to the cart owners at a very nominal price. Various methods were used to popularize the public interest and participation in the program, but the most important factor appears to have been the low price at which the equipment was made available. It may well be that with present conditions in Burma, a parallel idea would have fruitful results, and that the road maintenance costs would be sufficiently reduced, over a reasonable period, to make the program economically feasible.

Highway grades, too, have to be held to a very low figure in areas where the bullock carts and coolie carts are used. It has been found in India, for example, that a gradient of 1 : 40 (which is $2\frac{1}{2}\%$) is about the maximum that can be negotiated by either of these vehicles with the weight of loads that are commonly carried. In recent years, several major structures and highway approaches have been designed and constructed under this limitation.

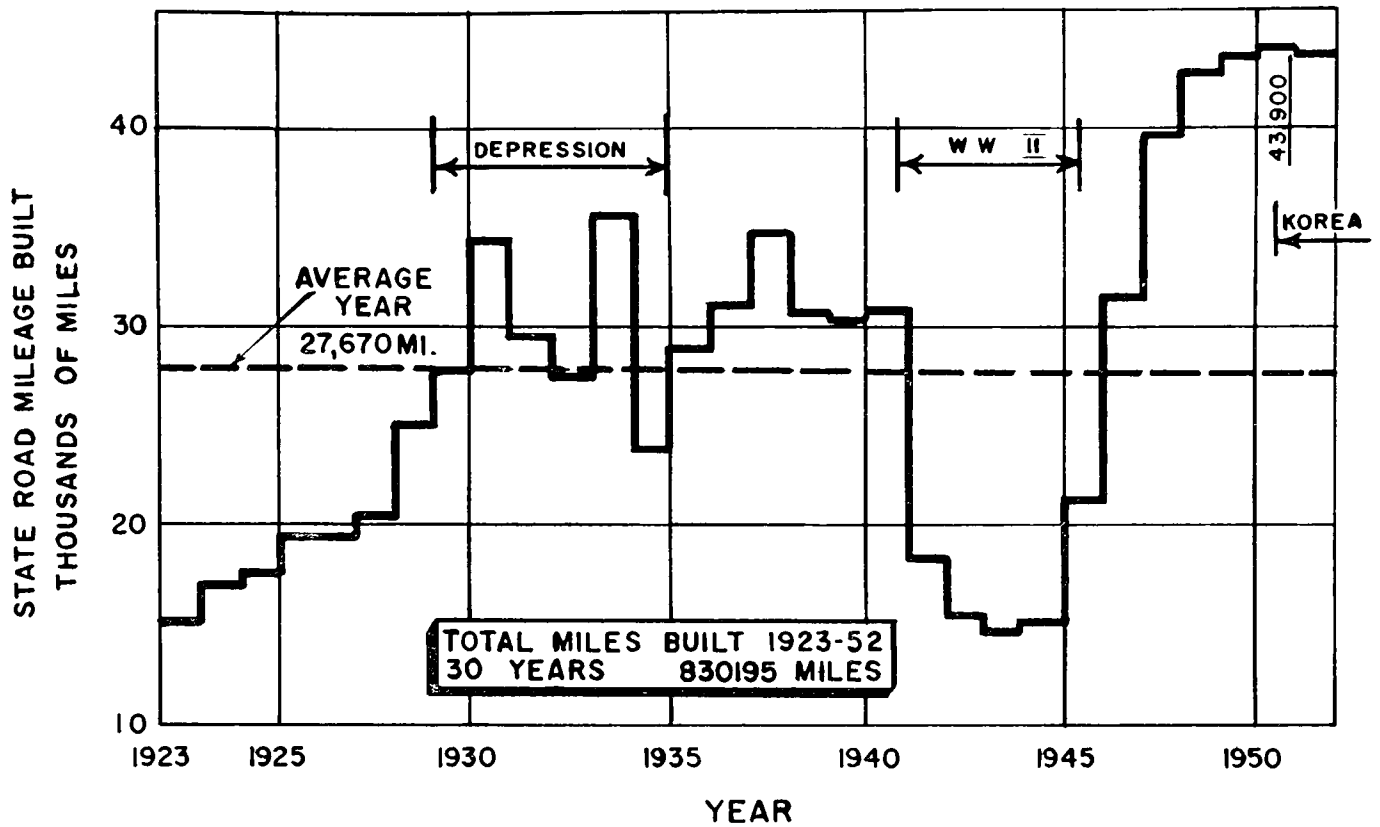
E. COMPARISONS WITH OTHER HIGHWAY SYSTEMS

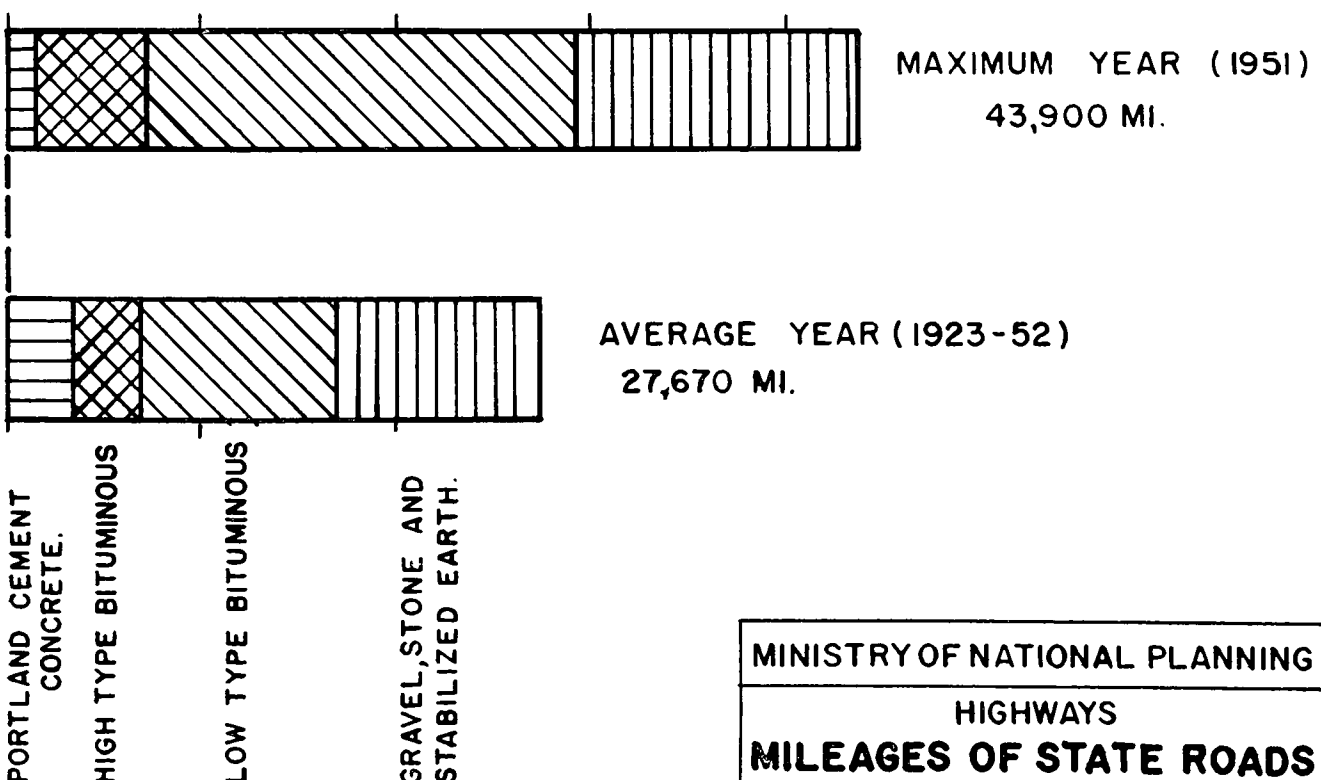
1. GENERAL COMPARISONS

Burma has been previously compared with other countries as to motor vehicle registration density (Table XVI–4). It was indicated that there was in Burma in 1952 one vehicle for each 800 persons, as compared to one for each 350 for several other countries and one for each 3·2 persons in the United States. However, the number of vehicles per capita is not the sole measure of the adequacy or inadequacy of motor transport. The stage of development of the country, its size, physical characteristics, climatology, topography, essential industries and agriculture, and other transport facilities, and many other factors have a bearing on the general problem.

To illustrate the influence of these factors, a general discussion of their effects in other countries and in several states of the United States is presented in the remainder of this section. The states are hereafter referred to as "comparative states," and a brief description is given of each. The statistical data is later set down in tables applicable to the several aspects of the study.

The total road construction program, as carried out year after year in the United States, although varying in extent somewhat in times of economic upheaval, has been on a constantly increasing scale. The magnitude of the increase is shown in Plate 4. In the past thirty years a total of 830,195 miles of state roads have been built in the United States. In the average year, more than 27,000 miles of highway were constructed, and in 1951, the maximum year, the figure was 43,900





MINISTRY OF NATIONAL PLANNING

HIGHWAYS

MILEAGES OF STATE ROADS BUILT IN U.S. 1923— 52

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK. RANGOON

DR BY. E J P DATE JUNE 53. PLATE NO. 4
CK BY. K B W

miles. Also shown on the plate are the pavement types for an average year and for 1951.

a. Comparative States

Iowa. This is a midwestern state, predominantly agricultural, although there is also some coal mining. The state road system dates from about 1900, and the Highway Commission was established in 1913.

Kansas. This is also a farming state. The earliest transport was by water, on the Missouri. This was replaced by rail transport, and then by the motor vehicle. There were 9,000 miles of improved roads in the state in 1937, and this has since grown to more than 37,000.

Ohio. This is a farm-industrial state. Early traffic used the Ohio River, and the earliest transcontinental highway, the National Pike, traversed southern Ohio.

California. Since the start of World War II, this state, once predominantly agricultural, has grown rapidly in the direction of light industry. Highway transport began to develop rapidly in 1900, and the Highway Commission was instituted in 1909. The state has been very progressive in the development of good highway construction and maintenance techniques.

South Dakota. This is a small farming state. The state road system came into being about 1905, and since then almost all the prairie trails have been converted to motor highways.

To indicate the degree to which the farmer in the United States has convenient access to communities other than his own by reason of being on or close to all-weather roads, consider the data in Table XVI–8.

TABLE XVI – 8

DISTANCE FROM FARMS TO ALL-WEATHER ROADS, U.S.

(per cent of all farms)

State	*Distance from Farm to All-weather Road, miles*					
	0–0·2	*0·2–0·3*	*0·5–0·9*	*1–1·9*	*2·0–5·0*	*Over 5 Miles*
Iowa	66	9	3·5	10·5	6	1
Kansas	47	10	3	16	14	6
Ohio	82	5	1·5	4·5	2	0·3
California	85	3·5	1	2·5	1·5	0·7
South Dakota	40	12	4	17	13	11
Whole U.S.	64·4	8	2·2	9·1	7·7	3·5

In 1945, two thirds of all farms in the United States were on all-weather roads (passable at all times and seasons), and in the northeast and Pacific coast states, the figure was four fifths.

The increasing access which the rural citizen has to the developing road network is also well shown on Plate 5, US Rural Road Mileage, 1904–53. Both the surfaced mileage and the non-surfaced mileage rose rapidly during the 50-year period, the latter at an especially high rate during the ten years preceding World War II. The proportion of the total rural mileage which is surfaced has also climbed steadily, and at the present time 57% of the total rural mileage is paved.

b. Comparative Countries

To establish the current nature and probable future of motor transport in Burma in the foreseeable future, the similarities with other countries, both in Asia and elsewhere, were scrutinized. While the data from several of these is incomplete, the attempt was made to cast it in a form to be useful in the studies of the highway trends. There follow some significant figures and comments on highway work in several selected countries.

Turkey. Turkey had a national income in 1950 of TL7,162 million (TL1 = $0.36 = K1.72), almost half of which was derived from agriculture, forestry and fishing. In 1950, the total highway budget was TL82·5 million, as follows:

Revenues	TL53 million
General Budget	19·5
Loans	10
	TL82·5 million

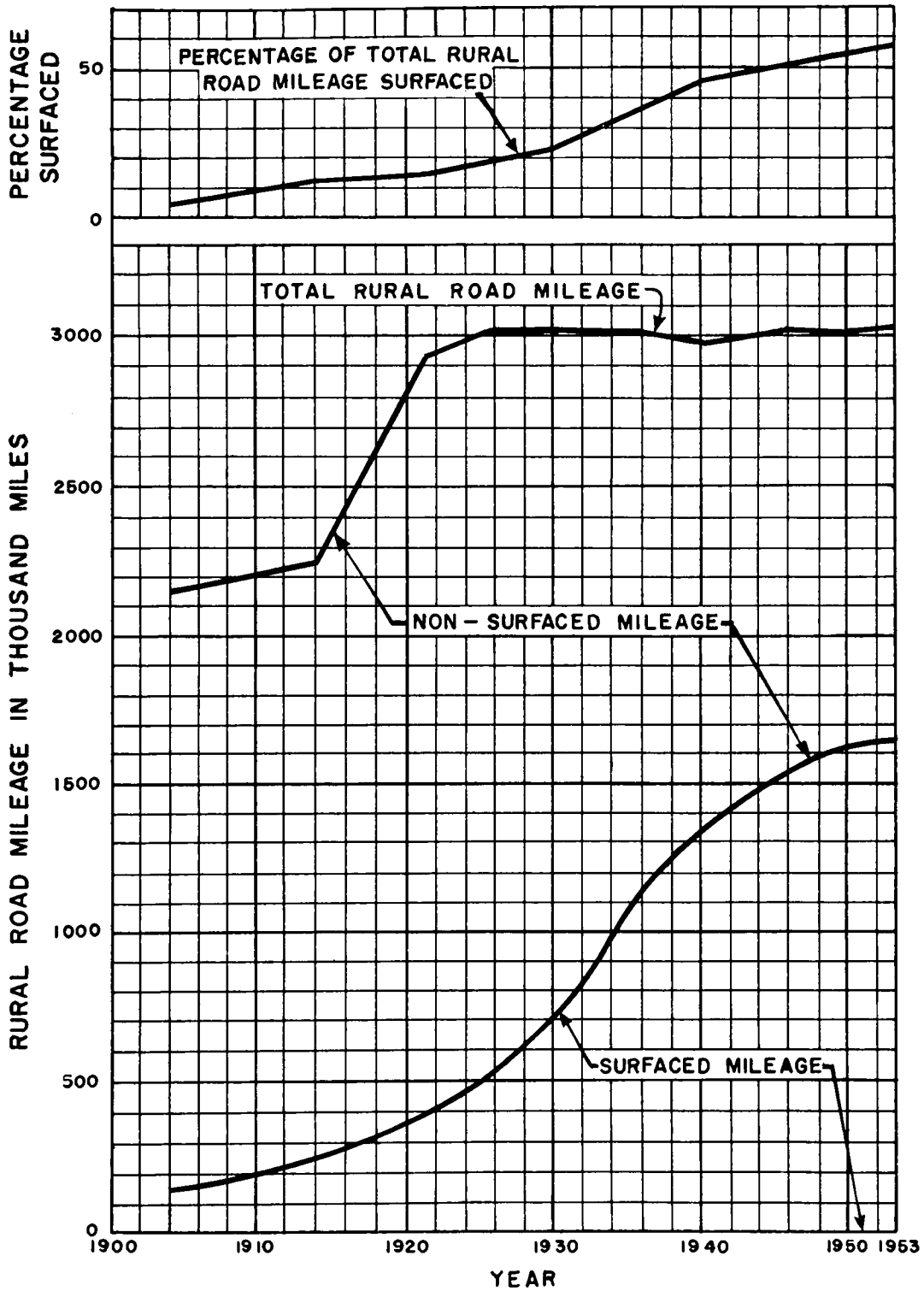
This income was expended as follows:

Provincial Highways	TL7 million
Trunk-line Construction	50
Maintenance and Administration	25·5
	TL82·5 million

Guatemala. In 1950, the national income was Q50 million (Q1 = $1 = K4.75), and almost 60% was derived from agriculture, fishing and forestry.

The net highway budget of Q4·03 million, 8% of the national income, was not sufficient for the proper maintenance and restoration of existing roads, and more funds were made available by the addition of Q1·43 million from the receipts of the coffee tax. In the original budget Q1·8 million had been allotted for maintenance, including shops and incidentals, a total of $525 per mile of highway.

Ceylon. In 1951–52, the expenditures for replacement and reconstruction totaled Rs.21·8 million, and the bridge and road maintenance was Rs.17·2 million,



MINISTRY OF NATIONAL PLANNING

HIGHWAYS

U.S. RURAL ROAD MILEAGE, 1904-53

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY EJP DATE MAY 53 PLATE NO. 5
CK. BY KBW

TABLE XVI – 9A

POPULATION, LAND AREAS, HIGHWAY MILEAGES

State or Country	*Population*	*Total Land Area (sq. mi.)*	*Per cent Cultivated*	*Present Highways, miles*			
				Metaled and Surfaced	*Metaled Only*	*Dirt Roads*	*Total*
Burma	19,250,000	261,749	10	2,080	3,527	2,449	8,056
Entire U.S.	150,555,592	2,977,128	19	1,616,557	1,319,495	66,457	3,002,509
Iowa	2,621,073	56,280	60	66,518	34,769	22	101,309
Kansas	1,905,299	82,276	43	37,415	91,749	337	129,601
Ohio	7,946,627	41,222	41	76,112	9,383	8	88,503
California	10,586,223	1,569,213	8	58,634	38,587	269	97,690
So. Dakota	652,740	77,047	33	31,079	64,079	174	95,332
Iraq	4,800,000	168,400	Not known	1,550	320	3,130	5,000
Ceylon	7,550,000	25,000	20	11,100		8,000	19,100
Guatemala	2,787,000	45,452	6·5	—	—	—	3,400*
Turkey	20,900,000	299,000	Not known				
(National roads)				8,000†	2,700	2,700	13,400
(Provincial roads)				—	—	—	13,500

Note: For Vehicle Registration, see Table XVI–4.
* National and departmental roads.
† Includes 2,850 miles of ruined macadam.

making a total of Rs.39 million. These funds were expended on a national system 11,095 miles in length. This represents only Rs.1,550 per mile per year.

Iraq. In Iraq, the provincial governments and the towns control the secondary roads and urban streets. For the national system, administered by the public works department, the maintenance costs are allocated on the basis of the Ministry's budget. The unit cost per year was ID40 per km. (ID 1 = $2.80 = K13.3) or $180 per mile per year, or K850 per mile per year.

2. STATISTICAL DATA, DENSITIES

There are presented here two tables, from which comparisons can be made to evaluate the current state of development of Burma's highway system. The tables are XVI–9A, Population, Land Areas, Highway Mileages; and XVI–9B, Highways—Land Areas. From these tables, the following observations can be made:

(*a*) Burma is proportionately less developed, agriculturally, than any of the comparative American states, except California, which has a high proportion of rugged mountainous area. However, the cultivation of individual holdings here is much more intense than for the other countries or states listed.

(*b*) In Table XVI–9A, the comparison of types of pavement and pavement surface is of interest in view of the differing degree of development of the several states and countries. The high percentage of surfaced road for the older systems is significant, in that this is probably the direction into which the pressure of traffic will force the highway administration in planning for the principal Union routes, I and II, and later the others, III–VIII.

TABLE XVI – 9B

HIGHWAYS—LAND AREAS
COMPARATIVE STATES AND COUNTRIES

State or Country	*Total Mileage, Roads and Streets*		*Miles of Roads and Streets per sq. mile Land Area*	
	Surfaced	*Total*	*Surfaced*	*Total*
Burma	2,080	8,056	0·008	0·031
Entire U.S.	1,864,405	3,321,472	0·63	1·12
Iowa	74,209	111,526	1·33	1·99
Kansas	42,442	136,844	0·52	1·67
Ohio	91,346	104,821	2·22	2·55
California	75,266	117,022	0·48	0·75
So. Dakota	32,615	97,713	0·43	1·28
Iraq	1,550	3,450	0·009	0·02
Ceylon	—	19,100	—	0·77
Guatemala	—	3,400	—	0·08
Turkey	8,000	26,900	0·03	0·09

Notes: For vehicle registration, 1950, see Table XVI–4.
For land areas, see Table XVI–9A.

TABLE XVI – 10

OUTLAYS OF STATE REVENUES
STATE-ADMINISTERED HIGHWAYS, 1950
(*in thousands of dollars*)

State	Capital Outlay, Roads and Bridges			Maintenance Outlay			General Outlays				Retirement of Obligations	Total Disbursement
	Primary (Rural)	Urban Extensions	Total	Primary (Rural)	Urban Extensions	Total	Admin. Engrg.	Highway Police	Interest	Subtotal		
Iowa	12,512	4,604	17,116	7,862	107	7,969	805	963	58	26,911	4,515	31,426
Kansas	20,421	1,266	21,687	8,473	404	8,877	2,029	712	—	33,305	998	34,303
Ohio	31,709	6,871	38,580	27,936	167	28,328	8,033	2,629	6	77,576	290	77,866
California	52,335	34,155	86,490	16,504	4,413	20,917	6,880	8,692	1,666	124,645	12,321	136,966
So. Dakota	7,378	505	7,883	4,307	—	4,307	585	162	—	12,937	—	12,937
Whole U.S.	922,237	302,421	1,533,859*	397,003	33,608	501,487	109,841	77,612	60,714	2,283,513	199,407	2,482,920

* Includes 132,971 (park, etc., roads) and 176,230 (secondary roads under state control).

(*c*) It is from Table XVI–9B that the lack of highway facilities in Burma really appears. For the average of all of the United States there are 0·63 miles of surfaced street or highway per square mile of land area. For Burma, the figure is one fortieth as great. For total pavements (both surfaced and unsurfaced), the story is only slightly better, the ratio being one thirty-sixth. Only Iraq has a comparable figure, as shown in the last two columns of the table.

3. STATE ADMINISTERED HIGHWAYS

In Section M of this chapter, the sources of the state revenues for highway purposes in the United States are tabulated. The fuel tax totals almost half of the states' highway income, and vehicle licence fees total a quarter of the whole.

In Table XVI–10, the disbursement of these funds for state-administered highways is shown by basic categories. The values in the table are listed in thousands of dollars, and represent the capital outlays for roads and bridges, the maintenance outlay, and the general outlays for state-administered funds, in 1950.

It will be noted that for both Kansas and South Dakota, almost 95% of the capital outlay was on the primary system. The counterpart proportion was 60% for the entire United States. Likewise, almost 80% of the outlay for maintenance went for service to the primary system.

The total outlays of state revenues for state administered highways, for the total of all of the states making up the United States may be summarized, from Table XVI–10, as follows:

	Thousands of Dollars	*Per cent of Whole*
Capital Outlay	1,533,859	62·0
Maintenance	501,487	20·0
Administration, Engineering	109,841	4·5
Highway Police	77,612	3·0
Interest	60,714	2·5
Subtotal, Current Expenses	2,283,513	92·0
Debt Retirement	199,407	8·0
Total Disbursements to State-administered Highways	2,482,920	100·0

During 1949, also, local governmental units expended on the streets of the cities, towns and villages of the United States a total of more than twenty million dollars, divided as follows:

	Expenditures (in thousands of dollars)
Right of Way	9,986
Construction	9,376
Maintenance	1,271
Total	20,633

In the same year, the spending by local urban units on streets of cities and towns was, for the entire United States, more than seven hundred million dollars, as follows:

Right of Way	13,062
Construction	301,062
Maintenance	341,530
Miscellaneous	53,169
Total	708,823

4. MAGNITUDE OF PROGRAM

During 1950, the magnitude of the operations carried out by the state highway departments was as shown in Table XVI–11. These were contracts awarded during the year, with and without federal funds involved in the financing. The work had to be planned; the contract drawings, specifications and estimates had to be prepared; and the work had to be supervised by the several departments.

TABLE XVI – 11

CONSTRUCTION CONTRACTS AWARDED BY STATE HIGHWAY DEPARTMENTS, 1950

State	*Projects with, or Partly with, Federal Funds*			*Projects without Federal Funds*		
	No. of Projects	*Cost ($1,000)*	*Miles*	*No. of Projects*	*Cost ($1,000)*	*Miles*
Iowa	407	22,260	1,257	682	10,903	2,399
Kansas	345	17,400	1,754	198	4,948	923
Ohio	231	48,676	470	298	14,408	2,141
California	113	36,139	381	253	25,407	528
South Dakota	187	11,988	1,194	9	1,293	98
Total US	5,787	820,659	23,429	7,674	694,045	32,038

There were in progress during the year a total of almost 13,500 projects, involving the expenditure of a billion and a half dollars and resulting in the construction and improvement of some 55,000 miles of highway in the United States.

Likewise, the federal aid projects completed during the year, on primary and secondary rural and urban highways, are shown in Table XVI–12.

5. TYPES OF CONSTRUCTION

Various types of highway construction are used in each of the states in the United States. Engineering comparisons are constantly being made to determine the most suitable and economic surface to use in any given location and set of circumstances, and alternate bids on different types are sometimes called for to verify the comparisons. Also, the price of local materials often has a determining influence.

Table XVI–13 brings the picture into focus for the whole United States. In it are shown the mileages of various types of pavement at the beginning of 1950, and the mileage changes resulting from new construction and replacement during the year.

6. SOURCES OF DATA

In this section, and in the part of the Report relating to highways, material and factual data, as well as comparisons and general information, have been drawn from many sources, the more important of which are listed below:

Burma

(**a**) Buildings and Roads Department, Ministry of Public Works, data on operations of Department, its administrative organization, programs, budgets, costs, etc., from prewar and postwar reports of the Department; records of the Department; Highway Act of 1907 and notifications; and numerous consultations with officers and staff of the Department and executive and district engineers in the central office and district offices throughout Burma.

(**b**) Motor vehicle registration and related data from Office of Motor Vehicle Registration, Rangoon.

(**c**) Population figures and growth rates (in part)

TABLE XVI – 12

US FEDERAL AID HIGHWAY PROJECTS COMPLETED, 1950

(costs in thousands of dollars)

State	*Total*		*Rural Highways*				*Urban Highways*	
			Primary		*Secondary*			
	Miles	*Cost*	*Miles*	*Cost*	*Miles*	*Cost*	*Miles*	*Cost*
Iowa	1,164·8	24,328	291·6	13,400	864·5	8,571	8·7	2,357
Kansas	1,980·1	23,386	427·5	13,834	1,537·1	6,963	15·5	2,569
Ohio	209·7	28,802	66·9	14,668	133·9	4,695	8·9	9,439
California	223·1	26,149	64·1	12,005	145·2	7,845	13·8	6,299
South Dakota	823·1	8,655	283·6	4,358	538·5	4,081	1·0	216
Entire US	19,876	753,199	5,145·1	307,680	14,185·5	232,291	545·4	213,228

TABLE XVI – 13

MILEAGE CHANGES ON STATE SYSTEMS, UNITED STATES HIGHWAYS, 1950

Type, etc.	*Total, Entire US on January 1, 1950 (miles)*		*Constructed During 1950 (miles)*
(*a*) On Primary Rural State Highways			
Primitive	669		—
Unimproved	3,409		—
Graded and Drained	9,114		608
	——	13,192	
Soil Surfaced	4,400		112
Slag, Gravel or Stone	43,351		3,983
Bitum. Surf. Treated	76,516		7,938
Mixed Bitum—Non-rigid Base	38,069		2,914
,, ,, —Rigid Base	44,434		3,901
Bitum. Penetr.—Non-rigid	9,995		236
,, ,, —Rigid	13,145		346
Bituminous Concrete	35,801		3,804
Cement Concrete	77,921		1,019
Brick and Block	826		—
	——	344,458	
Subtotal, (*a*)		357,650	24,870*
(*b*) Secondary Roads under State Control			
Primitive	1,697		—
Unimproved	29,720		—
Graded and Drained	28,872		1,147
	——	60,289	
Soil Surfaced	38,566		2,143
Slag, Gravel or Stone	46,004		5,199
Bitum. Surf. Treated	44,103		5,606
Mixed Bitum.—Non-rigid Base	1,967		241
,, ,, —Rigid Base	1,624		404
Mixed Penetr.—Non-rigid	685		110
,, ,, —Rigid	8,301		690
Bituminous Concrete	2,183		2,085
Cement Concrete	1,973		29
Brick and Block	138		—
	——	145,544	
Subtotal, (*b*)		205,833	17,654†

Type, etc.	*Total, Entire US on January 1, 1950 (miles)*		*Constructed During 1950 (miles)*
(*c*) Urban Extensions of State Systems			
Primitive	26		—
Unimproved	444		—
Graded and Drained	354		29
	——	824	
Soil Surfaced	371		19
Slag, Gravel or Stone	1,232		91
Bitum. Surf. Treated	4,985		372
Mixed Bitum.—Non-rigid Base	2,374		138
,, ,, —Rigid Base	2,337		232
Bitum. Penetr.—Non-rigid	627		—
,, ,, —Rigid	1,209		38
Bituminous Concrete	8,682		661
Cement Concrete	11,003		160
Brick and Block	1,572		1
	——	34,392	
Subtotal, (*c*)		35,216	1,741‡
Summary			
(*a*) Primary		357,650	24,870
(*b*) Secondary		205,833	17,654
(*c*) Urban		35,216	1,741
Total, entire United States for 1950		598,699	44,265§

* Of this, 23,317 is mileage of former types replaced.
† Of this, 17,536 ,, ,, ,, ,, ,, ,,
‡ Of this, 1,574 is mileage of former types replaced.
§ Of this, 42,427 is mileage of former types surfaced.

from Office of the Commissioner of the Census, Rangoon.

(d) "Report to Government of Burma on Low Cost Roads," F. L. D. Wooltorton, Public Works Department, 1948.

(e) "The Motor Roads of Burma," 4th Edition (1948), published by Burmah Oil Co. Ltd., Rangoon.

(f) "Burma Handbook," 1945, published by Government of Burma at Simla.

Other Sources

(a) From US Bureau of Public Roads:

(1) "Highway Statistics," Summary to 1945, and 1950.

(2) "Standard Specifications for Highway Bridges."

(3) "Standard Specifications for Testing and Materials."

(b) From Committee on Inter-Regional Highways, US: Report to the President and Congress, 1944. This contains much data on long-range regional highway planning, basic standards for design of roadways and structures in both rural and urban areas.

(c) United States Census of Agriculture, 1945, for data on farms, farm income and land areas.

(d) From Highway Research Board, U.S.:

(1) Bulletin 13, "Appraisal of Terrain Conditions for Highway Engineering Purposes," 1948.

(2) July 1951 Abstracts, Maintenance Costs.

(e) Soils investigations and testing:

(1) American Society for Testing Materials, Philadelphia, Pa, "Procedure for Testing Soils."

(2) US Bureau of Public Roads: Many reports in "Public Roads," various issues, on general and detailed aspects of the problem, including research on soil constants, soil road surfaces, pressures on culvert structures, subgrade surveys and studies, non-rigid pavements, drainage of sub-grades, and others.

(f) "American Highway Practice," by Dr. L. I. Hewes of US Bureau of Public Roads, John Wiley and Sons, 1949.

(g) "Highway Maintenance Manual," Division of Highways, State of California, US.

(h) "Organization Manual," Ohio Department of Highways, US, and Sixth Annual Report (1953), showing administrative structure of Division of Highways, State of California, US.

(i) World Bank Reports on Ceylon (1953), Guatemala (1951), Iraq (1950) and Turkey (1951). Published by Johns Hopkins Press, Baltimore, Maryland, US.

(j) "Regulatory Administration," Geo. A. Graham and Henry Reining, Jr., Editors. Published by John Wiley and Sons, 1943.

(k) "Automobile Facts and Figures," and "Truck Facts and Figures," published annually by Automobile Manufacturers Association, US general data on vehicles registration, road and street mileages, highway costs and financing.

(l) Associated General Contractors, U.S.: Paper on the "Influence of Modern Equipment on Highway Construction," 1952, a complete historical review of the invention and development of modern mechanical equipment for highway construction, and the effect of its use on prices, productivity and the industry.

F. DESIGN REQUIREMENTS

1. GENERAL CONSIDERATIONS

As with all road systems, the one in Burma suffers from having been built in segments, each of which was presumably modified from the last construction to meet the current requirements of good design practice. As a result, the design standards are different on different parts of the system, and even on different portions of the same road. These inequities and peculiarities should be removed whenever opportunity permits in order that the operating and maintenance conditions shall be as nearly uniform and to as high a standard as possible.

As a motorist drives along a through highway he should not be confronted with frequent and unreasonable changes in pavement width, with alternately wide and narrow structures, and with variable shoulder widths and treatments. Also the standards for horizontal curvature and for sight distance, and especially their combination under unusual conditions, need to be such that the vehicle can be driven at a fairly constant speed, and with a feeling of confidence on the part of the operator. Likewise, the grades should be such as to produce safe and feasible operating speeds, with no undue strain on the vehicle, and this is especially true for the use of heavy trucks in mountain areas where the operating speeds are also likely to be hampered by alignment restriction due to topography.

The design standards to be adopted and used for the rehabilitation program have to be developed concurrently with the basic requirements which should be adopted for all new construction under the long-range program for highway improvement. The latter standards should be of as high quality as the economics of the program will permit, and there should not be any compromises with basic requirements.

Very serious consideration, too, should be given to fashioning the details of the roadway and shoulder section for the Union and district road system to facilitate the use of modern maintenance equipment in order that the "housekeeping" on the reconstructed and new sections of the highways may be of the best quality, and economic as well. Likewise, the drainage details should be adequate, as simple as possible, and also susceptible to good maintenance.

In general, the design standards now being used by the Department are basically sound but need modification to be adapted to good modern practice. Compromises have been made in the past, in most cases to solve some local alignment, grade or property acquisition problems. The reconstruction offers a good opportunity to correct a number of these situations at the time that other construction operations are being carried on in the immediate locality.

The standards now established, though not always adhered to in adverse circumstances, are:

(a) Design speed: 30 m.p.h. With the sharp curves which now exist in a number of places on main roads, this speed could not be achieved.

(b) Sight distance: 800 ft. minimum, though there are a number of vertical curves on various roads of the system that are sharp enough to yield only 400–450 ft., and in a few instances 350 ft., or slightly more.

(c) Limiting grade: 3·33% (= 1 : 30). Many grades are much steeper than this, especially in upper Burma. In some instances the grade is too steep for only short stretches.

(d) Side slopes: 1½ to 1 and 2 to 1. It was noticed in the inspection trips that the cut slopes needed to be cut back at a great many locations, to prevent the blocking of the drainage ditches by slope earth.

(e) Crown of road: 1 : 60 (one fifth inch per foot, transverse to the centerline) is striven for, but not always obtained; 1 : 40 is observed to have been used in many cases.

(f) It is understood that in prewar times it was the practice to grass the slopes at bridge abutments. This practice should be re-established at once, following the shaping up of the embankment contours.

The development of design standards for the farm-to-market road section, and geometrics is important from the viewpoint that the most important factor, other than construction cost, is inexpensive maintenance.

For the determination of roadway capacity the recommendations and definition for capacity offered by the Highway Research Board are applicable. The definition follows:

The practical capacity of a roadway has been defined as "the maximum number of vehicles that can pass a given point on a roadway or in a designated lane during one hour without the traffic density being so great as to cause unreasonable delay and hazard, or restrictions to the driver's freedom to maneuver under the prevailing roadway and traffic conditions." The distinction should be noted between *practical* capacity, which is qualified by the degree of convenience experienced, and *possible* capacity which is not related to convenience. The practical roadway capacity depends on a number of factors such as the traffic speeds, the proportion of commercial vehicles to total vehicles, lane widths, lateral clearances, shoulder conditions, alignment and grades. These factors were studied in detail in developing the criteria from which to establish the pavement widths for the recommended typical sections for the Union and district road systems.

2. CONCLUSIONS AND RECOMMENDATIONS

It is proposed that new basic cross-sections be established for the Union road system and the district road system. It is preferable to have a wider section for those portions of Routes I and II just north of Rangoon. It is therefore proposed that from Rangoon to Pegu on Route I, and from Taukkyan to Prome on Route II, the roadway be reconstructed to a minimum width of 20 ft. The remainder of Routes I and II should have a roadway width of 18 ft. The other Union Routes, Nos. III–VIII, are designed with a recommended pavement width of 16 ft., while the width for the district road system is established at 14 ft. The design for the proposed farm-to-market road section incorporates a 12-ft. surface width.

The sections were designed on the basis that the modern techniques of compaction with moisture control, using mechanical construction equipment, would be used.

Proposed details of the four sections are as shown on Plates 6, 7, 8 and 9. The basic characteristics and dimensions are shown in Table XVI–14, which follows:

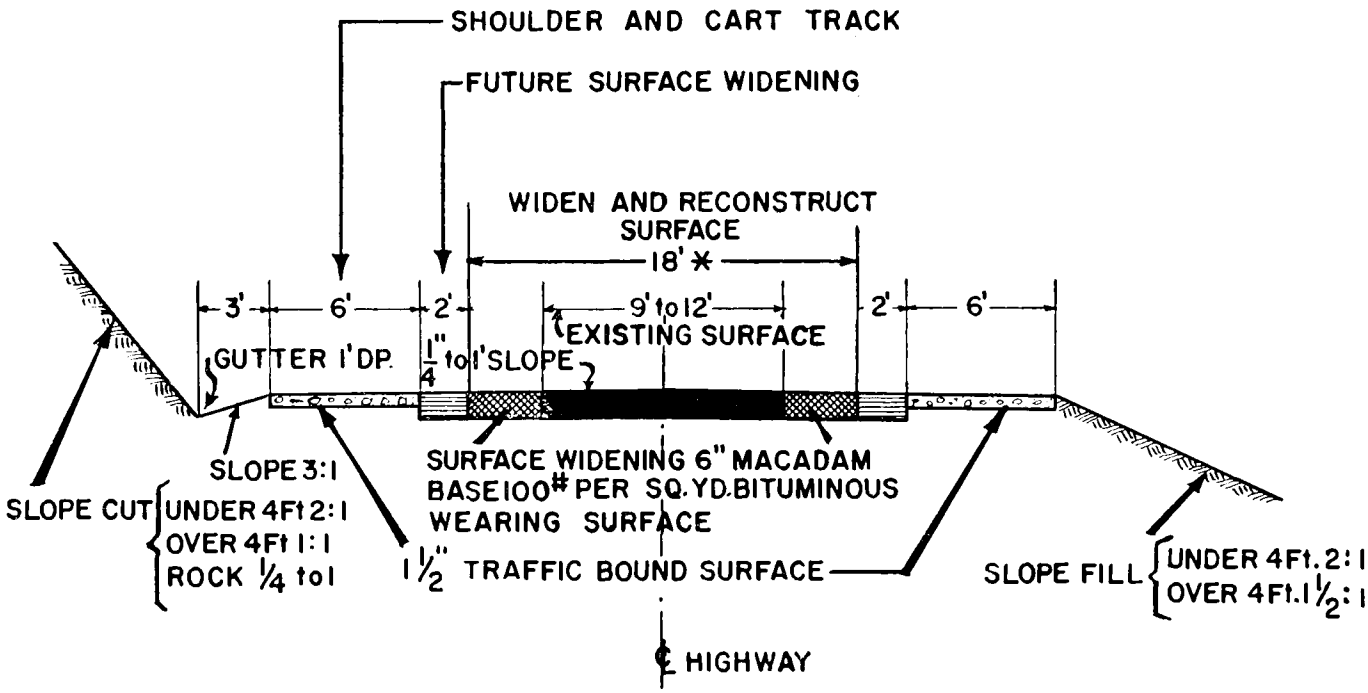
TABLE XVI – 14

RECOMMENDED PAVEMENT AND SHOULDER WIDTHS

	Width of Widened and Re-constructed Pavement	*Width of Shoulder*	*Total Platform Width*
Union Roads			
Route I, Rangoon to Pegu	20 ft. min.	6 ft.	32 ft. min.
Route I, remainder	18 ft.	6 ft.	30 ft.
Route II, Taukkyan to Prome	20 ft. min.	6 ft.	32 ft. min.
Route II, remainder	18 ft.	6 ft.	30 ft.
Routes III–VIII	16 ft.	6 ft.	28 ft.
District and Secondary Roads	14 ft.	6 ft.	26 ft.
Farm-to-market Roads	12 ft.	4 ft.	20 ft.

Notes: (*a*) Routes I and II, south of Pegu and Prome, respectively, are planned for future widening, as necessary with developing traffic, to an ultimate pavement width of 24 ft.

(*b*) Other portions of Routes I and II are similarly planned for an ultimate pavement width of 22 ft.



NOTES

* PAVEMENT SURFACE FOR WIDENED AND RECONSTRUCTED HIGHWAY TO HAVE 20FT MINIMUM WIDTH FOR:-

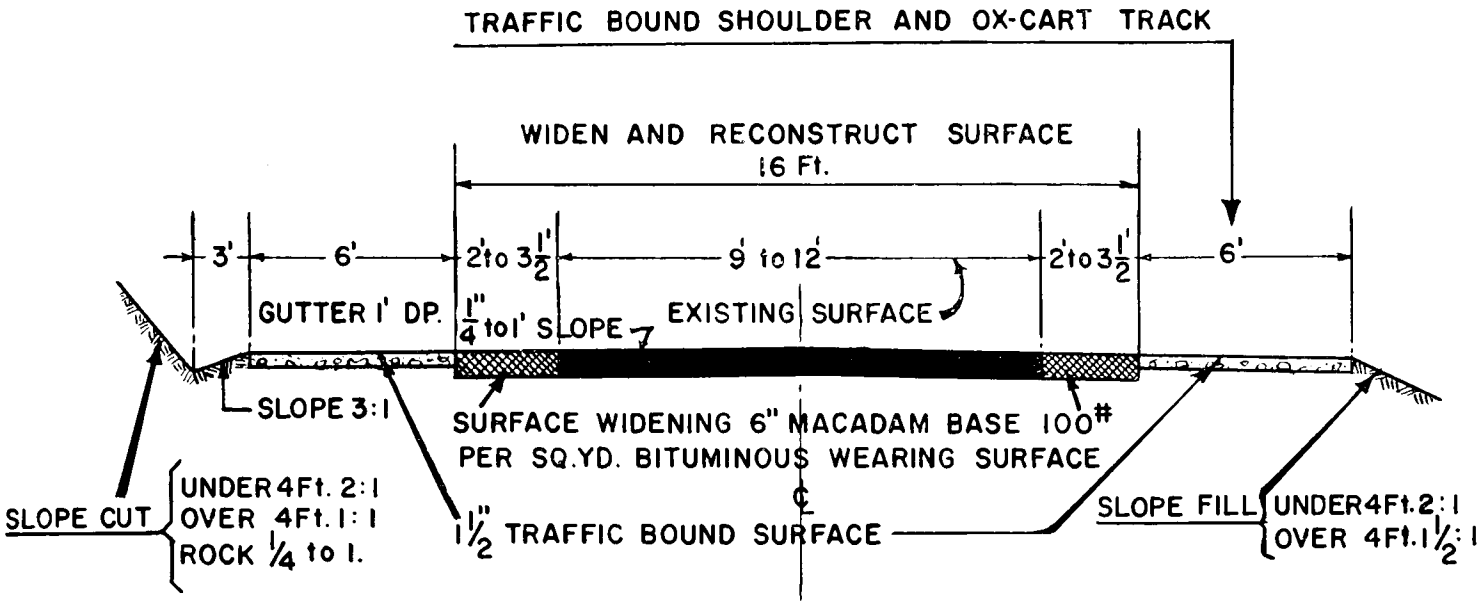
ROUTE I - RANGOON TO PEGU

ROUTE II - TAUKKYAN TO PROME.

WIDEN SECTION ACCORDINGLY.

MODERN TECHNIQUES OF MOISTURE CONTROL AND COMPACTION TO BE USED FOR EMBANKMENT AND FOUNDATION CONSTRUCTION.

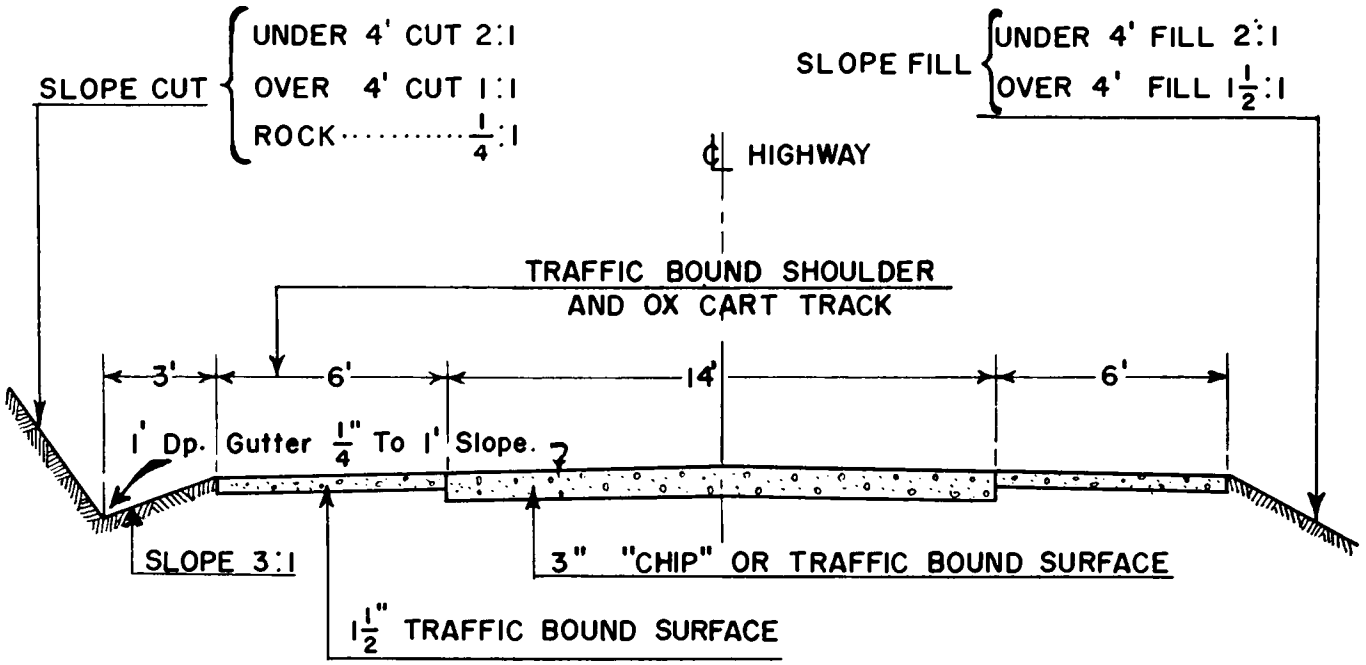
MINISTRY OF NATIONAL PLANNING			
HIGHWAYS **TYPICAL SECTION** **UNION ROADS I & II**			
KNAPPEN TIPPETTS ABBETT ENGINEERING CO NEW YORK. RANGOON			
DR BY. E.J.P. CK BY. K.B.W.	DATE JULY. 53.	PLATE NO.	6



NOTE

MODERN TECHNIQUES OF MOISTURE CONTROL AND COMPACTION TO BE USED FOR EMBANKMENT AND FOUNDATION CONSTRUCTION.

MINISTRY OF NATIONAL PLANNING		
HIGHWAYS **TYPICAL SECTION** **UNION ROADS III – VIII**		
KNAPPEN TIPPETTS ABBETT ENGINEERING CO. NEW YORK. RANGOON		
DR BY. E.J.P. DATE CK BY. K.B.W JULY. 53.	PLATE NO.	7



NOTE:-

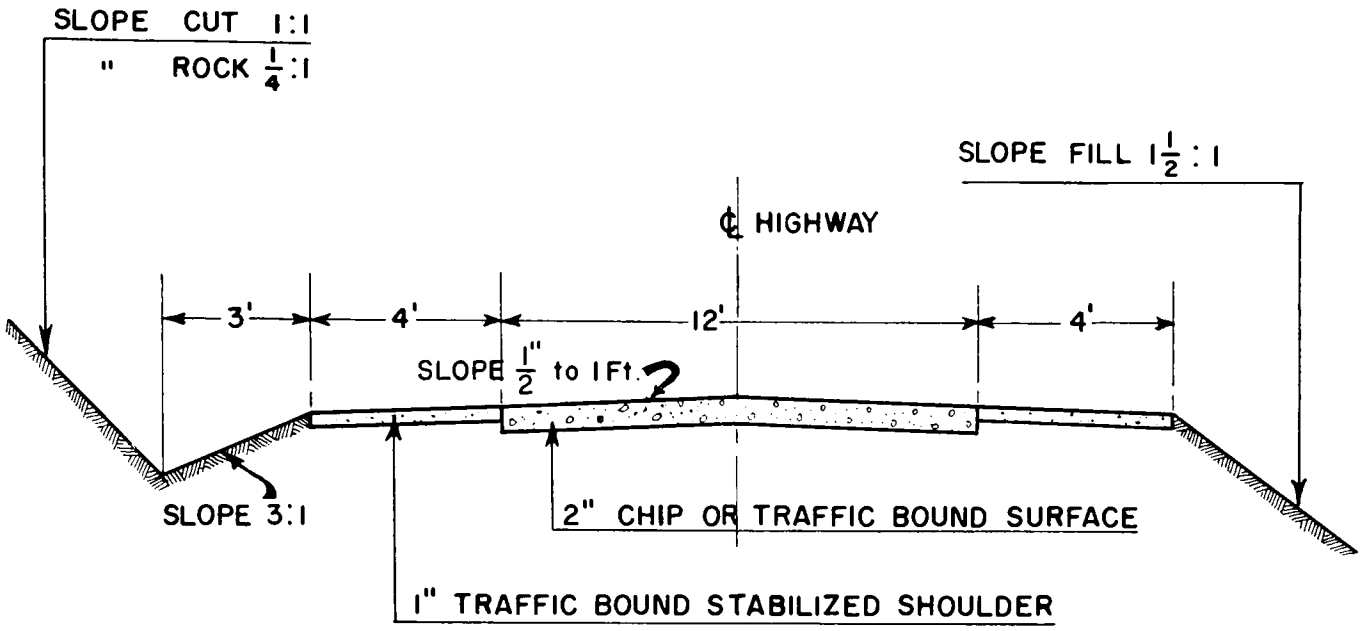
1) PORTIONS OF CERTAIN DISTRICT ROADS ARE ALREADY SURFACED, AND TO ESTABLISHED PAVEMENT WIDTHS GREATER THAN THE 14 FT. SHOWN FOR EXTENSIONS OF THESE HIGHWAYS, AND SURFACING, CONTINUE THE ESTABLISHED PAVEMENT AND SHOULDER SECTIONS, EXCEPT THAT THE LATTER SHALL NOT BE LESS THAN 6 FT. IN WIDTH.

2) MODERN TECHNIQUES OF MOISTURE CONTROL AND COMPACTION TO BE USED FOR FOUNDATION CONSTRUCTION.

3) ON CONSTRUCTION, PROVIDE STOCK PILES OF STONE, ONE MILE APART, CONTAINING 30 % OF THE TONNAGE INITIALLY PLACED ON ROAD SURFACE. THIS STONE TO BE USED BY MAINTENANCE FORCE TO REINFORCE WEAK SPOTS APPEARING IN SURFACE AFTER USE BY TRAFFIC.

   SPECIFICATIONS FOR TRAFFIC BOUND STONE, SIZE 1 1/2" DOWN TO DUST, "CRUSHER RUN" WITH DUST CONTENT RANGE TO BE 20% - 30%.

MINISTRY OF NATIONAL PLANNING		
HIGHWAYS **TYPICAL SECTION** **DISTRICT ROADS**		
KNAPPEN TIPPETTS ABBETT ENGINEERING CO. NEW YORK.		RANGOON
DR BY. E.J.P. CK BY. K.B.W.	DATE JULY. 53.	PLATE NO. 8



NOTE:-

ON CONSTRUCTION, PROVIDE STOCK PILES OF STONE, ONE MILE APART, CONTAINING 30 % OF THE TONNAGE PLACED ROAD SURFACE. THIS STONE TO BE USED BY MAINTENANCE FORCE TO REINFORCE WEAK SPOTS APPEARING IN SURFACE AFTER USE BY TRAFFIC.

SPECIFICATIONS FOR TRAFFIC BOUND STONE, SIZE 1 1/2" DOWN TO DUST "CRUSHER RUN", WITH DUST CONTENT RANGE TO BE 20 % – 30 %

MINISTRY OF NATIONAL PLANNING	
HIGHWAYS **TYPICAL SECTION** **FARM-TO-MARKET ROADS**	
KNAPPEN TIPPETTS ABBETT ENGINEERING CO NEW YORK RANGOON	
DR BY E.J.P. DATE CK BY K.B.W. JULY. 53	PLATE NO. 9

Based on the 1944 report on Inter-regional Highways* and on 1950 "Policies on Geometric Highway Design,"† it is proposed that the following standards be established for the rehabilitation program and all future designs for the Union, district and farm-to-market roads:

(a) Each part of the system as hereafter constructed or improved shall provide, or allow for the subsequent provision of facilities capable of serving safely a mixed traffic of passenger cars, motor buses and motor trucks, and that the volume of each of the constituent elements be that which is estimated to exist 20 years in the future from the date of construction.

(b) All roadways and structures shall provide for the passage and support of vehicles having a design load of 15 tons for the Union system, ten tons for the secondary and district roads, and five tons for the farm-to-market roads. Loadings shall be the corresponding H-loads, as established by the American Association of State Highway officials.

(c) Widths, heights, lengths and other load requirements of vehicles shall be as prescribed in Section N, "Proposed Highway Code," of this Report.

(d) Rural sections of the system shall be designed for the following safe travel by passenger vehicles:

Union System	60 miles per hour
District System	50 miles per hour
Farm-to-market System	40 miles per hour

(e) Urban sections shall be designed for the following safe travel by passenger vehicles.

Union System	50 miles per hour
District System	40 miles per hour
Urban System	40 miles per hour

(f) All road surfaces, pavements and structures on the system, when maintained with a reasonable expenditure of effort, shall be capable of supporting vehicles of the recommended weights without reduction in either weight or speed at any season of the year.

(g) On the rural sections, the maximum horizontal curvature for the several design speeds shall be as follows:

	Maximum	
	Absolute	*Preferable*
60 miles per hour	6°	5°
50 miles per hour	8°	7°
40 miles per hour	10°	9°

(h) On the rural sections, the no-passing sight distance for the various speeds shall be as follows:

	Minimum Distance
60 miles per hour	550 ft.
50 miles per hour	450 ft.
40 miles per hour	400 ft.

* A publication of the 78th US Congress, 2nd Session.

† Established and issued by the American Association of State Highway Officials.

(i) Side slopes shall be as shown on the sections, in Plates 6–9 inclusive.

(j) The maximum desirable grades shall be as follows:

Union System	6·0%
District System	5·0%
Farm-to-market	6·0%

Grades shall in no case exceed the above values by more than 2%, and then only for short distances. In portions of the system such as approaches to structures where a long approach grade is appropriate, the grade shall not exceed 2½% in these situations where coolie carts and bullock carts are an appreciable part of the traffic volume.

(k) Right-of-way acquisition shall be on the basis of the traffic and road widening, if any, expected to occur during the 20-year period.

(l) The clear height of bridges, over the entire width of roadway, shall be not less than 14 ft.

(m) Structures preferably shall be of the deck type, to facilitate later widening.

(n) The necessary provisions shall be made for ox-cart travel, as shown on the typical cross-section.

(o) The urban standards shall conform as closely as possible to those outlined above for the rural sections, except as to the basic limitations already stated.

(p) Special-purpose roads, such as those to the mineral development areas and the timber areas, shall be of the minimum proper characteristics to meet the demands of the purpose, and shall generally conform, to the degree feasible, to the details in the recommended sections above. The grade limitation shall be established at a maximum of 7·5%.

G. CONSTRUCTION METHODS

1. TRADITIONAL METHODS

Except for a limited mileage in the urban sections of the more important routes, the surfaced highways of Burma are at present one-lane facilities. The methods used for their construction were the conventional techniques used for some years in Asia. For these tarred and metaled roads, the process consists of the placing of a base course of soling stone, 6 to 12 inches in thickness, with 4 to 4½ inches of compacted metal, having a limiting size of 2 or 2½ inches, as a wearing course. The wearing course is then bitumen-coated and is occasionally resurfaced with 1- to 2-inch graded stone, premixed with the asphaltic material. As an alternative method, the surface is sometimes prepared by applying 3 to 4 inches of bituminous bound macadam, using stone having a maximum size of either 1 inch or 1½ inches. The shoulders are of laterite, or of local stone where this is convenient.

Generally the surfaced roads consist of 10 to 12

inches of laterite soling, and the wearing course consists of laterite or other spalls. The surface is occasionally primed and sealed with bitumen, but this process has not been nearly as well nor as frequently used since the end of the war.

Both bitumen and road metals are very expensive in Burma, and the cost has been pushed to still higher levels in recent years by the depredations of insurgency and dacoits. Every possible effort should be made to introduce modern techniques to profit from the experience of others in the search for less expensive asphaltic pavements. Materials such as bitumen which come in bulk should be bought and processed in that manner, with suitable storage facilities in order to cheapen the unit price. Also there are many local deposits of good aggregate for highway purposes, and these, too, should be developed to the greatest degree.

The subgrade preparation needs to be of a higher quality, using modern techniques, in order that it shall be firm and behave properly in all conditions of weather. If this were to be accomplished, it would take only a relatively thin flexible pavement to carry the existing traffic. The saving in material, too, would aid in reducing the total pavement cost. The improvement of the subgrade construction will also necessitate the development of a soils laboratory, with the proper testing techniques, in order to take advantage of current compaction methods. All of these steps, however, are in the direction of mechanizing the highway construction procedures in Burma.

The use of modern methods and machines for this work is a "must," and it is of such vital importance to the whole program that it should be undertaken at the earliest possible moment.

There are some small quantities of used mechanical equipment in several districts. Most of it is old, material brought here during the war, and the problem of repair is becoming serious. Likewise, there is need for adequate training for operators and other technicians to enable them to properly use the equipment.

There are discussed in the succeeding section several modern bituminous paving techniques, with which very good results have been obtained elsewhere. It is suggested that one or more of these be studied and adapted to use in Burma. Again, however, good compaction of the subgrade is needed and this cannot be obtained at a reasonable cost without the use of mechanical road-building equipment. Especially in the use of "road mix," the proper inter-mixing of the aggregates and the bituminous material is vital, and this, too, requires modern equipment.

2. MODERN METHODS

In the United States, because of the great total mileages of highways and the very general use of motor vehicles of all types, the processes of highway construction have become more completely mechanized than in any other country.

Of all the processes that go into the building of a highway, that of earth moving has undergone the most mechanization. The moving of earth, sand and rock in large quantities is a necessary part of the construction of the road.

The ability of man, aided by cheap mechanical power, to produce more has freed him from drudgery and has given him a better life, more leisure, better earnings, the chance to have modern conveniences and comforts, and to improve his social conditions.

The changes and developments in road construction in the last half century have been revolutionary. Possibly the earliest improvement of major consequence was the road roller as a tool for compaction. The earliest rollers were manual, but steam had been applied as a motive force in the period 1865–80. And by now, this tool has become improved to the degree that it has three or four speeds in each direction, low-pressure hydraulic steering, and gasoline or diesel high-speed heavy-duty engines.

The hauling of earth was improved, too, in 1850, when a self-loading cart was invented. Almost 75 years later, the scraper became a self-propelled vehicle. And the improvement since has been truly phenomenal in the direction of making the device more and more flexible, and in adapting the improvements in motive power.

Power graders and blade graders, too, were invented and perfected to solve a real need as the standards of construction rose and adequate road maintenance was needed for the growing highway network. The earliest bulldozers were animal powered, while the current diesel-driven "dozers" are possibly the most flexible and useful devices in the entire industry. The motive power unit, the self-laying-track type tractor, was a development of the early part of this century. In the twenties the use of horses and mules for power was replaced by the gasoline engine.

In the early thirties construction costs were further reduced by substituting diesel power for gasoline. In the late thirties costs were lowered still more by the use of rubber tires, the development of rigs of greater speed, the improvement in ease and safety of operation, and the production of units of greater capacity.

Early in the twenties, the US Bureau of Public Roads, together with a number of the state highway departments, began a study, as an aid in budgeting procedures, of the costs of various road-building operations. One of the processes receiving attention was that of excavation, and as a record-keeping device, a cost index was developed. Of this index, the Bureau has said:

"Since the index was started we have made a continuous study of the contractors' costs as determined by wage rates and the price of equipment and materials plus other factors. Over the years there has been a continued rise in labor rates, in the price of equipment and materials, and in the contractors' overhead. If these increases had not been offset by the development and skillful use of modern construction equipment, road excavation costs today would be about three times as great as they actually are."

This is borne out by the price trend for common excavation. The Bureau of Public Roads index started in 1922 is based on the average of all federal-aid projects awarded by all the state highway departments. The base period for the BPR index is the five years 1925 through 1929.

The Bureau's index shows that for the last 25 years common excavation costs were reduced continuously, as shown by the graph on Plate 10. In the early 1940s construction prices rose as a result of the impact of World War II with its greatly increased wage rates, higher prices for materials, shortage of equipment and decreased efficiency of labor.

In contrast to the reduction of the cost of common excavation, wage rates on road work climbed continuously during the same years. Plate 10 also gives the average hourly wage rates for unskilled labor on all federal-aid projects. The national average, which was 38 cents for 1926, in 1951 had skyrocketed to $1.27, an increase of 243%. As a matter of interest, the average price for roadway excavation on contract work in California during the spring of 1953 was $1.22 per cubic yard. Moreover, today's skilled labor is used on many operations on which unskilled labor was employed in the past. The variation in the highway excavation index as compared with average unskilled wage rates is shown in the graph at the top of Plate 10, and this indicates the continuous downward trend (excluding the war years) of the real cost of excavation. The ratio represents the unit price of excavation, the index figure, as compared to the hourly wage rate for unskilled labor. The continued decrease in the cost of common excavation was obtained despite the continued increase of refinements in specifications and engineering designs.

This period of cost decrease, and therefore of a better use of man's energies, occurred during the period of greatest advancement in the adaptation of heavy mechanical equipment to the road-building industry—for this was when the bulldozer was developing, diesel power was replacing gasoline power, vehicles were being speeded up, and the units were increasing in capacity.

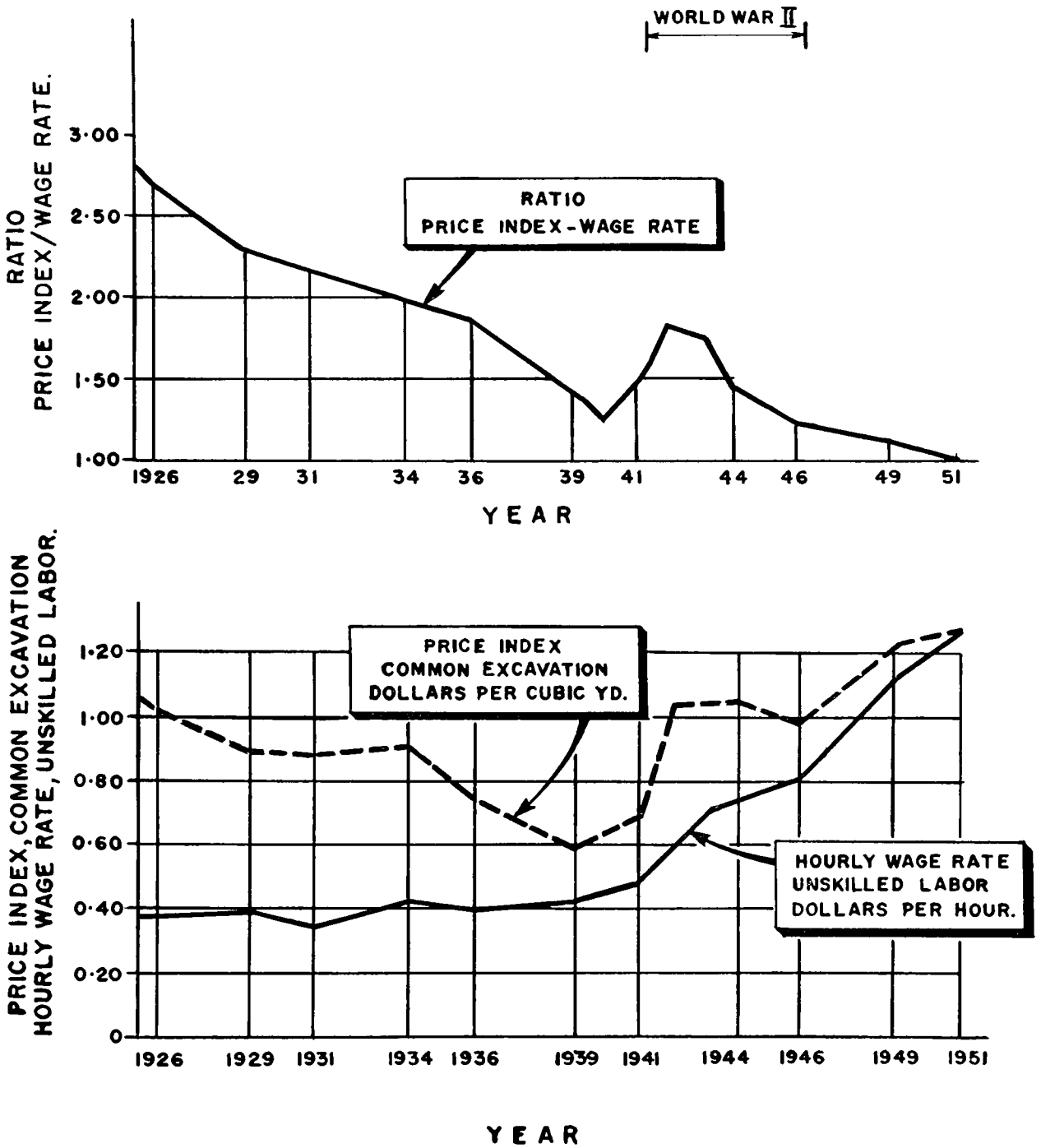
The progressive mechanization of the operations of road construction and maintenance has also brought about rapid advances in paving techniques. Probably the greatest development has been in compaction equipment, for better consolidation of materials has produced better subgrades, better foundation courses and improved methods of surfacing. The costly paving failures of the past, especially in non-rigid surfaces on secondary and county roads, have been largely eliminated or avoided. Also, by the use of the newer methods, it has been possible to gradually reconstruct the pavements already placed and in use, and thus to lengthen their lives also. Along with bettered compaction has come improvement in the grading of the mineral materials, in order to produce better structural characteristics of the pavement surface and subgrade, and in the application of the asphaltic materials to the surfaces. Rapid advances have been made in the technology of asphalts, especially in the cutbacks and in emulsified asphalts, to make them more suitable for highway surfacing and to permit their application during a greater portion of the year, and thus to gain a greater utilization of equipment.

Because some of the techniques are new to engineers and highway administrators in Burma, and because the improvements in existing methods have been very rapid in the United States, especially in the last decade, it seems wise to review current American highway practice for the construction of several types of pavements, especially those with non-rigid asphaltic surfaces. Many of the newer techniques can be readily applied to the rehabilitation of the highway system of the Union if well carried out by careful operators and construction men, and properly guided by engineers with experience in the methods. Specific recommendations are made later in the report for the accomplishment of this program.

One development especially merits the serious study of the Department, and that is the method of road construction which has come to be known as "road-mix." Of the more recent advances that have come into being with the mechanization of the highway-construction industry, this process offers the greatest advantage in the reconstruction of some portions of the road network of the Union. The general features and requirements are therefore more fully described below, in order that its application and limitations may be understood. A typical specification for the construction of this type of surface is also included.

a. Sand-clay Roads

Production of a sand-clay road consists in the proper selection of materials and in their proportioning and proper combination under good moisture conditions. In areas where gravel or crushed stone is expensive, and especially where cheap labor is available, the modern sand-clay road is economical for traffic



MINISTRY OF NATIONAL PLANNING.

HIGHWAYS

EXCAVATION COST

U.S. HIGHWAYS.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK. RANGOON.

DR. BY. E.J.P DATE JULY 53. PLATE NO. 10.
CK. BY. J.L

densities of less than 500 vehicles per day. Later, as traffic develops, it can serve as a subbase for a pavement surface.

It has been found that the best results are obtained when the maximum clay content is approximately 25% of what is called the "topsoil mixture," although a proportion of 20% is preferable. The object of the whole construction operation is to secure the maximum density of material in the upper three or four inches of depth.

In compacting the road material, the use of three-wheel power rollers has not been found especially effective. Team and traffic action, however, has a very good effect. The rollers used for compaction should be of the sheep's-foot type or the old-fashioned ring roller.

It has now become common practice to crown the road to a slope of $\frac{3}{8}$–$\frac{1}{4}$ inch per foot. Generally also, the surface width in the US has become established at approximately 20 ft. for two-lane traffic, and, with a 30-ft. road bed, 4-ft. shoulders are available. It is considered preferable that the shoulders be treated in the same manner, with a thin sand and clay mixture.

Perhaps the best indication of the general requirements for the construction of a sand-clay surface course or a subbase for a pavement surface will be given by a detailed specification for a particular case. This is given in the following exhibit in which specifications covering the materials, construction methods and basis of pavement are shown. The specification also indicates, as a side product, the current American practice in detail specifications, which is somewhat different from that in use in Burma. It is essentially a "performance" specification so framed that the engineer can compel the contractor to adhere to the various requirements.

SPECIFICATION FOR TOPSOIL OR SAND-CLAY SURFACE COURSE (ALSO SUBBASE OR SUBGRADE)

Description

This item consists of a surface of topsoil, sand-clay, or artificially mixed sand and clay constructed on the prepared subgrade under these specifications and as shown on the plans.

Materials

General. The surfacing material shall consist of topsoil or natural sand-clay of quality equal to that obtainable from locations designated by the engineer or of an artificial mixture of sand and clay, each of quality equal to that obtainable in pits designated by the engineer. All material shall be subject to prior tests and free from foreign matter and pebbles on a 1-inch round screen.

Tests. Surfacing material shall meet the following requirements:

(*a*) *Clay.* Material separated by subsidence eight minutes through water and possessing plastic adhesive properties.

(*b*) *Silt.* Fine material other than clay which passes a 200-mesh sieve.

(*c*) *Sand.* Hard material, usually siliceous, which passes a 10-mesh sieve and is retained on a 200-mesh sieve. From 40 to 60% of sand shall be retained on a 60-mesh sieve.

(*d*) *Coarse Material.* Hard material of gritty nature retained on a 10-mesh sieve and passing a 1-inch round opening. Sand and coarse material shall be free from feldspar, mica, schist, hardpan, or other soft or friable material in excess of 5%.

(*e*) *Material Passing* 10-*Mesh Sieve* when subject to mechanical analysis shall meet with the following requirements: clay, 9 to 25%; silt, 5 to 20%; and sand, 60 to 80%.

Construction Methods

Placing, Mixing and Shaping Topsoil and Sand-clay Surfacing. Placing sand, clay, natural sand-clay and topsoil shall start at a point farthest from the source of supply and progress toward the source. Hauling will not be allowed over the material placed until mixed and shaped as hereinafter specified.

The material deposited each day shall be twice plowed and harrowed, except when judged by the engineer to be too dry or too wet. Plowing shall begin on the outer edge and the material turned away from the center, then thoroughly harrowed with a cut-away disk harrow until pulverized; it shall then be plowed again beginning at the center and turning the material toward the center, then again harrowed with a cut-away disk harrow until the surfacing material is thoroughly mixed and pulverized; after which it shall be shaped by a standard road machine weighing not less than 2,500 pounds, to the cross-section and grades shown on the plans, and so maintained until accepted. During the process of plowing, harrowing and shaping, the contractor shall, at his own expense, rake or throw out any roots, sod, weeds and stones. Unless the materials contain sufficient moisture to insure proper combination and bond, they shall be sprinkled as directed by the engineer.

When the road under construction is being used by the public, the contractor, at his own expense, shall keep the subgrade and surfacing in such condition that the traveling public may use the road with comfort and safety.

Where the surfacing material consists of either approved *topsoil* or *natural sand-clay* without any admixture, it shall be evenly spread on the subgrade to such depth that when completed the surface will have the thickness shown on the plans. Compacting usually is one third of depth of loose material. The material shall be dumped on the subgrade in longitudinal rows containing not more than one third of a cubic yard to ten linear feet, and the number of rows shall be such that when the material is spread, the desired cross-section and thickness of surface will be obtained. After sufficient material has been dumped for one hundred to two hundred linear feet of surface, and before any part of the rows have commenced to pack, the

material shall be spread approximately to the required cross-section and harrowed to secure uniformity.

When the surfacing material is to consist of an *artificial mixture of sand and clay made by mixing the material of the roadbed with sand or clay from some other source*, the construction shall proceed thus:

(*a*) The surface of the roadbed shall be thoroughly loosened and pulverized to a depth of from four (4) to eight (8) inches, according to the nature of the two materials to be mixed, first by plowing, then by harrowing with a cut-away disk harrow.

(*b*) The material to be added shall be dumped and spread in the manner described above to form a loose layer of from three (3) to eight (8) inches as directed by the engineer.

(*c*) The added material shall then be thoroughly mixed and incorporated with the pulverized material of the roadbed. This mixing shall be done by means of plowing and harrowing as above specified and shall continue until the two materials are thoroughly mixed in proper proportion.

(*d*) If, after the two materials have been mixed as above described, any deficiency of the added material is apparent at any point, such deficiency shall be immediately corrected by spreading more of the required added material at that point and continuing the mixing as above described.

(*e*) After the mixing is complete, as above specified, the road shall be shaped and maintained as provided above, except that wherever later a poor mixture is observed, it shall be corrected by additional mixing or by adding necessary material and mixing.

When the surfacing is to be a *mixture of sand and clay, both of which materials are obtained from outside sources*, a layer of clay from three to six inches in depth shall be evenly spread and thereon a layer of sand of four to eight inches, and the two layers thoroughly mixed and shaped as above specified.

The order of spreading the clay and the sand may be reversed if required by the engineer.

Remixing and reshaping. If at any time before acceptance of the job, the surfacing materials appear to have been improperly mixed or exhibit a deficiency of either sand or clay, the contractor shall remix and reshape the surfacing or shall add material shown deficient as directed by the engineer and then remix and reshape the surfacing which appears unsatisfactory and again reshape the surface. After each rain prior to the acceptance of the job, the contractor shall repeat the process of remixing and reshaping.

Basis of Payment

This item of sand-clay surfacing will be paid for at the contract prices per cubic yard of sand-clay or topsoil surfacing in place, which prices shall include all clearing, grubbing, loosening, loading, spreading, plowing, harrowing, incidental work and hauling of surfacing material, and all labor, tools, and supplies necessary therefor. It shall also include all mixing, shaping, and maintaining true to section prior to acceptance.

As with almost all low and intermediate types of pavement, the sand-clay road needs constant and careful maintenance. The main portion of the operation is the dragging or blading to keep the road shaped and to eliminate any depressions that appear. Blading done after the material has been slightly softened by rain is preferable and light equipment can be used. The use of patrol graders has been found to be the best form of maintenance for this type of road. The cost of ordinary patrol maintenance, if the traffic does not exceed 600 vehicles per day, will average \$220–\$275 per mile per year. With a density of 400–600 vehicles the total annual cost of services appears to be moving in the direction of about \$1.25 per vehicle per day.

It has been observed that with this type of mixture of basic materials the fundamental composition of the mixture is retained, with proper maintenance, for approximately five years, and the average life of the road has been found to be about nine years. Previous to 1930, and based on many projects with this type of construction, the original cost was found to be approximately \$1,850 per mile, and the present cost approximately \$2,650 per mile. The present total cost of maintenance per mile averages \$565, broken down as follows:

Annual depreciation, based on nine-year life	\$261
Interest at 5%	74
Annual maintenance	230
	\$565

b. Crusher-run Base (Slurry Base)

The use of macadam paving in the United States has undergone several stages. In recent times it became less used because of the cost of placing the material. In about 1936, however, the State of California developed a modern macadam pavement which was called by them "Slurry Base." The use of this method of base construction became quite widespread and the process is now generally known as "Crusher-run Base."

Essentially, the mineral material is clean quarry waste, broken stone, crushed gravel, or a combination of these, all material being able to pass a $2\frac{1}{2}$-inch sieve. Further, 30–50% must pass a $\frac{1}{3}$-inch sieve and 7–14% must pass a 200-mesh screen. In California the practice is generally to use the material in a thickness of five inches. The 1937 unit cost was \$1.50 per ton or \$2.25 per cubic yard in place. The corresponding current prices are \$2.10 and \$3.15 respectively.

This material, as a base course, is used under bituminous surfaces, and a tack coat is spread first on the slurry base.

c. Gravel Roads

The use of gravel roads is gradually decreasing in the United States although many tertiary local roads are still of this material. As shown on Plate 5, more than one half of the total urban road mileage is now surfaced.

Generally, eight inches of loose material is placed on the surface and then compacted to approximately six inches in thickness. The cost of such gravel in place is currently about $1.60 $1.75 per cubic yard. On this basis a five-inch by 28-ft. base course would include 3,057 cubic yards of material per mile at a cost of $5,100. Also the three-inch compacted 22-ft. top will total $2,400 per mile and the total cost per mile is thus $7,500.

In the construction of gravel roads, the major items of cost are the stripping of the deposits at the pit, the loading to the crusher, the crushing process itself, the haul to the site, the separating of the gravel material and the blading and shaping of the surface.

d. Crushed Rock or Gravel

The untreated crushed rock or gravel road has been developed as an economical secondary and tertiary highway facility where the total daily traffic does not exceed 450 vehicles. It has been found that these materials can be crushed to a size of approximately one inch very cheaply, and bond well. In Oregon, as early as 1924, on a 20-mile road project, with a haul of 5·2 miles, the construction cost was $2.75 per cubic yard. On this project the base course was $1\frac{1}{2}$ inches in maximum size and the surface course $\frac{3}{4}$ inch.

It has been found necessary to keep the size of the particles in the top course to at least no larger than those in the bottom course. If this is not done, any oil treatment of the surface will tend to bring the larger pieces to the top.

A traffic density of about 450 vehicles per day is the dividing point between a dry stone or gravel surface and an oil-treated surface. One factor in the choice is the dust which accompanies heavy traffic and the other is that with this vehicle density there is a tendency for corrugations to develop transversely with the surface.

The maintenance of a crushed rock or gravel road is a combination of motor blade patrol work with supplementary gangs using motorized equipment. These gangs supply extra gravel and do extra blade grading and scarifying. It is essential that the maintenance be very carefully done in the early spring, following the winter frost, and the late fall. In the latter case it is quite essential to see that the drainage system is working well.

The maintenance of the secondary state and county roads is a difficult problem since the operations are quite varied and also scattered in area. This results in a high overhead cost. While it is important to keep account of the cost per vehicle-mile of traffic, the knowledge of the total cost per mile is very important for budgetary reasons. In establishing the total cost, it is necessary to adhere to a very strict system of rental charges against equipment. If this is not painstakingly done the total cost of operations may be completely false and incomplete. When the traffic on a crushed-stone road is at or near its maximum operating capacity the loss of gravel, which must be constantly replaced during the maintenance operation, will total $400–$425 per mile per year on a 22-ft. roadway.

For this type of construction prompt and watchful maintenance is also necessary. The sections for the use of motor patrol maintenance should be 20–25 miles in length. The crew consists of two men with a truck having a drag planer or a scraping grader and numerous small tools. The surface is kept smooth by planing or dragging and this can best be done with two 3-ton trucks having demountable blades, for these can be removed and the trucks used in hauling materials as well. For light blading, such as is commonly used, the blade should operate at a speed of 8–10 miles an hour. Bladers propelled by a caterpillar tractor are also now in widespread use, the blades being 8 ft. to 12 ft. in length.

This is a hard use to subject a metal blade to, since its original depth of ten inches may be reduced to as little as three inches in from two to three weeks if the vehicle travels 25 miles a day.

The costs of the maintenance operations are estimated to be as follows:

	Per mile per year
1. Prior to surface treatment	$425
2. Cost of patrol	$200
450 vehicles—total cost will be	$625

or approximately $1.40 per mile per vehicle per day.

e. Road Mix

Since about 1926 there has been developed a new type of asphalt-mineral road in the United States in which liquid asphalt is incorporated to a compacted depth of about $2\frac{1}{2}$ inches in the top of old and new gravel and crushed rock roads. The process is commonly called "road mix" and is also known as "oil mix" or "mixed in place." The mixture of oil with the mineral materials is made in place on the road, by wholly mechanical equipment. It is necessary to use scarifiers and tooth harrows to break up the surface lumps, after which the material is bladed to secure a

uniform distribution. Hot oil, at a temperature of 100° F. or more, is then applied with a pressure distributor in increments with mixing between passes, the latter being effected with spring tooth or disk harrows. Following this step the entire mixture is bladed across the road surface and finally into a central windrow. When the material is fully mixed the windrow is taken down by blading to an accurate cross-section, and the road is then opened to traffic. It is sometimes rolled first, and possibly a seal coat of light asphalt is applied later.

The road mix must be placed on a solid base and dry, stable subgrade. It has been found that a four-inch consolidated base course is the minimum that should be used. It is common to lay the base course a season in advance, followed by a prime coat. Slow-curing asphalts are used if the materials are densely graded and rapid-curing types are used with material having a very open grading.

It is essential to use graders having blades of sufficient length, preferable 12 feet or more, and with ample motive power. Two-, three- or four-blade graders are often used in tandem. The blades should be set at an angle approximately 45° to the roadway and the vehicle should be operated at a speed of 4–5 miles per hour so that the material will roll and not slide as it leaves the blades. The full process takes 30–40 bladings, including the windrow. It is essential to have good equipment, amply powered, and very careful operators are needed in order that the process be carried out uniformly. The common optimum is to use 4% of oil by weight. Material can be taken from roadside pits, although crushed aggregate is preferable, the limiting size being one inch. There is included, below, a current specification from one of the state highway departments to indicate in detail the current requirements and practices in construction of a road-mix base course and surface.

ROAD-MIX BITUMINOUS SURFACE COURSE (CLASS C)

D701. *Description*

This item consists of an intimate mixture of aggregate and bituminous material, mixed on the road, compacted by rolling and finished with a seal coat, the whole constructed on a prepared base in compliance with these specifications and conforming in all respects with the lines, grades, thickness and typical cross-section shown on the plans, or as otherwise specified.

D702. *Materials*

The materials used shall be those prescribed for the several items which constitute the finished work and shall comply with all the requirements for such materials as set out in this specification and in Division III, "Material Details." Specific references to Division III are as follows:

Materials	*Reference*
Coarse Aggregate,	
Class A or B, Size No. 7, 8, 9, 63*,	
Crushed Stone, Crushed Gravel, Slag	K1, K2, K3.
Covering Aggregate,	
Class A, Size No. 12, Crushed Stone,	
Gravel, Slag	K1, K3.
Bituminous Material for Mixture,	
Liquid Asphalt RC-2, RC-3, RC-4	M2.
Emulsified Asphalt AE-150, AE-200†,	
AE-M	M5.
Tar RT-6, RT-7	M6.
Bituminous Material for Seal,	
Asphalt Cement AP-3, AP-2, AP-1, AP-0	M1.
Liquid Asphalt RC-2, RC-3, RC-4	M2.
Liquid Asphalt MC-2, MC-3, MC-4	M3.
Emulsified Asphalt RS-2	M5.
Tar RT-9, RT-10, RT-11, RT-12	M6.
Blended Trinidad Asphalt LC, LD	M7.

Aggregate Sizes: No. 7 and No. 8 ($\frac{3}{4}$ in. max.), No. 9 ($\frac{1}{2}$ in. max.)

* If size No. 63 aggregate is used, the gradation requirements shall be as set out in Section K3 except, the amount retained on the No. 100 sieve shall be 95–100%.

† To be used only when Size No. 63 aggregate is used.

D703. *Construction Methods*

D703.1. *Shoulders*

Except as otherwise herein specified, shoulders shall be constructed as set out in Article D503.2.

When the rolling of the final surface is started, the outside rear wheel of the roller shall cover equal parts of the shoulder and adjacent aggregate.

D703.2. *Preparation of Base*

If the proposal provides for base preparation, the kind of new base constructed or the reconstruction of an existing base, as the case may be, shall be done under application provisions of these specifications prior to spreading the material for road-mix surface.

D703.3. *Spreading Coarse Aggregate*

The coarse aggregate shall be spread upon the prepared base to such loose depth that will produce the compacted thickness of the lift for which it is intended. In general, the compacted depth of any lift shall not exceed two times the dimensions of the top size of the aggregate being used. If the required compacted thickness of any course exceeds two times the top size of the aggregate being used, the course shall be constructed in two or more lifts, as directed.

The aggregate shall be spread without segregation by the use of spreader boxes or other approved spreading devices. No material shall be dumped in piles and spread therefrom.

After the aggregate has been spread, it shall be shaped to required cross-section and be free from irregularities.

D703.4 *Applying Bituminous Material*

The distributor used shall be as described in Article C503.1. Spray bars spanning the entire width of the surface are preferred.

To the aggregate, spread as above described, the bituminous material shall be uniformly applied in one or more applications as directed, in a total amount of from 0·5 to 0·7 gallons per square yard per inch of compacted depth, the grade and exact amount to be as directed. The aggregate shall be substantially surface-dry when the bituminous material is applied.

If a machine method of mixing is used, the engineer may direct that a heavier grade of bituminous material be used than would be used for road-mixing.

If liquid asphalt or tar is used, the application temperatures shall be as directed but shall not exceed those set out for the respective materials in Part M.

D703.5. *Mixing*

D703.5(*a*). *Road-mixing*. Immediately after any application of bituminous material, the aggregate and bituminous material shall, unless machine-mixing is used, be thoroughly road-mixed for its entire depth. Mixing shall be done with blade graders and multiple-blade maintainers, or other mixing devices if approved by the engineer. Mixing shall be such that all particles are thoroughly and uniformly coated and segregation avoided. After mixing, the mixture shall be evenly spread over the surface, true to grade and crown.

If the initial application of bituminous material does not sufficiently coat the aggregate, it shall receive an additional application sufficient to satisfactorily coat the aggregate and then be mixed and spread as before. If the edges appear to be too dry, an additional light application shall be made where needed. If directed, the mixture shall then be maintained in place by dragging with a drag or planer, the base of which is not less than 18 feet, until a uniform surface results, and until the bituminous material has hardened sufficiently to permit rolling.

D703.5(*b*). *Machine-mixing*. In lieu of road-mixing as above described, any machine method of mixing or mixing and spreading may be used if approved in writing before the work is started. Original approval shall not necessarily constitute continued approval if either of these methods as used does not give satisfactory results, in which case the contractor shall use the method described in D703.5(*a*).

If a machine-mixing, or a machine-mixing and spreading device is used, the device shall be designed as a unit and be capable of producing a uniform and well-coated mixture.

D703.6. *Rolling*

As soon as the properly mixed and shaped mixture has cured so it will compact without undue distortion, it shall be thoroughly rolled. Rolling shall be as specified in Articles D404.7 or C704.4, depending on the type of surface being constructed.

D703.7. *Checking and Correcting Surface*

Just before the rolling is complete, the surface shall be checked transversely with a template cut to the required cross-section and longitudinally with a 20-foot straightedge. Any variation exceeding $\frac{1}{4}$ inch will be plainly marked on the surface and shall be corrected by patching with a mixture of No. 63 or No. 11 aggregate as directed, and the same kind and proportions of bituminous material as used in the surface course. This patching mixture may be mixed under the mixing methods set out in Article F2402.1. If directed, the surface under the patches shall be primed with from 0·05 to 0·10 gallons per square yard of the same kind and grade of bituminous material used in the road mixture. The mixture shall be spread carefully over the area to be patched, using hand-raking if necessary. After spreading, patches shall be rolled and made to conform with the surrounding surface.

Any areas which develop an excess of bitumen shall be removed and replaced with proper materials.

D703.8. *Curing and Maintenance*

After the surface has been checked and corrected it shall be allowed to cure for ten days, during which time the contractor shall repair any areas which may have become damaged by traffic or other causes.

D703.9. *Sealing*

At the expiration of the curing period the surface shall be sealed as provided in Article D404.10.

D703.10. *Protection of Surface*

Any foreign material which may have accumulated on the surface shall be removed before the distributor, roller or any other traffic passes over it.

D703.11. *Seasonal and Temperature Limitations*

No surface shall be constructed between September 15 and May 15 without written permission of the engineer.

No bituminous material shall be applied when the air temperature is below 50° F., nor when the air temperature within the preceding ten hours has been below 35° F.

D704. *Measurement and Payment*

The quantities, complete in place and accepted, will be paid for at the contract unit price per ton for "Coarse Aggregate" including that used in patching, per ton for "Covering Aggregate," and per gallon for bituminous material applied including that used in patching and priming under patches, which payment shall be full compensation for furnishing, hauling and placing all materials, constructing shoulders and preparing base except as may be otherwise provided, checking and correcting surface, curing, maintenance, disposal of surplus material, and for all labor, equipment, tools and incidentals necessary to complete the work specified.

The specifications for the road-mix base course are similar, and incorporate the following requirements as well:

C802. Materials, admits medium curing asphalts MC-2, MC-3, and MC-4 for the base course only; the primer on the base course is restricted to RC and MC liquid asphalts, emulsified asphalt and RT tars; and the base course is to be laid on a hot asphaltic concrete subbase.

D703.7 is omitted, and the following three articles are added:

C803.3. *Checking and Correcting Surface*

After the final rolling is complete, the surface shall be checked transversely with a template cut to the required cross-section and longitudinally with a 10-foot straightedge parallel to the centerline. Any indicated variations exceeding $\frac{1}{4}$ inch shall be corrected with coated aggregate of the directed size. Coating shall be with one of the materials listed in C802 for patching mixture and the percentage of bitumen to be as shown in Article D404.1, if patching is with open-graded aggregate. If No. 63 aggregate is used, the amount of bitumen shall be from $2\frac{1}{2}$ to $4\frac{1}{2}$% exclusive of water or solvent. This patching mixture may be made under the provisions of Section D4, or it may be mixed by the mixing method described in Article F2402.1, as the contractor elects.

The patching mixture shall be placed and carefully leveled over the area to be patched, using hand-raking methods if necessary. After spreading, the patches shall be thoroughly compacted with a roller and made to conform with the required grade and cross-section. Unless otherwise directed, the surface under these patches shall be primed with approximately 0·10 gallons per square yard of any one of the materials listed in C802 for prime on base.

C803.4. *Prime Coat*

The need for and the application of a prime coat on the otherwise finished base shall be as specified in Article D404.8 for prime on binder, except the bituminous material shall be one of those listed in C802 for prime on base.

C804. *Measurement and Payment*

The quantities used in constructing the base, complete in place and accepted, will be paid for at the contract unit price per ton for "Aggregate" including that used in patching, per gallon for bituminous material applied including that used in patching mixtures and for priming, which payment shall be full compensation for furnishing, hauling and placing all materials, preparation of subgrade and construction of shoulders except as may be otherwise provided, mixing, patching, checking and correcting surface, disposal of surplus materials, and for all labor, equipment, tools and incidentals necessary to complete the work specified.

f. Plant Mix

"Plant Mix" is an outgrowth of the process of road mixing, with a closely controlled composition of ingredients. It was found that more viscous grades of oil, requiring heating, could be used. Originally the hot mixture was delivered in trucks to the road site, dumped into spreader boxes on trucks, and then spread. Later mechanical spreaders and finishers, such as the Adnun and Jaeger, were developed. These machines, in operation, are fed from the back of the moving truck.

With the use of heavier cutback asphalts it is necessary to postpone the rolling of the surface in order that evaporation may reduce the solvent content of the asphalt, and traffic should be detoured at this time, as well. With mechanical finishing it is not necessary to do further blading since the economy and uniformity of the machine output would be destroyed.

It is preferable to use the plant mix technique on roads of moderate and high density, as there is no windrow and the traffic can more closely follow the operation. There is also an advantage in using heated material since the working season can extend farther into the fall. The cost of plant mix surfaces is only slightly higher than the road mixes. The plant mixture is generally laid two to four inches in thickness loose measure, and under rolling and traffic the compaction is as much as 25%.

As the production rates for road mix operations under good management, 1,500–2,500 feet of finished 22-ft. pavement can be laid in one day with one setup. The necessary basic equipment for such a setup would be:

(1) A first-class 1,500-gallon tank distributor mounted on a ten-ton truck, and costing in the neighborhood of $10–13,000.

(2) Three or four self-powered pusher graders with a 12-feet by 20-inch blade.

(3) Disk and spring-tooth harrows having a width of half the roadway.

(4) A service truck and small tools.

This equipment is for the road operation only. The supply and distribution of material to the work site requires a plant, or rail delivery, an adequate truck fleet, and one or two spreader boxes. It is very easy, with good management, to achieve production and delivery of 1,200 tons of material in an eight-hour day.

As on all continuous mechanical operations, every effort should be made to avoid interruptions. Even minor interruptions are costly because the hourly operating costs continue through the period of no production. It is necessary to have a continuous flow of bituminous material to the work, and the dry ingredients must be on hand and spread in advance of the arrival of the bituminous material. The supply operation must be well organized, there must be well maintained service roads, and the drivers must give good performance.

g. Cost

As a convenient method of cost comparison, road mix surfaces are often priced per inch of depth over an area of one square yard. In 1936 the average price of this material for 120 projects in eight states was 13·4 cents. At this level, a $2\frac{1}{2}$-inch surface costs 34 cents per square yard or $4,400 per mile. Currently

the price is approximately 18 cents and the per-mile cost $6,500.

With no new mineral material added, the cost of labor equipment and liquid bituminous material for the maintenance operation will total about $2,650 for a 20-ft. pavement of 2½-inch compacted depth. The costs are as follows:

Scarifying and pulverizing	$300
Three passes of oil	$240
18,000 gallons of oil	$1,260
Blading, and miscellaneous	$850
	$2,650

The plant is generally set up at the material supply source, either pit, quarry or rail siding. It consists of a ¾-yard crane, a pugmill mixer, and appropriate heaters for the asphalt and drying units for the aggregate. An experienced mechanic is necessary for plant service. Screening of aggregate has become a common practice to improve the quality of the mixture.

As indicated earlier, finishers have replaced the spreader boxes and with these the mixture is placed and screened at a rate of 150–180 tons per hour. The compaction is commonly accomplished by three-wheel ten-ton rollers and with some cutback asphalts it is necessary to defer their use to permit solvent evaporation. The plant mix operation is best when carried out in clear, hot weather.

h. Maintenance

The best maintenance for surface of bituminous material is immediately to take care of small patching as the depressions appear, and the renewal of the surface with a thin application of bituminous material. Screenings are sometimes used. If there is raveling, oil and reprocessed surface material should be added. If the material has a tendency to shove along or to form ridges it is necessary to add more mineral constituents and to reprocess and reshape the surface. Patching can be done from stockpiles of mixed material along the route of the roadway. Portable heating plants are very effective and it has been found that the best technique is to build up the patches in thin layers. Asphalt emulsions are valuable in patching operations since they can be used in moderately cold and damp weather.

Also, good maintenance includes raising shoulders, ditching right-of-way, and work on small structures as on any road. The surface of road and plant mix pavement has been found to be good for almost any amount of traffic but the subgrade and shoulders must be prevented from becoming saturated with moisture, or even too damp. Failure occurs because capillary moisture tends to separate the courses.

During the period 1935–37, detailed cost studies were made on maintenance operations on numerous highways having plant and road mix surfaces. The results per mile per year, were as follows:

	Maintenance for Road and Plant Mix Surfaces	*Maintenance Outside the Surface*
1935	$140	$194
1936	$132	$164
1937	$156	$230

For the average of three years the maintenance cost per vehicle-mile per year was 31 cents for this type of construction. Currently, the total maintenance cost has risen to approximately $475 per mile per year—almost 40 cents per vehicle-mile per year.

i. Penetration Macadam

With this type of construction, the base course of mineral aggregate is compacted and the asphaltic material or tar is poured into the material in place. The penetration course is two to three inches thick. If placed on a good subbase the surface may later serve as a foundation course of a high type pavement, as traffic increases on the highway. Currently it is common practice to completely compact the base course before applying any bituminous material. Mineral aggregate used is that which will pass a 1¼ to 1½-inch screen. Generally, when bladed and compacted, the material will be about two stones thick. The asphalt is applied with a distributor, and it is preferable to heat the material.

In placing the intermediate course the keystone, to lock the surfaces, is spread uniformly, occasionally by hand from stockpiles, on the shoulders of the road. The general range of size for the keystone is one inch down to ⅝ inch.

The subbase of the penetration macadam pavement will be 8 to 12 inches in thickness, the maximum being needed in a severe climate. The material consists of broken field stone or gravel and is laid in two courses. If properly laid it serves also to prevent heaving and "boiling," and also as a drainage in bog areas. The top six inches of the material will cost $1,000 per foot of pavement width. Thus a road of 20 ft. width, exclusive of the subbase, grading and drainage structures will cost $20,000 per mile. This represents a cost of $1.70 per square yard, a very high figure. Based on contract experience $1.40–$1.50 would be a more common contract price. Generally in the northwest portion of the United States, an 18-ft. pavement is considered to cost $27,000–$37,000 per mile including grading and structures. In California and Oregon, where asphalts are relatively cheap, $1.20–$1.30 will be a preferable unit price. Here the cost of a 20-ft. road would be about $16,700 per mile. In the State of Washington, recent contract work has indicated the following prices:

Two-inch penetration surface	61 cents
Eight-inch base	79 cents
	$1.40 per sq. yard

The western figures are influenced by an adequate supply of cheap crushed stone, from the talus slopes in the mountain areas, at a cost of 70 cents to $1.50 per ton, and an asphalt price of nine to ten cents per gallon.

The cost of maintaining two-lane bituminous macadam pavements has tended to become $175 $200 per mile. Maintenance includes the periodical renewal of the surface, asphaltic coating material, seal coat, the elimination of waves in the pavement by rolling, and the patching of depressions. The roughness of the bituminous macadam surface, a common fault in the pavement, has been found to be often caused by an excess of asphaltic material. If there are construction defects in placing of the materials raveling will be common. In this case the immediate area should be completely rebuilt and the drainage watched to be sure of its adequacy. Emulsified asphalts are of help in the maintenance program. The rig for maintenance of penetration macadam pavement consists of a small truck bringing sand, pea stone, and tools, and hauling a 50-gallon kettle or emulsion outfit. One man sweeps the places to be patched and the second applies bituminous material with a broom or pouring pot. The third workman applies pea stone or fines, and looks after the fire in the kettle if hot patches are being made.

In severe climatic conditions the use of the harder asphalts is to be avoided. Winter maintenance of the pavement will include heavy sanding, and this may have to be carried on well into the spring. If the asphalt macadam is well built, it will not be necessary to apply a seal coat for at least six years after its opening. In the construction, care should be taken to avoid excess rolling of the softer stone before curing the asphalt. The base courses should not be rolled on a wet subgrade. The quantity of both seal coat and the soft bituminous material should be held down to the minimum possible. It is especially necessary that the coarse aggregate be hard and durable. The advantage of this type of construction is that it requires the minimum of heavy equipment, the road roller being the only large piece necessary.

j. Sheet Asphalt

Sheet asphalt has been found to be superior material for highway surfaces, especially city streets. If properly constructed, the maintenance costs are quite low, and will even reach a figure of ½ cent per square yard per year, although a figure of 1 cent to 1·25 cents is more common.

The average 1935 construction prices for sheet asphalt pavement in the South Atlantic States were as follows:

	1 inch of depth (cents per square yard)
Sheet asphalt	50–52
Binder	32–34
Cement concrete base	26–30
Black base	30 32

On this basis a three-inch pavement on a five-inch 1:3:6 base totaled $2.56 per square yard or $30,000 per mile. The same year, Portland cement concrete pavement was 38 cents per inch or $2.47 for a 6½-inch pavement, a total of $29,000 per mile for a 20-ft. wide pavement. Currently, the total unit price is $3.20 per square yard, or $37,500 per mile.

k. Portland Cement Concrete

Because the construction of Portland cement concrete pavement, both plain and reinforced, has become an important part of the whole highway construction program in the United States, more study has gone into its methods, cost factors, and other factors, than for other types of surface. It is commonly used for heavy duty pavement and as bases for sheet asphalt or other high type pavement. Several years ago the Bureau of Public Roads made detailed cost studies on 35 projects for this type of construction with the manpower and cost results listed below. It was found that the fundamental processes were the transportation, mixing, placing, finishing and curing of the pavement. The basic equipment consists of trucks carrying one to five batches of material to the mixer, a 27E paving mixer, and finishing machines which operate on the side forms of the pavement slab. Studies of the labor gangs on these projects indicate the following approximate distribution of men to the corollary operations:

		Men
Fine grading crew, 2 20	say	13
Form setting		11
Handling materials, including water		14
Crew at mixer, including truck drivers handling the dry batches to the mixer	average	15
Mixer, foreman and paver operator		2
Finishing crew—puddlers, spaders, machine operators, strike board and hand finishing, 6–23	say	11
Reinforcing-steel placers		2
Curing, 1–15	say	8
		76
Watchman, water boy, mechanic		3
Superintendent and timekeeper		2
		81
Of which truck drivers are		13

The equipment costs for such a setup were:

1. Total daily equipment items except field repairs, fuel, grease, oil	$204
2. Field repairs, fuel, grease, oil	$53
	$257

The equipment costs were based on a 7% lost time factor and the operation represents 17 working days per month. The over-all equipment efficiency is 78%. On the basis of this, equipment will produce and place 300 cu. yds. in a nine-hour day.

The payroll costs for this operation total (on the basis of productive time)	$298
Prorated, non-productive to productive time	$36
	$334

Batching and hauling are not included in the items above, but this is the portion of the operation in which interruption can cause the greatest loss in efficiency and money. Everything depends on having a continuous flow of materials to the work.

For a current analysis of the construction of concrete pavement, with current cost factors, see Table XVI 18 (*see p. 423*).

There has been a marked increase in efficiency in the use of working time in the paving operations in recent years. Job records kept previous to 1929 indicate that the job efficiency averaged 55%. During the period 1929–34, these operations were carried on at an efficiency greater than 85% and six actually exceeded 90%. This remarkable advance parallels the development and increasing use of mechanical road-building equipment, through the same period.

Generally, concrete pavement is paid for per cubic yard and often the cement is paid for as a separate unit. In 1930 ten million square yards of plain Portland cement concrete pavement were laid at an average cost of $1.78 per square yard, and 5½ million square yards of reinforced-concrete pavement at an average price of $2.16. Prices were lower in 1931–33 but they increased gradually in the next five years, and more into the war years. Currently, the average price for cement concrete pavement is about $5.40 per square yard, and the detailed analysis, by operation, is as shown in Table XVI–18.

The repair of cement concrete pavement consists in the doing of small patch work. Tamping of the material to consolidate it in the patches is important. If there are many depressions in the pavement the whole area between adjacent joints should be removed and replaced. The main maintenance operation is simple—to repair the joints and to refill them with hot bituminous material. In recent years surface scaling has become more common than in earlier time. The use of chains in vehicles in winter weather and the very general use of chemicals to prevent the formation of ice on the pavement, and to facilitate its removal from the pavement surfaces is becoming common.

The cost of maintenance for concrete pavement has an average value of $1,400 per mile per year, for a two-lane pavement.

3. CONCLUSIONS

Road materials are so high in cost in Burma that their use has to be planned and executed to secure the greatest possible utilization of the several items. This is especially true for bitumen and the aggregates in bituminous pavements.

The cost of mineral aggregates is so high in all parts of the Union that its use must be drastically reduced, and an adequate local supply of well-graded materials must be developed in each of the districts and areas.

Modern processes of construction must be studied and adapted to use here, in order that the rehabilitation program, which will require a very large expenditure of both men and money, may be carried out at a reasonable cost.

Failure to take parallel steps of reduction of materials cost and introduction of machines may lead to the collapse of the rehabilitation program for highways.

H. CONSTRUCTION AND MATERIAL COSTS

1. GEOLOGY AND MINERAL DEPOSITS

While the costs of processed aggregates for concrete construction and the placing of road surfaces are very high, as will be seen from Table XVI–15, there is an abundant supply of quarryable material in almost all parts of the country. The materials are used locally for building purposes to a limited extent, but only a very few deposits appear to be furnishing aggregates for the maintenance of the highways. Very little heavy mechanical equipment is in use at such quarries as are in operation, almost the entire operation being done by hand. This is wasteful of human energy, and the substitution of machinery in all quarrying operations, as recommended later in this Report, is a vital necessity if the cost of road materials is to be reduced and the production increased as it must be before the road can be rehabilitated.

The principal deposits and quarries are these:

(a) The Department quarries at Mokpalin in the Thaton District were opened up in 1923. The material is granite, with some gneiss, and is brought by rail to

the Rangoon area, where it is the principal road metal. Laterite, as a shoulder material, is also brought from the Mokpalin quarries and is largely used in the Pegu District.

(b) Another source of laterite, though it is not as hard as that from the Mokpalin deposits, is the long narrow ridge in the area between the railway to Prome and that to Pegu, the ridge being an extension of the Pegu Yoma range. The material exists as a laterite, or lateritic clay, and the best deposits are at Wanetchaung Station on the Prome line.

(c) There are sandstone outcroppings, indicating material of unlimited quantity, just south of Prome. They show to the east of Route II, and conveniently close to the highway. The quality can very easily be established with some further investigation, and if suitable for highway purposes in this respect, the deposit should furnish sufficient aggregate for the highway supply requirements over a considerable area. Sandstones from this area have been used in building construction with good results. At present, crushed stone in this area is being supplied at K220 per 100 cubic ft., an exorbitant price. With a good modern quarry established, and well faced, it should be possible to produce material at one tenth the current cost.

(d) On Route I, between Mandalay and Meiktila, there are numerous outcroppings of a good commercial grade of limestone. A small commercial quarry, on a contract basis, is now in operation about one half mile east of Mile 26 (from Mandalay). The deposits seem to lie from one half mile to eight or ten miles from the present route of the highway.

(e) Crushed limestone is also a common road material in the Shan States, the current price being K35 per 100 c.f. Deposits and outcroppings are noticeable along all parts of Route IV east from Meiktila toward Thazi, Kalaw and Taunggyi.

(f) On Route III between Mandalay and Maymyo, there are countless and occasionally nearly continuous outcrops of good limestone. They occur on both sides of the highway and close to it, and there is scarcely any overburden. The route between Miles 17 and 30 is especially favorable, and the material, if quarried, could be shipped by rail from the station near Mile 25 on the highway.

(g) There is also much limestone showing on Route III, between Maymyo and Lashio. In most cases it is close to the road, and with some short-haul trucking it would also be feasible to ship it out by rail, using any of the several stations along this portion of the line.

(h) On Route III between Lashio and Hsenwi, numerous deposits of limestone show, especially near Mile 10 (from Lashio).

(i) In the Shwebo district, and also in the Lower Chindwin area, basalts have been quarried. All of these materials are fine-grained and non-vesicular, make durable road surfaces, and in some instances are locally called "granite."

These were only a few observations of outcroppings encountered upon the field inspection trips. Many others exist along the secondary roads in all parts of the Union. Later in the Report, a specific recommendation is made that the Department establish other quarries, purchase and install the necessary equipment, and seriously produce the very large quantities of road materials that will be needed for the rehabilitation of the highways, thus reducing the very high unit prices which are now being paid for road materials throughout the Union.

2. CURRENT HIGHWAY COSTS, BURMA

a. Labor Costs

Based upon data in the annual Report of the Department for 1950–51, it appears that the total labor cost for postwar work is about four times what it was prewar. The daily wage comparisons for the two eras are about as follows:

	Daily Wage	
	Prewar	*Postwar*
Unskilled labor	K0.50	K2.25
Carpenters	K2.00	K8.00
Masons	K2.00	K8.00

Also, as has been found true in a number of other countries, labor is much less productive now than it was before the war. For example, the prewar production per man on excavation was about 100 c.f. per day. Currently, the figure is 75 c.f., a reduction in output of one fourth. The governing factors which prolong this condition of less efficient output are labor attitudes and the lack of skilled labor (and therefore of other labor) in all parts of Burma.

b. Material Costs

The cost of materials has also had a phenomenal rise in Burma, as in almost every other country, since the end of hostilities. As typical comparisons, consider the following prices, for comparable situations:

	Prewar	*Postwar*
Cement, per cwt.	K2.00	K8.00
Teak, per ton	K150.00	K800.00
River shingle, or hill gravel per cwt.	K35.00	K115.00

Thus it is seen that the cost index for materials has risen about four times, approximately the rise for labor, between prewar and, say, 1950–51.

The current prices of specific road materials in dif-

ferent areas of Burma are shown below in Table XVI–15 for Portland cement, aggregates and bituminous materials. These should be compared to the corresponding prices for materials in the United

TABLE XVI – 15

COSTS OF HIGHWAY MATERIALS, BURMA, 1953

	Price Kyats/L.Ton	*Price Dollars per Bbl. (376 lbs.)*
Portland Cement		
at Rangoon	168	5.95
at Thayetmyo	213	7.55
at Mandalay	240	8.45
at Taunggyi	260	9.20
at Kyaukpyu	372	13.15
	Price Kyats/100 c.f.	*Price Dollars per c.y.*
River Shingle, Prome	80	4.55
Crushed Stone, Prome	220	12.50
Crushed Stone, Mandalay	60	3.40
Crushed Stone, Lashio	25	1.42
Gravel or chips, Mandalay	80	4.55
Gravel, ½ in. and down, Lashio	12	0.68
Bitumen, delivered to storage		
at Mandalay	450/L.Ton	84.50/ton
at Lashio	520/L.Ton	98/ton

Source: Field trips to Districts, 1952–53.

States, as listed in Table XVI–20 (*see p. 425*), representing average prices for twenty cities. It will be seen that the aggregate prices in the upper Shan States tend to approach those in the United States, that the aggregate prices in lower Burma are very high, and that the price of Portland cement, even in Rangoon, is almost twice the average figure in the United States.

c. Total costs

Plate 11, "Cost Trends in the United States," has had added to it the corresponding graph for "Total Cost, Burma," representing the labor, materials and equipment costs by years. It will be noted that the costs rose very rapidly, and the figure of four as a ratio between postwar and prewar construction costs, as mentioned above, is an average figure.

This rise in the cost of materials and labor has an immediate reflection in the costs per mile of construction of various types of road surfacing, as shown in Table XVI–16. The minimum and maximum prices, per mile, are shown for the several pavements now in general use in Burma.

The cost of highway maintenance has also skyrocketed, though the fact that the work has not been as completely done as before the war has made the proportionate rise in costs seem less. For the same

TABLE XVI – 16

COSTS PER MILE—HIGHWAY CONSTRUCTION IN BURMA

	Prewar		*Postwar*	
	Minimum (K)	*Maximum (K)*	*Minimum (K)*	*Maximum (K)*
1. Bituminous Surface	40,000	60,000	140,000	200,000
2. Metaled Surface	35,000	52,500	122,000	175,000
3. Surfaced	11,000	15,000	35,000	45,000
4. Earth	3,000	—	9,000	—
5. Mule Track	2,000	—	6,000	—

Note: The costs per mile include structures, drainage and bungalows.

general pavements, the departmental reports reveal the maintenance costs to be:

TABLE XVI – 17

MAINTENANCE COSTS, BURMA

	Cost per Mile, in Kyats	
	Prewar Average	*1950–51*
1. Bituminous Surface	1,000	2,450
2. Metaled Surface	1,400	2,720
3. Surfaced	740	1,830
4. Earth	280	1,090
5. Mule Track	70	115

These figures should be compared to the maintenance costs for corresponding types of pavements on United States highways, as in the text of Section G, Construction Methods.

3. HIGHWAY UNIT COSTS, UNITED STATES

In comparing the current costs of highway construction in Burma with those in other countries, where the use of mechanized equipment and modern techniques is more advanced, the costs shown below from current and study projects are applicable. A wide variety of projects in all parts of the United States and including several types of pavements, is included.

In the previous subsection, the effect of mechanization of operations on the unit price of common excavation has been discussed. It will be noted, from Plate 10, that the excavation cost on highway work in the United States has continuously declined for the last 25 years. The 1951 ratio of unit price of excavation to hourly wage rate stands at 1.0, the price index and the hourly rate for labor each standing at 1.27.

There is given in Table XVI–18, a detailed cost analysis for the construction of reinforced cement

concrete pavement in the United States, based on 1953 price levels. As a matter of interest, actual bid prices in April 1953 for cement concrete pavement at several locations are as follows:

	Price per c.y.
Ohio: 8-inch reinforced-concrete base	$5.00
Ohio: 10-inch reinforced-concrete pavement	$5.40
New York: 11-inch two-course pavement, including cement	$4.80
California: 7½-inch reinforced-concrete pavement	$5.40

TABLE XVI – 18

COST ANALYSIS—CONCRETE PAVEMENT, 1953

Item	*Cost* $		*Per cent of Total*	
Cement	1.08		20	
Transportation to batching plant	0.38		7	
Subtotal	—	1.46	—	27
Coarse aggregate	0.49		9	
Transportation to batching plant	0.49		9	
Subtotal	—	0.98	—	18
Fine aggregate	0.19		3·5	
Transportation to batching plant	0.24		4·5	
Subtotal	—	0.43	—	8
Cost of cement, aggregate, transportation		2.87		53
Reinforcing steel, joint material, etc.	0.32		6	
Depreciation of equipment	0.48		9	
Labor and supervision	0.59		11	
Batch delivery, labor and equipment	0.38		7	
Overhead, interest bond set up, etc.	0.22		4	
Return to contractor including salary	0.54		10	
Subtotal	—	2.53	—	47
Total, per cubic yard		5.40		100
Total, per linear mile, 20-ft. pavement, 8″ thick	$14,080			

There is also given, in Table XVI–19, the estimated costs per mile of asphaltic concrete plant mix surface on four projects in the southwest United States, and which were constructed in 1936–37. The study was made on projects all of which had 20-ft. pavement surfaces, 2½ inches in depth. The four projects average to $5,100 per mile for this type of construction. The costs at present are higher, as are the wage rates paid workmen. Currently, in the same area, the total cost is approximately $6,400 per mile, one fourth higher than the 1936–37 figure.

In the subsection of the report devoted to modern methods of road construction, there are also to be found some general and average cost figures as to the current and recent price levels for the construction and maintenance of highway surfaces of various types.

The general picture as to price levels in the United States in the 15 years between 1935 and 1950 is contained on Plate 11. Based on the labor, material and equipment costs during 1935 as being equal to 100, the percentage change in each of these, and in their total, has been plotted year by year. It will be noted that the total cost in 1950 was 205% of that in 1935, and that labor cost had risen even more, to 240% of the earlier figure.

TABLE XVI – 19

ESTIMATED COSTS PER MILE—PLANT MIX SURFACE

(20 feet wide by 2½ inches deep)

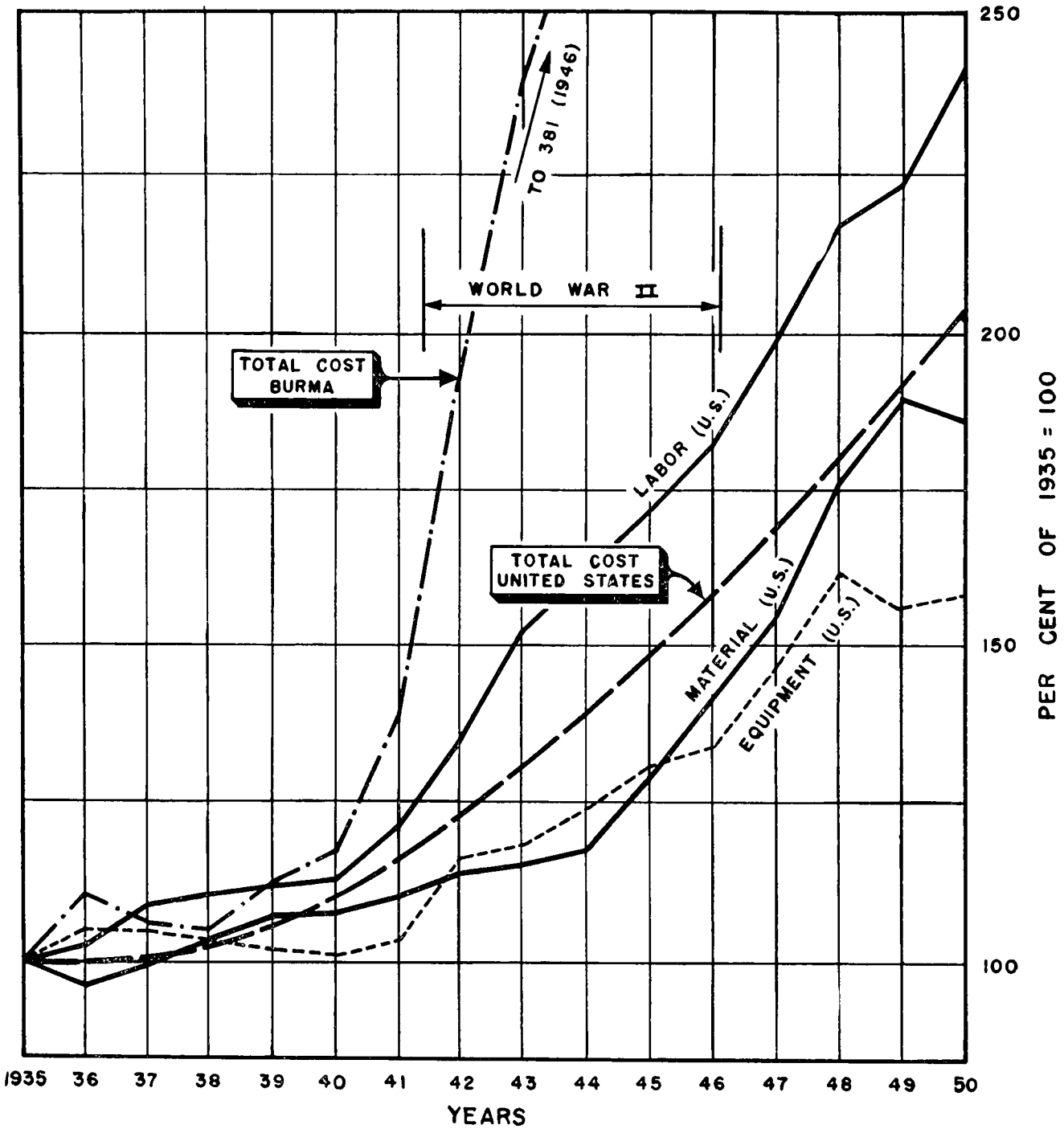
Outlay	*Projects*			
	A ($)	*B* ($)	*C* ($)	*D* ($)
Plant Mixture				
(*a*) Crushing-plant installation	257	878	348	364
(*b*) Aggregate production	954	1,766	992	779
(*c*) Mixing-plant installation	128	439	174	182
(*d*) Mixing (including drying)	442	433	460	361
(*e*) Haul	707	1,040	1,526	332
(*f*) Spread, finish, compact	442	434	460	362
Subtotals	2,930	4,990	3,960	2,380
Bituminous Material	1,680	1,960	1,190	1,330
Total costs per mile*	4,610	6,950	5,150	3,710
Project Data				
Length of projects (miles)	16·308	4·675	12·500	9·366
Kind of aggregate	Cr. Gravd.	Cr. Rock.	Cr. Gravd.	Cr. Gravd.
Average haul (miles)	4·0	6·0	8·3	2·3
Type bituminous material	MC–5	MC–5	MC–5	SC–4
Apparent actual profit	10%	26%	—	—

* Excluding any costs for base preparation, prime or seal, and on an average of 1,600 tons of mixture per mile.

Average cost of surface per linear mile	$6,400
Base course 6-inch crush stone	$3,000
Prime and seal coats	$700
Total cost per linear mile	$10,100

Partial data for these same years was available for Burma, and the graph of this information has therefore been superimposed on the United States figures, where comparable. It will be noted that the total cost in Burma had a tremendous rise during the war years. The peak was reached during 1946, when the total cost was 3·8 times the 1935 figure. At that time, the United States ratio was 1·6 times the earlier value.

For comparison with the prices of road materials in Burma previously listed, there is offered Table XVI–20 (*see p. 425*) in which the late 1952–53 prices for similar materials are shown. It will be noted that the average price of cement per barrel (376 lbs. = 1 barrel = 4 sacks) in the United States is only $3.15, while in Rangoon the cost is $5.95, almost twice as great. In other localities in Burma, the



TOTAL COST IN BURMA PER CENT OF 1935=100			
YEAR	%	YEAR	%
1935	100	1942	195
1936	110	1943	239
1937	105	1944	286
1938	104	1945	350
1939	112	1946	381
1940	118	1947	374
1941	163	1948	325

MINISTRY OF NATIONAL PLANNING

HIGHWAY

COST TRENDS IN UNITED STATES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE MAY, 53 PLATE NO. 11
CK. BY K.B.W.

TABLE XVI – 20

ABSTRACT OF MATERIAL COSTS, 1952–53

(20 cities in United States)

Item	*Average* ($)	*High* ($)	*Low* ($)
Portland Cement, per bbl.	3.15	3.69	2.65
Portland Cement, at mill	2.70	—	—
Sand, per ton	2.08	2.50	1.35
Gravel, ¾–1½ inch	2.60	3.00	1.85
Crushed Stone, 1½ inch	2.55	3.77	1.40
,, ,, ¾ inch	2.60	3.71	1.40
Premixed Concrete, per cubic yard (1: 2: 4, 50 c.y. or more)	10.95	13.00	9.30
Pine Lumber, No. 2, per MBM	92.50	116.50	67.00

cement price is even higher, reaching the astronomic figure of $13.15 per barrel in Kyaukpyu.

Likewise the cost of crushed stone ranges both ways from that in the United States, the Prome price being $12.50 per cubic yard as compared to the $2.55 average figure in the US, and the Lashio price is $1.42 per cubic yard.

The processing and supplying of building and construction materials to jobs in the United States is a very competitive enterprise, and price levels at any given period are apt to exhibit only a very small range. Most of the differences in costs of materials arise from the transportation of the materials from mill, or mine, or quarry, to the job site.

With most materials being brought from sources as close as possible, the transport is largely by truck, except in the large metropolitan areas in which water transport by barge to some point close to the project site is feasible.

I. MAINTENANCE

1. PRESENT METHODS

The highway maintenance operations of the Departments of Buildings and Roads are carried on within the decentralized organization described in the preliminary report. The general policies to be followed, and the over-all programs are established in the office of the chief engineer. Funds are established by the general budgetary procedures of the department, are built into the annual budget for the Ministry, and are then appropriated by Parliament. The current maintenance costs for various types of pavement in Burma are tabulated in Table XVI–17, and comparisons with similar costs for modern crushed stone, road mix, plant mix and other types of pavement surfaces in the United States may be drawn. Hand maintenance is almost universal in Burma. Probably the only piece of road machinery that is in general use is the road roller. Tar for road use is heated in boilers, but the road gangs then complete the operation with pouring cans, brushes and brooms. Asphalt distributors have been used experimentally, but the results were unsatisfactory. As such equipment is in very common and successful use elsewhere, its lack of success in Burma indicates technical or supporting deficiencies. The maintenance tools in use are the mamvatie, the pick and the cane head-basket.

The prewar program comprised regular patching operations followed by general bituminous surface reconditioning each third or fourth year, depending on the budget limitations. Because of the need for widespread major maintenance and reconstruction to repair the destructive ravages of war and insurgency, the Department has not been able to furnish the degree of highway maintenance needed in any modern well-kept system. Good maintenance is vital for (*a*) the safety and comfort of the traveling public, and (*b*) the preservation of the capital investment.

Maintenance before the war, described as "needing one coolie per mile," can hardly have been adequate. Postwar repairs leave much to be desired. The occasional motorist is annoyed by having to travel at a low speed, to steer over raveled edges and around large chuck holes, but to the truck operator and even more to the bus operator, who is charged with the safety of his passengers, these shortcomings and inadequacies are both dangerous and costly.

2. MODERN METHODS

There are described, in Section G, the current American construction and maintenance techniques and the principal types of mechanical highway equipment. Many, if not all of these procedures and equipment could be adapted to use in Burma. If this were done, better and more systematic maintenance would result, the cost of maintenance would be drastically reduced, and the traveling public would benefit. The commerce, trade and developing industrial life of Burma would be advanced by having an adequate, well maintained highway network over which vehicles could travel safely at reasonable rates of speed.

3. LABOR REQUIREMENTS

The argument has been advanced that to mechanize the construction and maintenance of highways in Burma would result in unemployment. This need not be the case for the following reasons:

(*a*) Road gangs will not be eliminated but merely transferred to any of the numerous but now neglected supporting maintenance activities. Most important of these is the work required on drainage structures and ditches. If the drainage is not taken care of, the foundation of the highway will fail, and the whole system will again fall into disrepair.

(*b*) Many of the workers from the road gangs can also be retrained in the use of the new equipment. Others will be needed to staff the repair shops required for the new equipment.

In the United States and elsewhere, the mechanization of the highway operations has resulted in: (1) a greatly extended program and more adequate results, (2) less outlay for construction and maintenance and (3) increased employment. In this connection, and to illustrate the total manpower requirements of highway construction and maintenance, there is introduced Table XVI–21 in which the total number of employees for several categories has been shown for each of the comparative states, and for the United States as a whole.

TABLE XVI – 21

FEDERAL AND STATE HIGHWAY EMPLOYMENT IN THE UNITED STATES, 1950

	Construction			*Maintenance*	*Engineering. Supervision and Admin.*	*Total*
	*With Federal Funds**	*State Funds*	*Total*			
Iowa	1,449	771	2,220	1,567	818	4,605
Kansas	1,558	540	2,098	1,816	748	4,662
Ohio	1,841	768	2,609	4,870	2,215	9,694
California	2,370	1,863	4,233	2,903	3,999	11,135
South Dakota	662	24	686	721	463	1,870
Entire US†	61,769	40,465	102,234	122,018	52,791	277,043

From Highway Statistics, 1950.

* On primary and secondary highways urban extensions.

† Does not include 3,214 employed on Federal Forest Roads, National Parks, etc., nor the construction contractors' forces.

4. CONCLUSIONS

On the basis of the experience gained in many countries where modern methods of mechanical highway maintenance are being used successfully and with low costs; the demonstrated inadequacies of the traditional hand methods, as used in Burma; and the magnitude of the endeavor of rehabilitating an entire highway system to meet the demands of current and expanding traffic; it is recommended that:

(*a*) Modern maintenance methods be adopted in all parts of the Union, using mechanical equipment for the major operations.

(*b*) Training and instruction programs in the use of the equipment be instituted at an early date to furnish competent operators. The instruction techniques should take advantage of all known modern methods of imparting industrial instruction in order that the best possible result be obtained.

J. MATERIALS AND TESTING LABORATORY, SHOPS

1. LABORATORY

In the Preliminary Report it was recommended that a modern laboratory for testing the quality and suitability of local materials, for determining stabilization procedures, and for verifying the quality of imported materials, be established. It was also suggested that in addition to the central laboratory in Rangoon, branch laboratories in other parts of the Union might be required to avoid the delay of shipping materials to the central establishment.

The laboratory should also be equipped to test borrow pit and other subsurface materials. Mobile field units should also be provided to assist in the field explorations.

The laboratory, with trained and competent personnel, is an essential part of the expanded instruction program for the rehabilitation of the highways if durable and economical construction is to be realized.

2. SHOPS

It has also been proposed that a modern workshop be erected and equipped, partly with surplus material now available at the Mingaladon Airport shop. A tremendously expanded highway construction and maintenance program, such as will be necessary to rehabilitate the highways of Burma, will also require expanded shop facilities. As a first step in the program, the shop would serve as a training center for mechanics, welders and machinists. The shop should also include warehousing space and a stock of spare parts for the heavy equipment.

K. PLANNING AND SURVEYS

1. PROCEDURES

It appears from the annual Reports of the Department of Buildings and Roads, from its predecessor bodies, from other historical data, and from conferences and correspondence with the responsible officials in the Department, that the processes of planning and surveying for the integrated development of the highway systems are inadequate. The object of the highway rehabilitation program is the construction of a network of modern roads connecting all segments of the population. To accomplish this, the Department should be engaged in a continuous study of traffic and highway matters both within the Union and overseas, and should constantly re-examine its programs, adjust them, and replan them as necessary to meet the growing needs of traffic.

To carry out such a program it will be necessary to give special emphasis to planning and surveys as con-

trasted to the day-by-day operations of the Department in the carrying out of current programs. It is therefore recommended that a special group be set up within the Department charged solely with this function. The responsibilities, duties and administrative arrangements should conform to the following requirements:

The group should bc administered by an Engineer of Plans and Programs under the direction of the Chief Engineer—Roads.

Operating under the supervision of the Engineer of Plans and Programs, the group should be responsible for (*a*) the orderly planning of improvements on the Union, district and farm-to-market road systems, (*b*) the programming and financing of such improvements and (*c*) the programming and financing of advanced engineering studies and negotiating of agreements for such studies with other political subdivisions or engineering organizations.

Personnel of the planning group, in addition to the Engineer of Plans and Programs, should include office engineers, staff engineers, engineers assigned to special studies, supervisors, statisticians, analysts, auditors, draftsmen and the necessary secretarial and clerical help.

The group should be composed of four sections; namely,

a. Planning Survey Section

This section is concerned with the gathering, analyzing, and reporting of research and statistical information from the field, and traffic, road inventory and physical matters in general.

b. Planning Section

The functions of this section are the classification of all highways; the preparation of sufficiency ratings for highway sections, classified by systems; the development of long-range planning and improvement programs; and the preparation of instructions and data to be used by other departments, circles and divisions.

c. Program Section

The functions of this section are essentially the programming and financing of construction projects, to maintain control of all funds used in planning for and the construction of highway improvements, and to act as the coordinating agency on all matters pertaining to the programming and financing of projects on all parts of the system.

d. Crossing Section

This section should study conditions at crossings and intersections, should advise the Engineer of Plans and Programs of dangerous or otherwise unsatisfactory situations, and should recommend needed improvements. It should also act as the coordinating agency with Burma Railways. This work should include such matters as traffic control studies, intersection layouts, railroad grade crossings, underpasses and overpasses.

e. Special Assignments

The following work may be performed by engineers on special assignment under the Engineer of Plans and Programs:

(1) Developing technical data for long-range planning.

(2) Conducting research work pertaining to special studies.

(3) Making field inspections and reports on selected projects to be considered for programming.

(4) Contacting division and other highway offices on matters pertaining to planning and programming.

(5) Performing other assigned duties.

2. RECOMMENDATIONS

Prior to planning, much survey work will be required:

(*a*) Aerial mapping and photogrammetry.

(*b*) Location and mapping of major sources of inexpensive aggregates, for use in the rehabilitation and maintenance programs.

(*c*) Traffic studies.

(*d*) Soils stabilization.

(*e*) Detailed construction survey.

(*f*) A financial study to discover the best method of financing the local highway improvements should be undertaken.

One of the most effective highway planning organizations devised in the United States is that for the Department of Highways of the State of Ohio. Data on its administrative arrangements have been furnished to the Department of Buildings and Roads as a possible aid in planning the attack on this phase of its long-range problems.

L. HIGHWAY ADMINISTRATION

The general administrative organization of the Department of Buildings and Roads has been fully described in the Preliminary Report. It is sound, and was well adapted to the procedures for which it was established.

However, in view of the recommendations as to basic changes to be made in the Department operations, as outlined elsewhere in the Report, certain administrative changes will be necessary to adapt the organization to its newly prescribed functions. The

changes, including the basic modification in which a planning and programming group is established, yield the proposed organization shown on Plate C. The proposals for the plans and program organization were described in detail in Section K.

The suggestion that the existing department be subdivided to establish a separate Department of Traffic Control is highly recommended. Consideration should also be given to the possible desirability of incorporating some or all of the functions of the Department of Highways in the proposed new Ministry of Engineering Services referred to in Chapter XXV.

M. HIGHWAY FINANCING

1. HISTORICAL

In the United States, the financing of highways has progressively developed in three directions.

(a) Originally when there were few, if any, motor vehicles, roads and streets were local facilities and paid for entirely by local taxation. While still a prime source of revenue for local streets and for township and country road systems, local property taxation has decreased in importance for the primary and state highway systems, and in part, the cost of the local roads and streets is being met by the shares of the state-collected transport revenue distributed to the local units of government.

(b) As higher types of street and road construction and surfaces became necessary, it became common to issue revenue bonds to pay for the cost of such improvements. This practice was especially prevalent between 1900 and 1920. As the use of vehicles increased by leaps and bounds, it often became necessary to replace the pavement before the life of the bonds had run out, and the imposition of the cost of a second bond issue, and in some instances a third, caused an intolerable tax burden to a great many municipalities and county governments. This occurred at a time when expanded funds were needed to construct other streets and roads to meet the demands of increasing traffic.

(c) At the present time, the principal sources of state revenue for highway construction and maintenance are the special taxes and fees paid by motor vehicle users. These include motor vehicle taxes, motor vehicle registration and corollary fees, and special taxes applied only to motor carriers. Other sources, though less important, are property, sales and other taxes levied upon and paid by the general public. As described in later paragraphs, the Federal Government instituted in 1919 the so-called Federal Aid System, by means of which it also carries a share of the cost of the highways.

In 1950, the special imposts on highway users accounted for almost 2·6 billion dollars of revenue, nearly three fourths of the state and federal funds applicable to highways. Only about half of this income, however, was applied to state highway improvements and repairs. The remainder was used for local streets and roads, for non-highway purposes and for the costs of tax collection. The distribution of these funds, with the collection costs deducted, was as follows:

	Millions of $	*Per cent*
Construction of state highways	801	32
Maintenance and administration of state highways	586	24
Other state highway purposes	211	8
Local roads and streets	672	27
Non-highway purposes	217	9
Total	2,487	100

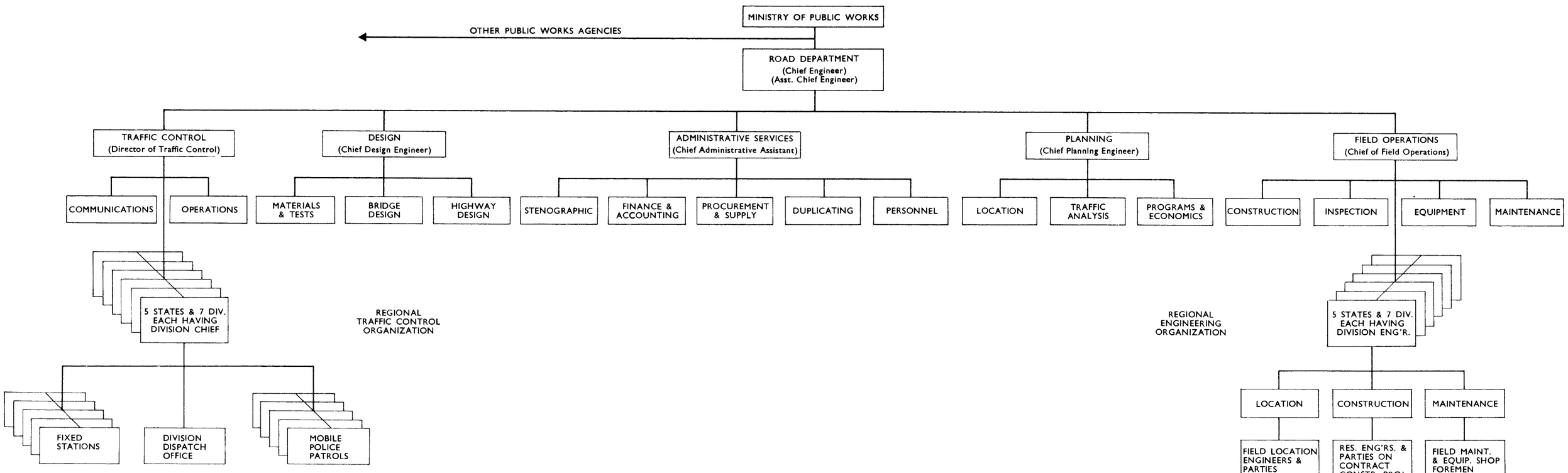
The state-collected revenues from motor vehicle users are distributed to the local government units in a variety of ways, but are reserved for the purposes of aiding and financing the necessary street and highway construction and maintenance by cities, towns and counties. This is usually done by formula, considering the population, highway mileage and vehicle registration within the several units.

Of the total state revenues collected, the sources and proportions were as follows:

State taxes		
Fuel tax	46%	
Vehicle fees	25%	
Motor carriers	1%	
General funds	1%	
		73%
Road, bridge and ferry tolls		2%
Federal aid funds		12%
Bond revenue		11%
Miscellaneous		2%
		100%

It will be noted that the fuel tax, which in the US is commonly called the "gas tax," is the largest single source of state tax revenue, and produces nearly half of the total state revenues for highway purposes. In the states of the United States the collection of this tax is generally in the hands of the State Treasurer, or the Commissioner of Revenue and Taxation, or some similar office. In most cases, this actual detailed responsibility is with a special group, often called the Motor Fuels Tax Division. Generally, the tax is levied only against gasoline used for highway purposes. Such non-highway users as airplanes, marine craft, and agricultural machinery are tax-free. At present, the

SUGGESTED ORGANIZATION CHART
FOR
THE HIGHWAY DEPARTMENT OF BURMA



NOTE: THE REGIONAL TRAFFIC CONTROL AND ENGINEERING ORGANIZATIONS APPLY TO EACH OF THE FIVE STATES AND SEVEN DIVISIONS OF THE UNION OF BURMA.

REV. 18/1/54

PLATE NO. C

price of gasoline varies in the several parts of the US, depending upon transport charges from the refinery to the point of retail distribution, but is in the range of 21–24 cents per US gallon. To this is added the tax, for which typical state levies are as follows:

	Cents per gallon
California	4·5
Iowa	4
Kansas	5
Ohio	4
South Dakota	5
Average for all states	3·48

It has been found necessary, from time to time, to review the tax in the light of current economic conditions, especially highway costs which are often a rough barometer of business levels, and to determine whether the tax rate is such that sufficient revenue is produced to enable the various highway bodies to carry out an adequate program of construction and maintenance.

2. FEDERAL AID

Since it offers a reasonable pattern for the similar distribution of government funds to local units for highway funds in Burma, a brief review of the so-called Federal Aid system in the United States follows.

The procedure was initiated in 1916 with the first authorization of the primary system. Funds were divided between the states on the basis of population factors and highway mileage on the designated system. The authorizations by Congress under the Federal Aid Act for the years 1917–53 are shown on Plate 12. It will be observed that for the period 1917–33, the authorization tended to average approximately 100 million dollars per year. During 1935–45, except for the dislocations of the war years, about 150 million dollars per year were authorized, and since the end of the war the figure has been 450 to 500 million dollars per year. This latter increase is due in part to the need to do the work that was deferred during 1940 45, but also reflects the phenomenal increase in motor traffic since the end of hostilities.

The Federal Aid highway system consists of about 235,000 miles of rural roads and city streets selected and incorporated into the network jointly by the states and the Federal Government. The mileage is almost entirely on state systems and is thus part of, and not in addition to, United States mileages reported in Section E. As of June 1951, the Federal Aid secondary system consisted of 417,000 miles of highway, with 45% being in state systems and the remainder in county or other local systems.

The Federal Aid system, like many other American governmental agencies and procedures, represents gradual growth and experience. As early as 1891, for example, New Jersey, one of the states in the United States, had established a State Aid Act to assist counties, townships, and local communities in the construction and maintenance of local highways. By 1917, when the Federal Aid Act was enacted by Congress, all of the 48 states had established, in some form, a similar system. Incidentally, each by then had also established and was operating a separate state highway department charged with road construction and maintenance.

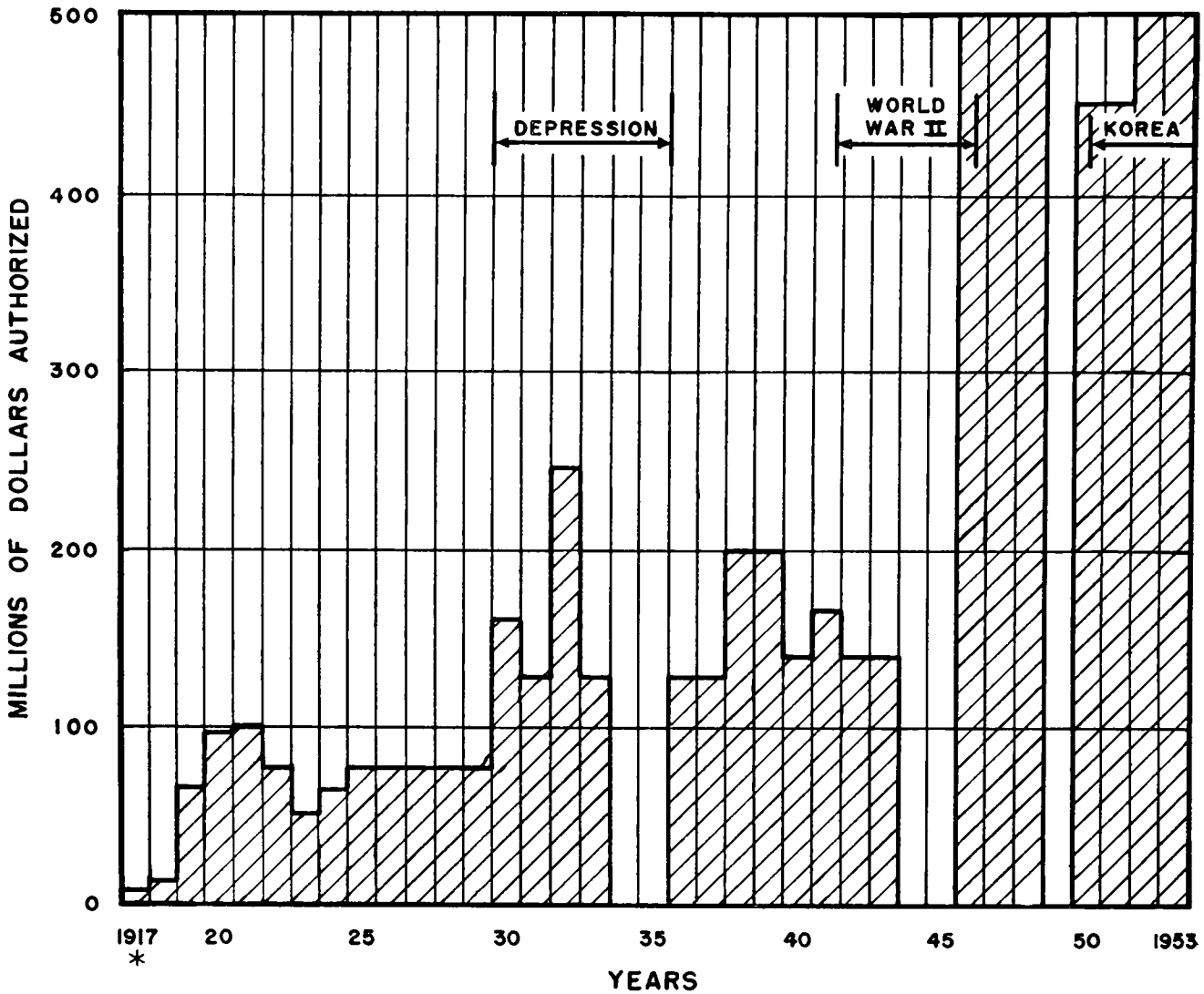
Another valuable characteristic of the Federal Aid system is that while apportionments are made each year to the states, considerable flexibility is allowed in expending the funds. This allows the states to have orderly planning and budgeting of their funds.

Federal funds are available for expenditure only on the designated Federal Aid systems, and in general must be matched by an equal amount of state or local funds. Federal aid may not be expended for maintenance nor for land acquisition. The cost of most Federal Aid projects is paid initially out of state highway funds, or in some cases by counties or other local governments. The Federal share is paid as reimbursement to the states as the work progresses, with final payment made upon completion.

3. HIGHWAY FINANCING, BURMA

At present the construction, repair, and maintenance of the national and primary roads are financed by allotments from the general revenue of the Government of the Union based upon decisions reached by Parliament. For repairs, the Department of Buildings and Roads submits annual budgetary requests which, when incorporated in the general budget for the Ministry of Public Works, are also acted upon by Parliament.

District roads are the responsibility of the district councils. The streets in the municipalities are also a local responsibility, except that where the national and primary roads traverse the communities, these sections of highway remain under the jurisdiction of the Department. The district local fund boards administer funds applicable to town streets. The various local fund bodies often have no trained personnel and working crews for the execution of highway work, and the department staff is partially used in these situations, the projects being performed as deposit works. Also, the municipalities, district councils and local fund boards exercise control over very minor total expenditures. The local bodies generally have to maintain and repair the district roads and town and city streets with moneys obtained from local taxation and occasional grants from the Government.



* Federal Aid Enacted

Note:
Special appropriations for Public Works Administration Highways (1933-35) and Defense Highways (1942-44 and 1951-52) not included in totals.

MINISTRY OF NATIONAL PLANNING			
HIGHWAYS **TOTAL FEDERAL AID U.S. HIGHWAYS 1917-1953**			
KNAPPEN TIPPETTS ABBETT ENGINEERING CO. NEW YORK RANGOON			
DR. BY E.J.P. DATE CK. BY K.B.W. MAY, 53	PLATE NO.	12	

While the local bodies have the right to levy any taxation that is necessary, the fear has grown up that it is unwise to raise this part of the tax burden, since it would greatly increase the total tax burden. This is an unsound position. Additional funds must be secured from either local or national sources to permit adequate highway maintenance and repair to be carried out, and to engage in a long-range well-planned highway development program. This can best be done by greater budgetary allowances for highway programs. The Department, reorganized along the lines suggested elsewhere in this Report and enlarged to cope with an enlarged program, is the proper agency to handle the national, the secondary and certain of the urban highways. The staff must employ a greater degree and wider variety of specialized training and skills, in order that the entire network of highways may be brought to not only its prewar condition but to the advanced state required to meet the challenge of present and developing traffic conditions.

There are other special-purpose roads, such as those serving irrigation projects and forest areas. These are not public routes and are therefore the responsibility of the several departments in question, rather than of Buildings and Roads, and funds for these special-purpose roads are derived from the several departmental budgets.

4. CONCLUSIONS

Considering the inadequacies of both local funds and the facilities of the Department of Buildings and Roads, it is concluded that:

(*a*) A modern local-aid system should be established. Funds from national sources, in sufficient amount to do an adequate job, must be furnished. It is even more important that the local road bodies be assisted by the Department to assume more and more of the problem of local road administration, maintenance, repair and construction as they progress.

(*b*) That a pattern, adapted from the United States Federal Aid secondary system, should be used as a guide in developing a system for Burma.

(*c*) That at present the motor traffic is of such volume that the revenue produced from a tax on gasoline used in motor vehicles would produce inadequate funds for the necessary maintenance and construction program. At present, the preferable source for the major part of the funds needed should be the general funds of the Union, distributed to the districts and communities in proportion to their highway needs. Some part of the funds should be on a share and share basis, so that the local body also makes a contribution to the development of its parts of the highway system. Other funds can be, as now, on a grant basis.

Later, as traffic develops, it probably will become expedient and desirable to use a gasoline tax, or some similar special-purpose levy, as a source of highway revenue.

(*d*) That the present system of licensing of vehicles should be continued, with the fees modified to conform to the recommended Motor Vehicle Code outlined in Section N of this chapter. It is essential that the control by taxation and licensing of vehicles using the highways be maintained in the interests of public safety to prevent overloading on the roadway pavements and structures and to insure continuance of the right to enforce traffic regulations.

With the enactment and use of the code, there will soon develop a sufficient body of experience as to vehicle characteristics such as weights and axle loads to enable the authority to establish a weight tax for the heavier vehicles using the highways. This is one way, and possibly the simplest and most equitable way, to establish the proportionate contribution to be made by different weights of vehicles to the cost of building and maintaining the highways.

(*e*) It should be kept in mind that transport by motor vehicles is only one aspect of the whole transport structure. While the road systems of the Union must be repaired, reconstructed and rehabilitated, and must grow with the growth of traffic, the whole network must be brought to and kept in its proper relationship with the other forms of transport (air, water and rail), to develop an integrated whole, a system which serves the entire Union with the maximum economic and social benefit.

N. HIGHWAY CODE

1. NEED FOR REVISION OF THE 1907 CODE

The basic legislation under which motor vehicle traffic now operates and is controlled in Burma is Burma Act No. V of 1907. This was passed in Council on March 14 that year, received the assent of the Governor-General on May 4, and was published and placed in effect on June 1, 1907. The Act is "In the regulation of traffic and the preservation of the surface of public roads and places in Burma."

Under it, the local government was empowered to make rules for traffic on public roads and places and for the preservation of the surface of such roads and places. These rules were to include, as major items, those which would (*a*) prohibit or restrict the use of vehicles causing damage or excessive wear to surface, (*b*) provide for licensing of drivers, (*c*) establish speed limits, (*d*) establish the rules of the road, (*e*) establish the requirements for mechanical features and equipment of vehicles, including lights, (*f*) establish weight and passenger limitations for vehicles, and (*g*)

establish penalties for violations of any rule established under the Act.

Subsequently, and from time to time, the Public Works Department established and modified the Burma Road Rules; established left-hand driving as the rule of the road; established and modified a list of "notified roads" (upon which subsequently government funds could be expended); established a distinction in road administration and responsibility as between the Executive Engineer of the Public Works Department, representing the Government, and the Deputy Commissioner and Public Works staff of the districts, representing local government; established load, wheel and tire restrictions for vehicles (these became effective on October 1, 1909); gave power to the Public Works Department or the local deputy commissioner to close roads for repair with proper notice and establishment of detours for traffic; gave power to regulate traffic in the interest of preventing danger or injury to the public; and prohibited bullock carts from using the traveled surface of any road unless provided with springs.

With the introduction and widespread increase in the use of motor vehicles, and especially with the development of the handling of freight by truck, many of the provisions of the original law, and certain of the modifications and notifications thereunder are outmoded and should be modified. In special need of overhauling are those portions of the Act relating to animal traffic on the highways. For example, the rules promulgated under the law included one forbidding the travel or driving of elephants on any road unless the animal was provided with a bell or other audible warning signal. Also, any person in charge of an elephant was required to remove it from the road if requested to do so by any person leading, riding or driving an animal rendered restive by the presence of the elephant.

Also, the development in the use of motor transport of all kinds, which to a very large degree occurred during the war years, with the accompanying general increase in the speed at which vehicles operate, has brought about a new set of conditions for highway transport and traffic control. The highway code should at all times be flexible enough to accommodate itself to changes.

Further, as the use of highway transport develops, any law or code must anticipate changes in order to influence and guide the direction of development of motor transport for the maximum benefit to the public. For these reasons, because the present law cannot be effectively enforced, and because it is impractical to revise a basically outmoded law, a new Motor Vehicle Code has been prepared. The recommended Code, with the more important features developed in detail and the remainder in synopsis form, is included as Section N 5 of this chapter.

2. BASIC FEATURES OF RECOMMENDED CODE

The basic features incorporated in the Motor Vehicle Code recommended for Burma take into account the current state of motor transport in Burma; the reasonable trends which this transport may take in the foreseeable future; the present status of the national and local highway systems; the changes which will be brought about by the rehabilitation and modernization program; the design, use and capacity of modern motor vehicles; the need to live for some time with the problem created by the co-existence of slow-moving traffic, largely bullock carts, and fast-moving and heavy motor traffic. The more important features of the new code include:

(*a*) Provisions for the registration of motor vehicles in the categories of private cars, hiring cars, buses, private buses, trucks and special vehicles; the payment of fees therefor, and the issuance of licenses and certificates of registration.

(*b*) Provision for revenue licenses for commercial vehicles, such as hiring cars, buses, private buses, and trucks; the payment of fees therefor; and limiting operating conditions.

(*c*) Issuance of permits for bus services, including the requirements for the establishing of routes, procedure in connection with the granting of the permits, and permits for hiring car service, including the procedures in connection with the granting of permits. Anticipating changes in the nature of bus traffic or the shifting of traffic, the code provides for the combination of bus companies to whom permits have been granted in order that more economical operation and better service to the traveling public may result. It is further contemplated that bus services may be established and carried out by Burma Railways in connection with its own operations.

(d) Issuance of permits for truck service for hire, with the requirements necessary to exclude certain kinds of truck hauling; including the procedures in connection with the establishing of rates and granting of permits.

The Code envisions that Burma Railways may find it economical and desirable to establish feeder services, by truck, for its own operations, or to replace, in the future, short terminal positions of its lines with such services. For this reason, requirements and procedures are established for this purpose.

Since this section of the Code may well govern the development of commercial trucking, a very important segment of the transport facilities of Burma, and since this development, if carried out in an orderly and proper manner, will be of great help to the economic

welfare of the nation and its people, great care should be taken in carrying out the objectives of this section. It is therefore recommended that there be created, as chief administrative officer, a commissioner of motor vehicles; that the registration of vehicles and related matters be handled by a registrar of motor vehicles; and that assistants and staff be established for each to effectively carry out, implement and enforce the code.

The responsibilities of the commissioner are enumerated in detail, and the relationship is established between his office and the Transport Commission, recommended elsewhere as the policy making and regulatory body for an integrated and complete transportation system for the Union of Burma.

(e) The establishment of offenses under the code and penalties therefor; and the development of correct procedures for handling offenses under the Code.

3. FLEXIBILITY IN CODE LIMITATIONS

All legislative acts, except those involving basic social concepts, must be so written as to admit changes in their requirements and limitations from time to time, as economic and social conditions progress. This is especially true where technologic improvements occur at a rapid rate.

The attempt has been made to provide a statute which meets the basic requirements of traffic, permits of the flexibility needed for changing conditions, is conveniently and fairly enforceable, and is reasonable in administration. Certain details must be developed in the operational procedures outlined in the Code, but these are administrative matters to be solved among the several government agencies involved. In doing this, the agencies should be guided by their own previous experience and the current practices of others. In this connection, the several states and government agencies in the United States have organized a quasi-official, but largely advisory group known as the American Association of Motor Vehicle Administration, to coordinate their efforts and to exchange information. It is believed that very good general data adaptable to local conditions and practices can be obtained from this organization.

In most cases in the recommended code, the basic limitations have been shown. Where final determinations are matters of local needs and experience, details have been left to the administrative agencies. This is especially true of the insurance requirements, and of the penalties to be levied for violations of the several parts of the Code. In the latter case, the basic principle should be that the severest penalties should be reserved for those offenses in which the danger to other persons, either in vehicles or as pedestrians, is the greatest.

In the assignment of effective dates for the several parts of the Code, care should be taken not to impose any real economic or other hardship on vehicle owners. For example, it is just to institute speed limitations or new registration procedures upon short notice, if enough time is allowed beyond the date of enactment to permit the necessary educational and publicity measures to be taken, the procedures to be developed and initially instituted, and (in the case of buses) the necessary rearrangement of schedules to be made. It is not reasonable, on the other hand, to establish new load or size limitations on such short notice, for the owners of the existing vehicles which would be illegal under the new limitations would be unable to operate their vehicles after the fixed date. Their equity would thus be unfairly destroyed. This kind of date should be set considerably in advance, with the added provision that new vehicles purchased in the interim period should meet the new requirements.

The fee schedules for registration and licenses should be so fixed as to impose no economic hardship upon individual drivers and owners of vehicles. The basic objective of licensing is to establish control over the ability of drivers in the interest of public safety, and in the case of larger and heavier vehicles to safeguard the public and to prevent the destruction of its collective property, the public highways of the nation. In the case of commercial vehicles, a further objective is to give, by the granting or withholding of licenses and permits, control over the quality and nature of service rendered by the carriers to the public.

In establishing the speed limits under the Code it may be wise, as has been found in a number of state and municipal vehicle codes in the United States, to establish no definite limit. Instead the Code will provide that "the vehicle must at all times be operated safely, and prudently, and not operated in a reckless and dangerous manner." Most such codes go on to say that if a vehicle is operated at a speed in excess of —— miles per hour, it is the responsibility of the operator to prove that he was not driving in a reckless and dangerous manner. In this way, it is possible for the enforcement agencies to secure court convictions against operators who are guilty of a wide range of offenses against public safety, but who would not have violated the rules as to speed. On the other hand, with the burden of proof on the operator, a strong deterrent against excessive speeds is established. Again, the relative penalties under the code and the manner in which the latter is enforced should be in the interest of the safety of the general public.

It is of vital importance that the weight and size limitations to be placed upon vehicles under the Code

shall be definite, reasonable and easily enforceable. They should be realistic in terms of the design and capacities of modern motor vehicles, and capable of adjustment as motor vehicles undergo further development and change. Since grave and even tragic structural damage can occur to roadway surfaces and subgrades, as well as to structures if they are overloaded, the public interest and investment in the highway system of the nation demands that this portion of the Code be severely enforced.

Recent experiments on a heavy-duty highway in the United States, carefully constructed in recent years and to modern high standards, have indicated the real need of controlling axle weight on heavy vehicles, and especially dual axles. In a concrete pavement, for example, a 20% increase in the axle load, from 18,000 lbs. to 21,600 lbs., produced six times as many cracks as had existed in the pavement under continued applications of the lighter axle load. The damage to flexible pavements of the bituminous type such as are used in Burma would have been even greater.

It is therefore vital that clear-cut design standards be established for the roads of each classification, that construction be carefully carried out by the design capacities, and that the weight and axle requirements of the Code be strictly enforced.

4. COORDINATED TRANSPORT

One of the basic features of the new Code is that it envisages a coordinated system of transport in which each of the modes participates in the over-all system to the degree consistent with its basic usefulness, convenience and economy in order that the general public welfare be served to the maximum extent. The Code also establishes procedures for the consolidation of bus lines, if necessary, in order that more efficient service be rendered to the traveling public.

The relationship between the administration of the code and the Transport Commission is indicated in the Code. This relationship is more fully presented in Chapter X, Transportation.

5. PROPOSED MOTOR VEHICLE CODE

The draft of the recommended model Motor Vehicle Code, partly in detail and partly in synopsis form, is included herewith.

UNION OF BURMA MOTOR VEHICLE CODE

ACT No. ——, 1954

Section

1 Enabling clause, with effective date and repealing all existing acts, by name.

PART I

REGISTRATION OF MOTOR VEHICLES

Section

I–1 Prohibition on possession or use of vehicles without registration.

I–2 (*a*) Requirement that registered vehicle comply with regulations promulgated under Code as to weight, dimensions and equipment for that class of vehicle.

(*b*) No motor vehicle shall be registered as a private car or a hiring car if the tare of that vehicle exceeds two and one-half tons.

I–3 (*a*) No motor bus shall be registered unless the person for the time being entitled to the possession of that motor bus is the holder of:

(1) A bus permit for a regular bus service; or

(2) A certificate of eligibility (granted under the Code) for bus permits for occasional bus services; or

(3) A private bus permit for that motor bus.

(*b*) No person shall be registered as the owner of a motor bus unless he is the holder of:

(1) A bus permit for a regular bus service; or

(2) A certificate of eligibility (granted under the Code) for bus permits for occasional bus services; or

(3) A private bus permit for that motor bus.

I–4 All motor trucks, tractors, trailers and special-purpose vehicles of the same nature now operator hereafter placed in operation upon the public highways should have placed on them data in respect to the vehicle height, width and length; kind and size of wheel and tire; unladen weight and carrying capacity as duly authorized by the Commissioner of Motor Traffic. This data shall be prominently painted, or otherwise permanently shown, on the vehicle.

I–5 to I–13 Requirements covering description of motor vehicle upon registration; keeping of register of vehicles by categories; application for registration; payment of registration fee; issuance of license and certificate of registration; data on vehicle to be furnished with application, including weight; detailed procedure on change of ownership, application and registration of new owner, cancellation or registration.

PART II

CONSTRUCTION AND EQUIPMENT OF MOTOR VEHICLES

II–1 Regulations may be made prescribing the requirements as to construction, weight, dimensions and equipment of motor vehicles as prescribed in Part VIII. Any such regulation may be expressed to be applicable to motor vehicles

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generally or to any specified class of motor vehicles.

II–2 Requirements as to number and position of license plates, shape thereof, etc.

PART III

REVENUE LICENSES

III–1 Legal requirements to prevent possession or ownership of motor vehicles without revenue license.

III–2 A revenue license to be issued under this Part for a motor vehicle shall be a license of one of the following descriptions, that is to say, a private car license, a hiring car license, a private bus license, a bus license, a truck license, a motorcycle license, a motor hearse license, a motor ambulance license, an invalid carriage license or a land vehicle license, and shall be issued having regard to the class of motor vehicles to which that vehicle belongs.

III–3 Requirement that the revenue license be not issued except on the production of the certificate of registration, and that of insurance or security.

III–4 (*a*) No bus license shall be issued under this Part except for a bus the registered owner of which is the holder of:

(1) A bus permit for a regular bus service;

(2) A certificate of eligibility (granted under the Code) for bus permits for occasional bus services.

(*b*) No private bus license shall be issued under this Part except for a private bus the registered owner of which is the holder of a private bus permit authorizing the use of that bus.

(*c*) No truck license shall be issued under this Part except for a truck the registered owner of which is the holder of a permit granted under the Code authorizing the use of that truck.

III–5 No revenue license for a hiring car, motor bus, truck, motor hearse or motor ambulance shall be issued by a licensing authority unless that car, bus, truck, hearse or ambulance, as the case may be, has, within the period of two months immediately preceding the date on which the license is to come into force, been examined and certified to be fit for use under all requirements of Part IX of the Code.

III–6 to III–10 Requirements as to form of application for revenue license; license fees, form and period of revenue licenses, including limitations on such periods; and the power to insert conditions in revenue licenses in the interest of safety.

III–11 (*a*) The licensing authority shall specify in every revenue license issued by the authority:

(1) for a private bus, the maximum number of persons authorized to be carried in that bus; and

(2) for a hiring car or a bus, the maximum number of passengers authorized to be carried in that car or bus, as the case may be, with limitations as to extra seats in the case of hiring cars, and limitations as to seating space, aisles, etc., for hiring cars, private buses, or buses.

III–12 The licensing authority shall specify in every revenue license for a truck issued by that authority the maximum load (that is to say, the payload) which may be carried on the truck. For the purpose of determining the maximum load, each person permitted to be carried on the truck shall be deemed to weigh one hundred and ten pounds.

III–13 Requirement that revenue license be carried on motor vehicle, and produced when required by court or the registrar.

III–14 to III–19 Requirements as to procedure when altering motor vehicle; surrender or cancellation of revenue license; issue of new revenue licenses with change in ownership; dealer's licenses and use of vehicles thereunder; temporary licenses; permission that Commissioner may issue permits for carriage of goods (with weight limitation stated) on private cars, carriage of mail or newspapers by hiring cars or buses; or for other purposes.

PART IV

PASSENGER VEHICLE PERMITS

Bus Services

IV–1 No bus shall, on or after the appointed date, be used on any highway except under the authority of a bus permit granted by the Commissioner under this Part and for the time being in force.

IV–2 Description of classes of bus permits, including those for occasional service.

IV–3 (*a*) The period for which a bus permit under this Part shall be in force shall:

(1) In the case of a permit for a regular service, be such period, not being less than two years nor more than ten years from the date on which it is expressed to come into force as shall be specified in the permit; and

(2) In the case of a permit for an occasional service, be such period as shall be specified in the permit.

IV–4 (*a*) Every application for a bus permit shall be made to the Commissioner in such form as the Commissioner may provide for the purpose.

(*b*) Every application for a bus permit for a regular service shall be made not less than three months before the date on which the applicant requires the permit to come into force.

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(*c*) Every applicant for a bus permit shall submit together with his application a statement in such form as the Commissioner may provide for the purpose, containing:

(1) Particulars of the type or types of the buses proposed to be used under the permit;

(2) Particulars of the route or routes on which it is proposed to provide the service;

(3) In the case of a permit for a regular service, the timetable and fare-schedule of the proposed service;

(4) In the case of a permit for an occasional service, particulars of the area in which and of the event or events in connection with which a service is to be provided and such other particulars as the Commissioner may require including particulars relating to the frequency of the proposed service and the time to be taken on the journeys included therein;

(5) Such particulars as the Commissioner may require as to the hours of work or rest, hours of continuous duty, wages and other conditions of employment of the persons employed or proposed to be employed for the purpose of the service; and

(6) Such other particulars as the Commissioner may require.

IV–5 Publication of notice of application for permits for regular bus service; objections from others already furnishing service along or near the route, including Burma Railways; requiring public hearings on permit application.

IV–6 (*a*) Subject to the provisions of Section IV, the Commissioner shall have full power and discretion to make a determination either to grant or to refuse an application for a bus permit.

(*b*) The Commissioner, in exercising the discretion in regard to the grant or refusal of bus permits and to the route or routes in respect of which permits may be granted, shall have regard primarily to the interests of the public generally, including those of persons requiring as well as those of persons providing facilities for the transport of passengers for fee or reward and shall, in particular, have regard in the case of any application for any such permit, to the following matters:

(1) The extent to which the proposed service is necessary or desirable in the public interest;

(2) Suitability of the proposed route or routes;

(3) The extent, if any, to which the needs of the proposed route or routes are already adequately served;

(4) The needs of the area as a whole in relation to traffic (including the provision of adequate, suitable and efficient services and the provision of unremunerative services) and the coordination of all forms of passenger transport, including transport by railway;

(5) The question whether any provision or any other written law prescribing a speed limit is likely to be contravened;

(6) The financial position of the applicant, insofar as it may affect the efficient operation of the proposed service;

(7) The following considerations of policy, that is to say,

(i) That wherever any transportation facilities (including facilities provided by the railway) in any area or on any route are, in the opinion of the Commissioner, satisfactory and efficient to meet at reasonable charge the transportation requirements of the public within that area or on that route, it is desirable to grant bus permits authorizing the carriage of passengers within substantially the same area or over substantially the same route in competition with the said transportation facilities, and

(ii) That it is desirable, except where special circumstances render it inexpedient to do so, to give preference (other things being equal) to an application by a Cooperative Society for a permit to provide services which fulfill transportation requirements in the locality in which the society carries on its activities wherever such services will not be in competition with services provided on established trunk routes, and to give preference to an application by any Municipal Council for a permit to provide services on any route on which a bus service was provided in the month of ——, and

(iii) That, where in the case of any application for a bus permit authorizing the provision of a regular service the following condition is satisfied, namely, that the applicant is at the time of his application the holder of a permit authorizing the provision of a substantially similar service, preference should be given to his application over any application by a person in whose case the said condition is not satisfied, unless the refusal of the first-mentioned application is justified on the ground that the conditions of any permit previously held by the applicant have not been complied with or is justified by special circumstances.

IV–7 Subject to the provisions of this Code and of any regulations made in that behalf, the Commissioner may attach to any bus permit all such conditions as he may think fit to impose with respect to the matters mentioned in Section IV–6 and generally for securing the safety and convenience of the public, including conditions requiring:

(*a*) That the fares to be charged shall be such as may be specified in the permit.

(*b*) That the service shall be operated in

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accordance with a timetable specified in the permit.

(*c*) That copies of the timetable and fare-schedule shall be carried and kept exhibited in buses used on the service.

(*d*) That every bus used on the service shall be of a specified type and be maintained at all times in a fit and serviceable condition.

(*e*) That no bus shall be used on the service unless a certificate of fitness in respect thereof is in force for the time being.

(*f*) In a case where permits are issued to different persons involving the use of the same section of a highway, or where any route or part thereof lies within the administrative limits of any local authority, that passengers shall not be taken up or shall not be set down (i) except at specified points or (ii) between specified points.

(*g*) That the requirements of any written law with respect to the time for which drivers or conductors of buses may remain continuously on duty and to their hours of work or rest and to their wages are complied with in the case of the drivers and conductors of the buses used under the authority of the permit.

(*h*) That the speed limits prescribed by any written law and applicable in the case of buses shall be observed in the operation of the service.

(*i*) That mails or newspapers shall be carried to such places and at such times as the Commissioner may specify, if payment for such carriage is made in accordance with rates approved by the Commissioner, and in the case of mails, that they shall be carried in accordance with terms and arrangements approved by the Commissioner and embodied in a contract between the applicant and the proper postal authorities.

(*j*) That the holder of the permit must make adequate provision, whether by the setting apart of funds or in any other prescribed manner, for depreciation of buses, buildings and plants and for the purchase of new buses.

(*k*) That in the case of a permit for a regular service, the holder shall be bound, if required to do so, to provide bus services or hiring car services on any neighbouring route or routes in the area deemed by the Commissioner to be the area served by the regular service provided under the permit, whenever the Commissioner is of the opinion that such additional bus or hiring car services are necessary in the public interest.

IV–8 (*a*) For the purpose of meeting any increased demand for passenger transport, the Commissioner may by order direct the holder of a bus permit for a regular service to increase the frequency of the services provided under any permit, or to provide additional regular services, whether on the whole of the route or routes specified in the permit or on any such route or part thereof;

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and any service which is provided in compliance with the order shall be deemed for the purposes of this Part to be a service authorized by that permit. No such order shall be made unless the holder has first been given an opportunity to be heard.

IV–9 Provisions for revocation, suspension or transfer of permits; right of appeal from determinations of Commissioner, and notices thereunder, etc.

IV–10 Regulations may be made with respect to all or any of the following matters:

(*a*) The procedure on applications for, and the determination of, questions in connection with the grant, variation, suspension and revocation of bus permits, the fees payable in respect of such applications and permits, and the manner in which, whether in a lump sum or in installments, such fees shall be payable.

(*b*) The custody of permits under this Part, and their production, return and cancellation on expiration, suspension or revocation and the custody, production and return of documents and plates.

(*c*) The plates and marks to be carried on buses and the manner in which they are to be displayed.

(*d*) The records to be kept by holders of such permits in relation to the persons employed by such holder as drivers or conductors of buses and to the time of the commencement and cessation of work by such persons and the intervals of rest taken by them.

(*e*) The documents to be carried by drivers of buses and the particulars to be entered therein.

(*f*) The records to be kept in respect of the journeys performed by buses (in addition to the registers required by Part VIII).

(*g*) The preservation of records so kept, the inspection of such records by any authority specified in the regulation, and the production for the purposes of such inspection of such records on demand made by any such authority.

IV–11 Establishment of effective date.

IV–12 (*a*) The Minister and the Transport Commissioner may require the Commissioner to prepare and present a plan;

(1) For the amalgamation of any or all of the companies which are authorized under this Act to provide bus services in any area or on any routes specified by the Minister; or

(2) For the transfer to any one of such companies of the business previously authorized under this Act to be carried on by any other such company or companies in any area or on any routes so specified; or

(3) For the formation of a new company, and the transfer to it of the business previously authorized under this Act to be carried on by any

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other company or companies in any area or on any routes so specified.

In this sub-section, "authorized" means authorized by a bus permit or two or more such permits.

Hiring Car Services

IV 13 Similar requirements for permits for hiring car services, carrying out applicable requirements of Sections IV–3 to IV 11, modified as necessary.

Private Bus Permits

IV–14 Outline generally similar requirements for the granting of permits for private buses, for the transport of school students and staff, etc.; for ground transport as a part of an airways operation, transport of employers' staff, etc. (including those of government departments or other public or local authority); or transport for any other prescribed purpose of that general nature.

IV–15 Regulations may be made for the purposes of carrying out or giving effect to the provisions of Section IV 15; and without prejudice to the generality of the powers hereinbefore conferred, any such regulation may provide:

(*a*) The particulars to be contained in applications for private bus permits, and the fees payable in respect thereof;

(*b*) For the conditions which shall or may be attached to such permits, the variation, modification or revision of conditions or the addition of new conditions;

(*c*) For the revocation or suspension of such permits;

(*d*) For the duration of such permits, and

(*e*) The plates and marks to be carried on private buses and the manner in which they are to be displayed.

PART V

GOODS TRUCK PERMITS

V 1 No truck shall, on or after the appointed date, be used on any highway except under the authority of a permit granted by the Commissioner under this Part and for the time being in force, except trucks being operated under a dealer's license or trailers drawn by passenger cars.

V–2 A permit authorizing the use of a truck shall be one of the following classes, that is to say:

(*a*) A public carrier's permit; and

(*b*) A private carrier's permit.

V–3 (*a*) A public carrier's permit shall entitle the holder thereof to use trucks specified in the permit (hereinafter referred to as "the authorized trucks"):

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(1) For the carriage of goods for fee or reward, and

(2) For the carriage of goods for or in connection with his business as a carrier of goods, whether by road transport or any other means of transport, and for such storage or warehousing of goods as may be incidental to his business as a carrier; and

(3) In the case of a permit held by a person carrying on a canal, dock or harbor undertaking, for the carriage of goods for or in connection with that undertaking.

(*b*) A private carrier's permit shall entitle the holder thereof to use the trucks specified in the permit (hereinafter referred to as "the authorized trucks") for the carriage of goods, otherwise than for fee or reward:

(1) For or in connection with any trade or business carried on by him and specified in the permit; or

(2) For any other purpose so specified.

(*c*) The carriage of goods by a person engaged in any trade or business, in any case mentioned in any of the following paragraphs shall not be deemed to be carriage for fee or reward:

(1) The delivery or collection, by that person, of goods sold, used or let on hire or hire-purchase in the course of that trade or business;

(2) The delivery or collection by that person of goods which have been, or are to be, subjected to a process of treatment or manufacture in the course of that trade or business;

(3) Where that trade or business is that of a manufacturer, agent or dealer in any goods, the carriage of goods for demonstration purposes in a truck;

(4) Where that person is a manufacturer of motor vehicles, the carriage of goods by him under and in accordance with regulations made in that behalf;

(5) Where that person is engaged in agriculture in any locality, the carriage by him of goods for or in connection with the business of agriculture carried on by any other person in the same locality;

and accordingly a private carrier's permit shall be sufficient to authorize any such carriage by that person.

(*d*) For the purposes of this Part of this Code, the performance of its functions by any department of Government, or a local authority, or any prescribed public authority, shall be deemed to be the carrying on of a trade or business.

V–4 to V–6 Requirement for identification of authorized trucks under permits; restriction on use of authorized trucks; duration of permits (two and three years are suggested for public and private carriers, respectively), special permits for short term or special purposes.

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V–7 (*a*) Every application for a permit under this Part shall be made to the Commissioner.

(*b*) Every application for a permit under this Part for the current period shall be made not less than three months before the date on which the applicant requires the permit to come into force.

(*c*) Every applicant for a permit under this Part shall submit, together with his application, a statement in such form as the Commissioner may provide for the purpose:

(1) Containing such particulars as may be prescribed as respects the trucks proposed to be used under the permit;

(2) Furnishing particulars of the area (hereinafter referred to as "the proposed area of operation") in which it is proposed to carry goods under the authority of the permit;

(3) Specifying the place or places, if any, outside the proposed area of operation, between, or from, or to which it is proposed to carry goods under the authority of the permit and the route or routes to be used for such carriage; and

(4) In the case of an application for a public carrier's permit, specifying the facilities for the transport of goods intended to be provided for other persons under the authority of the permit.

(*d*) Every applicant for a permit under this Part shall furnish such other information as the Commissioner may reasonably require for the purposes of the consideration of the applicant and, in particular, an applicant for a public carrier's permit shall, if so required, submit in such form as the Commissioner may provide for the purpose:

(1) Such particulars as may be so required with respect to any business as a carrier of goods for fee or reward carried on by the applicant at any time before the making of the application and of the rates charged by him;

(2) Particulars of any agreement or arrangement, affecting in any material respect the provision, within the proposed area of operation, of facilities for the transport of goods for fee or reward, entered into by the applicant with any other person by whom such facilities are provided, whether within or without the area;

(3) Particulars of any financial interest (whether as a partner or as a shareholder or as a result of any loan, guarantee or other financial transaction) which any other person providing facilities for the transport of goods for fee or reward, or controlling (either solely or in conjunction with any other person) the business of any person who provides such facilities, has in the business of the applicant, and in the case of an applicant being a company, of any right which any such person as aforesaid has to nominate any director of the company.

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V–8 Special provisions, to permit or require use of extra trucks, to modify conditions of service as outlined in permit, advertisement and holding of public hearings on changes, etc.

V–9 (*a*) The Commissioner in exercising the discretion in regard to the grant or refusal of permits under this Part shall have regard primarily to the interest of the public generally, including those of persons requiring as well as those of persons providing facilities for transport of goods; and shall, as far as may be, be guided by the following considerations of policy, that is to say:

(1) That, wherever any transportation facilities (including facilities provided by the Railway) in any area or over any route are, in the opinion of the Commissioner, satisfactory and efficient to meet at minimum charge the transportation requirements of the public within that area or along that route, it is undesirable to grant permits under this Part authorizing the carriage of goods within substantially the same area or along substantially the same route in competition with the said transportation facilities; except that as between highway carriers, fair competition should be encouraged.

V–10 (*a*) It shall be a condition of every permit under this Part:

(1) That every authorized truck shall be maintained at all times in a fit and serviceable condition;

(2) That the requirements for any written law with respect to the time for which drivers of trucks may remain continuously on duty and to their hours of work or rest and to their wages are complied with in the case of the drivers of the authorized trucks;

(3) That the provisions of any written law with respect to speed limits, tare, laden weight and loading of trucks are complied with in relation to the authorized trucks; and

(4) That the provisions of any regulation made under this Part relating to the keeping of records, the carriage of documents, and the production and inspection of such records and documents, are complied with.

(*b*) The Commissioner may attach to any permit under this Part all such conditions he may think fit to impose in the public interest and with a view to preventing uneconomic competition, including conditions requiring:

(1) That the authorized trucks shall be used only in such area or between such places as may be specified in the permit;

(2) That the authorized trucks shall not be used in such area or between such places as may be specified in the permit;

(3) That the goods carried in the authorized

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trucks shall be restricted to such classes or descriptions of goods as may be specified in the permit;

(4) That such classes or descriptions of goods as may be specified in the permit shall not be carried in the authorized trucks;

(5) That goods shall be carried in the authorized trucks only for such persons as may be specified in the permit;

(6) That the charges to be made for the carriage of goods shall not exceed or be less than such maximum or minimum charges respectively as may be specified in the permit;

(7) That the maximum laden weight of any authorized truck shall not exceed such weight as may be specified in the permit;

(8) That a speed-governor shall be fitted to any authorized truck; and

(9) That the maximum payload to be carried in each authorized truck shall not exceed such amount as may be specified in the permit.

V–11 Procedures for variation in conditions of permits; variations as to authorized trucks; revocation, cancellation, transfer, etc., of permits; etc.

V–12 (*a*) Regulations may be made with respect to all or any of the following matters:

(1) The procedure on application forms and the determination of questions in connection with the grant, variation, suspension and revocation of permits under this Part, the fees payable in respect of such applications and permits, and manner in which, whether in a lump sum or installments, such fees shall be payable.

(2) The means by which authorized trucks are to be identified, whether by plates, marks, distinctive colours or otherwise;

(3) The custody of permits under this Part, and their production, return and cancellation on expiration, suspension or revocation, and the custody, production and return of documents and plates;

(4) The notification to the Commissioner of trucks which have ceased to be used under permits;

(5) The records to be kept by holders of permits under this Part in relation to the persons employed by such holders as drivers of authorized trucks and to the times of the commencement and cessation of work by such persons and the intervals of rest taken by them, including records in relation to any such holder when acting as the driver of any authorized truck;

(6) The documents to be carried by drivers of authorized trucks and the particulars to be entered therein;

(7) The records to be kept, showing as respects every journey of an authorized truck, particulars of the journey, of the greatest weight of goods carried by the truck at any one time during the period to which the records relate and the description, points of loading and destination of the goods carried;

(8) The preservation of records so kept, the inspection of such records by any authority specified in the regulation, and the production for the purposes of inspection of such records on demand made by any such authority;

(9) The grant of exemptions either generally or in relation to particular persons or trucks from all or any of the requirements imposed by regulations made under paragraphs (5) to (8) and the circumstances in which and the conditions subject to which such exemptions may be granted.

PART VI

INSURANCE AND THIRD-PARTY RISK

VI–1 Requirement that users of motor vehicles be insured or secured against third-party risk.

VI–2 Requirements as to policies.

VI–3 Requirements as to security.

VI–4 Production of certificates of insurance or security upon application for revenue license.

VI–5 Insurance requirements and procedures.

VI–6 Corresponding requirements as to security.

VI–7 Regulations as to form of application, certificates, records.

PART VII

DRIVING LICENSES

VII–1 For the purposes of this Part, motor vehicles shall be deemed to be divided into the following classes, that is to say:

(*a*) Motor buses.

(*b*) Trucks, and, in addition, motor ambulances and motor hearses.

(*c*) Hiring cars.

(*d*) Motor cycles.

(*e*) Invalid carriages.

(*f*) Private cars, and motor vehicles not hereinbefore specified.

VII–2 (*a*) Subject to the provisions of subsection (*b*):

(1) No person shall drive a motor vehicle of any class on a highway unless he is the holder of an effective driving license which is valid for motor vehicles of that class; and

(2) No person shall employ any other person to drive a motor vehicle of any class on a

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highway unless the person so employed is the holder of an effective driving license which is valid for motor vehicles of that class.

(*b*) Conditions as to lcarner's permit, and operation of vehicle by person having such permit.

VII–3 Requirements as to application for driving license, fee, knowledge of mechanism and its operation.

VII 4 Insurance of license, duration of same (an effective period of one year is recommended, with renewal required), temporary licenses, etc.; cancellation, suspension, etc., of licenses.

VII–5 Special requirements for licenses to drive hiring cars, motor buses, trucks, with classes of licenses for several types of vehicles.

VII–6 Provision for participation in international licensing conventions; extension of reciprocity to holders of foreign licenses; tourist licenses or permits.

PART VIII

USE OF MOTOR VEHICLES ON HIGHWAYS

Speed Limits

VIII 1 (*a*) A motor bus or a truck having a tare exceeding one ton, shall not be driven:

(1) On any highway within an urban area, at a greater speed than 20 miles per hour, or

(2) On any highway outside an urban area, at a greater speed than 25 miles per hour.

(*b*) No motor vehicle having a total weight in excess of six tons, including load, shall be operated upon the public highways at a speed in excess of five miles per hour when such vehicle is equipped with iron or steel tires, nor greater than ten miles per hour when equipped with tires of hard rubber, or other similar material.

(*c*) A motor vehicle of any class or description, to which subsection (*a*) does not apply, shall not be driven:

(1) On any highway within an urban area, at a greater speed than 30 miles per hour, or

(2) On any highway outside an urban area, at a greater speed than consistent with safety of passengers and public. Any speed in excess of 40 miles per hour shall be considered unsafe unless the contrary can be proved.

(*d*) Regulations may be made, as respects all highways in any specified area or any specified highway or part of a highway, prescribing for all motor vehicles or any specified class or description of motor vehicles or any specified motor vehicles, speed limits more stringent than the limits set out in above.

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Size Limitations

VIII–2 (*a*) After ——, except as otherwise permitted hereunder, no motor vehicle shall be operated on the public highways of Burma whose over-all dimensions exceed the following:

(1) Width 8 feet.

(2) Height 12 feet.

(3) Single vehicle, length 25 feet.

(4) Tractor, semi-trailer 36 feet.

Weight Limitations

(*b*) After ——, except as otherwise permitted hereunder, no motor vehicle unit shall be operated on the public highways of Burma:

(1) Whose total weight, including load, exceeds —— tons, if a single vehicle; exceeds —— tons, if a multiple vehicle.

(2) Whose weight on any single axle, including load, exceeds —— tons.

Tire and Wheel Limitations

(*c*) After —— (the effective date of this Code), no truck, tractor, trailer, traction or hauling engine, road roller or any other motor vehicle shall operate upon or over the public highways of Burma, the fare of the wheels of which are fitted with flanges, ribs, clamps, cleats, lugs or spikes. This restriction should apply to all rings or flanges upon guiding or steering wheels on any such vehicle. In case of tractors, traction engines, road engines, or hauling engines which are equipped or provided with flanges, ribs, clamps, cleats, rings, or lugs, such shall be permitted to pass over certain highways provided that cleats are fastened upon all the wheels of such vehicles, not less than three inches wide and not more than one inch high, and so placed that not less than two cleats of each wheel shall touch the ground at all times, and the weight shall be the same on all parts of the said cleats. The foregoing regulations relating to flanges, ribs, clamps, cleats, rings or lugs shall not be applied to tractors and traction engines used solely for agricultural purposes and which do not operate upon the public highways. To meet exceptional and present cases, the following requirements shall be applied to tractors and traction engines: the guide band on the front wheels shall not be less than three inches in width, but no flanges, ribs, clamps, cleats, rings or lugs will be permitted upon the front wheels. The full set of cleats upon the rear wheels of the original design as furnished by the manufacturers with the vehicle must be used, and no rivet heads or bolt heads shall project, and the use of such tractors and traction engines for agricultural purposes shall not be allowed for hauling purposes, excepting the hauling of threshing and other agricultural equipment

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necessary for the use of the owner on his farm. This provision shall in no case relieve the owner of any tractor or traction engine from liability for damage to public roads from defective wheels or excessive loads.

(*d*) The tire of each wheel of a truck, tractor, trailer, traction engine or other motor vehicle shall be smooth, and the weight of such vehicle, including load, shall not exceed 800 lbs, per any inch of tire width.

Exceptions, Permits, Responsibility

(*e*) Motor vehicles or loads thereupon having any maximum dimensions or maximum weight in excess of those listed in subsections (*a*) or (*b*) above may secure from the Commissioner of Traffic, by proper application in writing, permission to operate over or upon the public highways under such restrictions and safeguards as the Commissioner may prescribe. The owner, driver, operator or mover of any vehicle over any public highway shall be responsible for all damages which the said highway, or any structure on any other part thereof, may sustain as a result of violation of any of the provisions of the foregoing rules, regulations and requirements. The amount of such damages shall be determined by the executive engineer in charge of the section of the road concerned and his decision should be final and binding on all the parties, and the same may be recoverable in an action of tort, against the party concerned, by the Commissioner of ——, or any PWD officer nominated by him for the purpose.

It should be specifically provided as part of the Road Rules, that any violation of any of the foregoing rules, regulations and requirements shall be punishable by a fine as established in Part XI. The amount of fine should not be confused with the sum of "Damages" payable by the party for his violation of the rules, regulations and requirements resulting in actual physical damage to the structure of the highway concerned.

VIII–3 (*a*) Regulations may be made:

(1) Declaring any specified highway outside Rangoon to be unsuitable for use by:

(i) Motor buses; or

(ii) Trucks having tare exceeding one and one half tons; or

(iii) Articulated vehicles, trailers or six-wheeled motor vehicles; or

(iv) Any other class or description of motor vehicles having a tare exceeding two and one quarter tons; and

(2) Prescribing the conditions of restrictions subject to which such motor vehicles may be used on such highway.

VIII–4 No motor vehicle shall be used on any highway unless it is in all respects in such a condition that it will not cause or be likely to cause, danger to any person in the vehicle, or on the highway, or using the highway, or to any property on or adjoining the highway.

VIII–5 Detailed regulations as to lights on motor vehicles for urban and rural use.

Rules of the Road

VIII–6 (*a*) A motor vehicle meeting or being overtaken by other traffic shall be kept to the left or near side of the road.

(*b*) A motor vehicle being overtaken by other traffic shall be driven so as to allow such other traffic to pass it.

(*c*) A motor vehicle shall not be driven so as to overtake other traffic unless the driver of the vehicle has a clear and unobstructed view of the road ahead of him.

(*d*) A motor vehicle overtaking other traffic shall be kept on the right or off side of such other traffic.

(*e*)–(*f*) Requirements as to not causing obstructions on highway; requirements for right and left turns at intersections.

General Requirements

VIII 7 (*a*) No person shall drive a motor vehicle on a highway when he is under the influence of alcohol or any drug.

(*b*) No person shall drive a motor vehicle on a highway recklessly or in a dangerous manner or at a dangerous speed.

(*c*) No person shall drive a motor vehicle on a highway negligently or without reasonable consideration for other persons using the highway.

VIII–8 Signals by driver, with illustrations.

VIII 9 to VIII 13 Regulations as to driving in reverse, use of horn, riding on outside of vehicles, number of front-seat passengers, use of motor cycles.

VIII 14 Detailed requirements as to action to be taken by driver, owner, passenger and police in case of accident.

VIII 15 Requiring that traffic directions and signals of police be obeyed.

VIII–16 (*a*) Subject to such regulations as may be made in that behalf under subsection (*b*), traffic signs and notices may be erected or exhibited on, or so as to be visible from any highway:

(1) By order of police officer not below the rank of superintendent in charge of district, for the purposes of any temporary regulation of traffic; or

(2) By order of the licensing authority of the area in which the highway is situated or, in the case of a highway in charge of the Public Works Department, by order of that Department:

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(i) For the purpose of regulating the movement of traffic or indicating the route to be followed by traffic, or for any other purpose relating to or connected with the use of motor vehicles on that highway; or

(ii) For the purpose of prohibiting, restricting or regulating traffic over any bridge, or any section of the highway which is in a dangerous condition or in course of repair, construction or reconstruction.

(*b*) Regulations may be made prescribing the size, color, type or form of traffic signs and notices, declaring the significance of such signs and notices, and restricting or regulating the erection and exhibition of such signs or notices for the purposes of this section.

VIII–17 Safety requirements as to filling of petrol tank.

VIII–18 Requirements as to stopping and parking on highways.

VIII–19 (*a*) Regulations may be made under this Code prescribing a highway code comprising such directions as may appear to the authority empowered to make such regulations to be proper for the guidance of persons using roads and including directions relating to the prohibiting, regulation and control of traffic.

(*b*) Regulations may be made under subsection (*a*) amending, varying, replacing, adding to or rescinding any of the provisions of Sections VIII–6 to VIII 18 of this Code.

VIII–20 (*a*) No person shall drive, or cause or permit any person employed by him or subject to his orders to drive any hiring car or motor coach or truck:

(1) For any continuous period of more than four and a half hours; or

(2) So that the driver has not at least ten consecutive hours for rest in any period of 24 hours calculated from the commencement of any period of driving.

(*b*) For the purposes of subsection (*a*), any two or more periods of time shall be deemed to be a continuous period, unless separated by an interval of not less than half an hour in which the driver is able to obtain rest and refreshment.

(*c*) The wages paid or payable by the owner of any hiring car or motor bus or truck to any person employed by him as the driver or the conductor thereof shall not be less than the minimum rate of wages prescribed in that behalf by regulation.

VIII–21 Prohibition against charges of excessive fares for hiring cars, buses, and prescribing methods for the recovery of such excess fares.

VIII–22 Requirements as to handling of "lost and found" property.

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VIII–23 Requirements as to offenses committed by carrying of excess passengers and of goods other than personal luggage, in hiring cars and buses.

VIII 24 Requirements as to keeping of time schedules for buses.

VIII–25 Requirements as to tickets, etc.

VIII 26 Requirements as to buses overtaking each other on highway.

VIII–27 Where the weight of goods found at any time on a truck on a highway exceeds the maximum loads specified on the revenue license for that truck, or where the distribution of the load is such as to cause danger, the driver of the truck shall, save as provided in Section XI–1, be guilty of an offense under this Code.

VIII 28 (*a*) Regulations may be made:

(1) Prohibiting, restricting or controlling the use of motor vehicles generally or any specified class or description of motor vehicles, as respects highways or the highways in any specified area or any specified highway or part of a highway;

(2) Prescribing any condition or requirement not expressly provided for in this Code, as to the construction and equipment and use of all or any specified class or description of motor vehicles;

(3) Prescribing the compulsory use of taxi meters complying with the prescribed requirements on hiring cars generally or on any specified class or description of hiring cars or on hiring cars used in any specified areas and providing for the regulation of the use and the inspection and testing of taxi meters;

(4) Prohibiting, restricting or regulating the carriage of petroleum or other fuel, acids and other explosive, dangerous, or offensive articles on motor buses;

(5) Providing for the licensing, supervision and control of conductors of buses and of ticket inspectors employed by owners of buses, for the revocation or suspension of such licenses and for the imposition and recovery of fees for such licenses;

(6) Prescribing the duties and regulating the conduct of drivers, conductors and ticket inspectors of hiring cars and buses;

(7) Prescribing the minimum educational or other qualifications required for the grant of conductors' licenses in respect of buses;

(8) Providing for endorsements to be made on such licenses on conviction of the holder thereof of any offense under this Code;

(9) Providing for the regulation and control of queues at stopping places for buses, the facilities to be provided at such stopping places and the charges to be made for the use of such facilities;

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(10) Prescribing the use of stopping places or public stands for buses and restricting the halting or stopping of buses on all highways generally or on the highways in any specified area or any specified highways or part of a highway;

(11) Providing that badges be worn by drivers and conductors of hiring cars and buses;

(12) Providing for the regulation and control of the conduct of passengers in hiring cars and buses;

(13) As respects hiring cars or buses:

(i) Authorizing the removal from such cars or buses of persons committing a breach of any provision of this Code or of any regulation by the drivers or conductors thereof or by any police officer on the request of the drivers or conductors thereof;

(ii) Requiring passengers in such cars or buses who are reasonably suspected by the drivers or conductors thereof of contravening any provision of this Code or of any regulation to give their names and addresses to a police officer or to the drivers or conductors thereof on demand;

(iii) Requiring passengers in hiring cars or buses to declare, if so requested by the drivers or conductors thereof, the journey they intend to take or have taken, and to pay the fare for the whole of such journey and to accept tickets provided therefor;

(iv) Requiring, on demand being made for the purpose by the drivers or conductors of such cars or buses or by any other person authorized by the registered owners thereof, the production during the journey and the surrender at the end of the journey by the holders thereof of tickets issued to them;

(v) Requiring passengers in such cars or buses, if so requested by the drivers or conductors thereof, to leave the cars or buses on the completion of the journey for which they have paid;

(vi) Requiring the surrender of tickets by the holders thereof on the expiration of the period for which they are issued;

(14) As respects every public stand in any specified area or any public stand:

(i) Regulating the use of the public stand and authorizing the issue of permits in that behalf;

(ii) Prescribing the fees to be charged for such permits, and the manner of disposal of the fees recovered on the issue of such permit;

(iii) Prescribing the manner in which motor vehicles may enter or leave the public stand or be placed therein;

(iv) Regulating and controlling the behavior of the drivers and conductors of motor vehicles using the public stand;

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(v) Prohibiting or restricting the cleaning or repair of motor vehicles in the public stand;

(vi) Restricting the admission or entry of persons into the public stand and regulating the behavior of persons who enter therein;

(15) Prescribing the minimum rates of the wages to be paid by the owners of hiring cars, motor buses or trucks to the drivers and conductors employed by them;

(16) Prescribing the particulars which are to be entered by the driver of a bus in the record-sheet required by Section VIII–24, and the manner in which and the intervals at which such particulars are to be entered;

(17) Prescribing the circumstances in which and the conditions subject to which, exemption from the provisions of Section VIII 24 and VIII–25 may be granted by the Commissioner in respect of any bus or hiring car;

(18) Providing that any specified provision of this Part shall not apply in the case of any truck which is for the time being used for the purposes of Union Government services.

(*b*) No regulation applicable in any area within the administrative limits of any local authority shall be made for or in respect of any matter for which that local authority may make bylaws or regulations under any other written law, except with the prior approval of the Ministry of Transport and Communications.

PART IX

EXAMINATION, INSPECTION AND TESTING OF MOTOR VEHICLES

IX–1 (*a*) For the purpose of ascertaining the mechanical condition of any motor vehicle or the condition of the tires fitted thereon, any examiner or authorized officer:

(1) May stop a motor vehicle on a highway if he has reasonable grounds for believing that the vehicle or any tire fitted thereon is not in a fit condition; and may by written order direct the driver of the vehicle to produce the vehicle for examination at any suitable place reasonably convenient to the driver and specified in the order; and

(2) May in any case where the motor vehicle has been or is suspected to have been involved in an accident, enter, test and inspect the vehicle, wherever it may be, and may for that purpose require it to be stopped or enter any premises on which the vehicle is for the time being kept or suspected to be kept;

IX–2 Power of Registrar to require inspection and examination of all vehicles, provide for hiring of garages, etc., to act as inspecting agents.

PART X

ADMINISTRATION AND PROCEDURE

Section

X–1 (*a*) There may be appointed persons to be or to act as:

(1) Commissioner of Motor Traffic, and referred to herein as Commissioner;

(2) Such deputy and assistant commissioners as may from time to time be required for the purposes of this Code;

(3) Registrar of motor vehicles, and referred to herein as Registrar;

(4) Such divisional road transport officers, certifying officers and examiners of motor vehicles as may from time to time be required for the purposes of this Code.

X–2 Subject to the provisions of this Code, the Commissioners shall be charged with the following functions and duties:

(1) The control, organization and coordination of passenger and goods transport by road;

(2) The making of recommendations to the Minister of Transport and Communications and the Transport Commissioner, with regard to the coordination of road transport with rail transport and with all other commercial transport; and

(3) The other powers, functions and duties conferred or imposed on the Commissioner by or under this Code.

PART XI

OFFENSES, PENALTIES AND PROCEEDINGS IN COURT

XI–1 (*a*) Any person:

(1) Who contravenes any provision of this Code or any regulation, or fails to comply with any order, direction, demand, requirement or notice lawfully issued, made or given under any provision of this Code or any regulation; or

(2) Who being the holder of any permit or licence granted or issued under this Code, fails to comply with any condition attached to that permit or license, as the case may be,

shall be guilty of an offense under this Code, unless he establish to the satisfaction of the court that such contravention was not due to any act, omission, commission, default or neglect on his part.

XI–2 Penalties for driving under the influence of alcohol or narcotics; recklessly or dangerously; negligently, without insurance or security; for giving false information; for fraudulent imitation of revenue licenses, registration certificates, identification plates, etc., or insurance or security certificates.

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XI–3 Penalties for contravention of the speed, size, load and weight, and wheel and tire limitations of Part VIII, Use of Motor Vehicles on Highways.

XI 4 Penalties for contravention of Part IV, Passenger Vehicle Permits and Part V, Truck Permits.

XI–5 General legal requirements and general penalty limits.

PART XII

SUPPLEMENTARY

XII–1 Definition of fees in Code, and provisions that they be collected by means of revenue stamps, cancelled by or by order of the Commissioner. Fees collected shall be credited to the General Fund.

XII–2 If by reason of an offense under this Code any injury is caused to any highway, or bridge, or to any lamp-post, stand-pipe, telegraph or telephone post or wire, or a gate at a railway crossing, or to any other fixture or equipment of any description whatsoever, affixed or erected on or about a highway and in charge of any department of Government or of any local authority, the department or authority may cause such injury to be repaired, and may either before or after the repairs are effected, recover the estimated or actual cost thereof from the owner of the motor vehicle which caused the injury.

XII–3 Power of Commissioner to decide classifications of motor vehicles, admissibility of evidence from examiner, certifying officer, road transport officer or other prescribed person.

XII–4 Powers of Minister to make regulations which shall not become effective until approved by the Parliament of the Union.

PART XIII

DEFINITIONS

XIII 1 In this Code, unless the context requires otherwise, the following definitions and interpretations shall apply:

Articulated vehicle: define trailer vehicle.

At night: from a quarter hour after sunset.

Commissioner: Commissioner of Motor Traffic.

Highway: includes every place over which the public has right of way, or to which the public or any part of the public is granted access, and every place where the motor traffic therein is regulated by a police officer.

Local Authority: any municipal council, town council or village council.

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Truck and Lorry: as generally used, and for the purposes of this Code, the words truck and lorry shall be synonymous.

Transport Commission: the regulating, co-ordinating and governing body for all forms of transport in Burma.

Urban Area: any area within the administrative limits of any local authority; or any other area declared by regulation to be an urban area for the purposes of this code.

O. COMMERCIAL TRANSPORT

Prior to World War II, commercial transport, both of passenger and goods on the highways of Burma, was of relatively small importance. Since the war, and particularly since the commencement of insurgency, highway transport has developed rapidly, notwithstanding the poor condition of road surface and structures over which the transport vehicles must travel. That commercial transport has been able to cope with bad roads and insurgency and still increase business is a demonstration of the flexibility of this mode of transportation.

The advantage of highway transport is that it can operate in areas and provide services that cannot be maintained by the railways, either because there are no railway facilities at the origin or the destination of the goods, or because the railways cannot operate with sufficient flexibility to meet changing conditions. Highway transport is certain to grow with the development of the country, and should be encouraged to do so, but it should be regulated to achieve the best over-all development of the Union transportation system.

The Civil Supplies Labor and Transport Union operates a trucking system in the Rangoon area. It is a cooperative enterprise supported by the Union under a management committee of 14 members. This organization owned 35 trucks in 1951, but that number has decreased to 16 in 1953 through obsolescence and inability to provide spare parts. Hauling service is also furnished to Pegu and Tharrawaddy.

The rates charged vary. Within Rangoon corporate limits both trip rates and commodity ton rates are used, while for hauling outside of Rangoon either ton-mile rates or a daily rental rate is charged. Typical rates are as follows:

Rangoon, Army hauling,	3-ton truck	K10 per trip
	,, ,,	K5.75 per ton
Rangoon, civil supplies	Condensed milk	K7.25 per ton
	Sugar	K7.00 ,, ,,
	Cotton yarn	K10.00 ,, ,,
	Hardware	K10.25 ,, ,,
Mingaladon, Army hauling,	3-ton truck	K23.00 per trip
	5 ,, ,,	K24.00 ,, ,,
Outside Rangoon,	per ton-mile	K0.45 ,, ,,
	3-ton truck	K45.00 per day
	5 ,, ,,	K46.00 ,, ,,

The only rate above that can be compared with Burma Railways charges is that of K0.45 per ton-mile for hauling outside of Rangoon. This is approximately three times the Railway's rate for bulk commodities on long hauls.

There are a number of private trucking operators who each own one or more trucks and run unscheduled trucking services to various towns and cities of Burma. Typical rates for these services as compared to the Rangoon Mandalay rate of Burma Railways are as follows:

RATES

Origin and Destination	*Truck K per ton-mile*	*Burma Railways K per ton-mile*
Rangoon Mandalay	0·217	0·1432 average
Rangoon Prome	0·283	—
Rangoon Pegu	0·565	—

The number of vehicles engaged in this service is understood to be:

1,227 operating between Rangoon and North Burma,
8,850 operating on various routes in Burma.

The cooperatives and private trucking firms have the advantage over Railways in their facilities for soliciting traffic and their ability to negotiate rates. They are also able to operate more freely through insurgent-held areas than can Railways. Highway transport operators are at a disadvantage in that their rates on long hauls are about 50% higher than the railway rate and probably cannot be reduced while operating under existing road conditions and with their present fleet of small-capacity trucks. To meet the competition of private trucking, Burma Railways should give consideration to establishing feeder lines by using highway transport to bring traffic to their stations from towns to which they have no lines.

P. TRANSPORT COMMISSION

The need for a transport commission to regulate rates and services on all common carriers of passengers and goods has been outlined in Chapter X. It is proposed that highway transport be subject to the regulatory activities of this body. The control of highway transport can be maintained through the device of licensing the transport facilities over specific routes, or for unscheduled service. Licensing common

carriers has been recommended as a function of the transport commission.

Q. RECOMMENDED CHANGES IN GEOMETRICS AND LOCATION

As indicated in Section C of the Report where the general features of the present route locations, alignment and geometrics are outlined, certain faults in these features were observed during the inspections of the Union and district routes. Details of the faults and recommended corrective measures are listed below. The data and recommendations are shown by routes, and on each the locations are generally outward from Rangoon. Local by-pass projects and relocations are distinguished in the list just below by italics. The major relocations are described in subsection 2, below.

These modifications are chosen to reflect current modern highway practice, and to conform reasonably to the new standards of design proposed elsewhere in this Report. The present conditions of structures and recommended repair, reconstruction and replacement are also shown elsewhere in this Report.

1. RECOMMENDED CHANGES ON UNION ROUTES

Route I (Rangoon–Mandalay, east)

Mile 50–Mile 100—From south of Pegu to approximately Pyuntaza there is occasional flooding during June–July at a number of locations. Where needed, the grades should be raised.

Daiku—A slight relocation in the main route, west of the village, is proposed.

Pyuntaza—Slight changes, at a small cost, should be made in the route alignment through the south part of town. Also, the sharp bends 3·2 miles north of town should be eliminated.

Nyaunglebin—The highway should be relocated to by-pass the town, although one crossing of the Railway is still needed. The new by-pass would be 0·9 mi. in length, compared to 1·45 for the present route. The sharp bends 1·5 mi. north of town should be eliminated.

Peinzalok—Improve the road to west of the town, by easing the curves, making other minor improvements.

Kyauktaga to north—Relocate 2·6 mi. of highway to west of railway to eliminate two grade crossings and two very abrupt bends in the alignment. The relocation will include the replacement of the existing structure over Tonkan Chaung, south of Penwegon, and a modification in the alignment of the Kungyangwa road (to the east) to provide for a combined use of the new structure.

Penwegon—The by-pass will eliminate the grade crossings in the village and three very sharp curves in the existing road.

Mile 173·5—Flatten the curve at the Railway crossing here, 3·5 mi. south of Toungoo, and another at the crossing of Kaban Chaung, 2·3 mi. south of the city.

Toungoo—Modify the alignment at the north edge of the city, to eliminate two very sharp bends.

Myohla At the crossing of the railway, in town, fix the sharp curve and increase the radius on several bad curves one mi. to the north, and another at the south edge of Yeni.

Thwatti—A minor relocation of the route in the town should be undertaken to do away with two sharp curves; and a realignment is needed at the crossing of the railway 6·5 mi. to north to eliminate a sharp left curve.

Lewe—Eliminate the sharp bend one mi. north of the village.

Mile 271—Raise the grade near Mon Chaung, to eliminate flooding.

Mile 272 Just north of the crossing of the Sinthe Chaung, 5·5 mi. south of Tatkon, there is a sharp turn which should be taken out.

Seinzabin—Eliminate the sharp double curve here, and realign the highway to eliminate the bend 0·4 mi. south of the crossing of Nawin Chaung.

Mile 312·5.—The double crossing of the railway just north of Zidaw and in Pyawbwe could be eliminated by a 2·5-mi. relocation of Route I to the west of the railway.

Mile 320–Mile 328—Flooding often occurs at several points of this section, and the grades should be raised accordingly.

Kandaung Eliminate the sharp curve 1·1 mi. south of the village, and the reverse curve 1·7 mi. to the north.

Meiktila—The proposed by-pass for Route I in this city could consist of improving an existing road from Route IV northward 0·5 mi. to Khanda, crossing the railway, and the construction of one mi. of the new road, location to pass east of Kyingon, and thence joining the location of existing Route I just to the north.

Ngathet The sharp curve 0·7 mi. north of the village should have its radius increased.

Wundwin—The alignment of Route I through the village should be bettered by a slight relocation.

North of the Shawbin Chaung at the north edge of Wundwin, there are a total of 31 bridges in a 6½-mi. length of the national highway. In ordinary practice, this would be very unusual. It is believed that some of these are drainage structures no longer effective and could thus be abandoned and no longer maintained.

Ywashe—Two sharp curves should be improved, by relocation to furnish increased radius, and an improvement can also be made at Shwedaung by a slight relocation.

Between Yetwa and Kyaukse, a distance of 7·5 mi., there are 16 bridges on Route I.

Ywatha—Improve the alignment by eliminating the sharp bend in the road in the village, close to the crossing of the Zawgyi.

Nyaungbinggyi—A relocation, to reduce the sharp curve in the roadway, is proposed.

Sizon—A 2·5-mi. relocation is recommended to elim-

inate the railroad crossing here and a second one near the Paleik railroad station.

Tagundaing A very sharp reverse curve 0·8 mi. north of the village should be eliminated by relocation.

Route II (Rangoon–Mandalay, west)

Mile 38, from Rangoon—Two sharp bends at the approaches to the bridge at Myaungtanga should be eliminated.

Mile 46 Two sharp bends at 0·4 mi. south of Taikkyi and another 0·3 mi. north should be replaced with curves of proper radii.

Okkan—Realign highway south of village to eliminate sharp bend there, and another at south edge of village.

Tharrawaddy—Route should be relocated at south edge of city, to remove sharp bend in alignment.

Letpadan Eliminate sharp bend to right.

Gyobingauk—At railway crossing 4·8 mi. south of village, the short-radius curve on the highway should be eliminated.

Pyalo—Several sharp curves, in and close to the village, should be replaced with those of longer radii.

Allanmyo—Relocate the highway to eliminate the bad double curve at the north end of town, and several curves just to north.

Leindaw—Several sharp curves and bends occur near the village, and others two mi. south of Egayit. These should be eliminated, and the curves north of Pakkon should also be improved.

Nyaungbintha—At the crossing of the Linban Chaung, a slight alignment change is needed.

Tanbinde Here, a double curve enclosing the railway crossing should be relocated to improve both alignment and sight distance.

Kyaukpadaung North of the town, the crossing of Taungzin Chaung will require a structure nearly 400 ft. in length.

Popa—The switchback in the present alignment, 1·5 mi. to the south and the bad curves the same distance to the north should be removed.

Eywa—Extensive alignment changes will be necessary in the village, 2·5 mi. to the south. It is also proposed that a relocation be planned to eliminate three sharp curves about 1·2 mi. south of Taungtha.

Taungtha—The routing and alignment through town should be improved.

Route III (Mandalay–Lashio)

Mile 51–Mile 52·5—The severe curvature condition in this 1·5 mi. of highway can be corrected by a short relocation, near Yethalaukkan, and between Miles 53·5 and 54·5 a sharp curve should be eased, and the grade changed.

Mile 70.—There needs to be a slight relocation to overcome severe curvatures.

Hsipaw, Mile 125. There are several very sharp turns on Route III in the village, and these should be eliminated.

Route IV (Meiktila–Indo-China, via Takaw)

Meiktila—In the east side of the city, the alignment of Route IV should be improved to eliminate sharp bends at the railway crossing in Tamongan and just west of the Kyeikpale station; or better still, keep the 3·5 mi. of route south of the railway and avoid both crossings and the several villages now traversed.

Mile 232–Mile 252—This stretch of roughand mountainous graveled highway extends eastward from nine mi. west of Kunghing, where the route crosses the Nam-Pang River. It should be relocated to reduce the grades and better the alignment at the time the route is improved to increase freight traffic and commercial trade with Indo-China.

Route V (Toungoo Ho-Pong)

Mile 0 Mile 30—A number of minor relocations are needed, mainly to improve curvature on the way to Mawchi.

East of Toungoo, the route crosses the Sittang River. There are very sharp curves 0·3 and 2·5 mi. east of the crossing, and these should be eased.

Loikaw–Pyinmana A connection from Route V westward to Route I at or near Pyinmana is proposed in the current highway program, and preliminary work has already been done on some portions of the project. A route proceeding eastward from Yezin (on Route I) to Pinkhwun, and there connecting to the district road extending to Pekon, from which it would proceed southward to Meng-Pai, and thence to Route V, would probably offer the best engineering location, at least cost, for this connection. It is recommended that the validity of such route, or feasible alternative, be established at once by aerial mapping and that the location and detail design be established on this basis.

Route VI (Yunnan–Assam, via Myitkyina)

Almost all of this route is that which was built during World War II, to furnish transport and supply aid to the military operations in Burma and across into China. Most streams are not bridged, the crossings being by ford only. The route is almost entirely of general mountain construction, and in any reconstructions undertaken the earthwork quantities are likely to be material.

A systematic program of planning and construction should be undertaken for the improvement of this road as a potential trade artery with Burma's neighbors. The major fords will have to be replaced with permanent crossings, the sharp curves and abrupt bends in various portions of the route should be eliminated, and the grades should be reduced to favor truck operation.

Branching northward from Route VI at Myitkyina, there is a dry-weather jeep road extending to Sumprabum and Putao. The route follows, generally, the west bank of the Irrawaddy. In view of the possible development in this portion of northern Burma, surveys and planning should be undertaken, on a limited basis, for the improvement of this road. The general location is good, but the detailed alignment and grades will have

to be much improved to raise the road to even an all-weather secondary facility.

Route VII (Mandalay–Tamu, via Shwebo)

Mile 8–Mile 9, from Mandalay—The grade on this portion of Route VII should be raised sufficiently to avoid the occasional flooding from the Irrawaddy.

Mile 96–Mile 198—Between Ye-U and Kalewa, there are many chaungs, and their crossings are often delayed by flood waters.

Mile 175–Mile 183—In this stretch between Pyinmana and Shwegyi there are three sections of hill construction which are subject to landslides. The condition should be corrected by proper treatment of the back slopes and deep cuts.

Route VIII (Payagyi–Mergui)

Kyaikhla—At the railway crossing in the village, a slight improvement in the alignment is needed, to take out the sharp bend and the two short radius curves now existing.

Mile 10·5, from Payagyi—At the Waw, improve the approach grades and alignment at the crossing of the Pegu–Sittang Canal. This work should be done when the existing one-lane Bailey bridge is replaced.

Mile 238·5–Mile 240·5—Some alignment changes are needed over this portion of the route, starting 13·5 mi. south of Ye.

Mile 338—A sharp bend in the road occurs here and should be eliminated.

Mile 355·3—A sharp bend occurs here, another occurs at Mile 360, and minor alignment changes are needed in the next 1·5 mi.

Mile 398—Starting at this point on the road, which is 77 mi. south of Tavoy, numerous alignment changes should be made in next six mi. of route, to improve curvature.

Mile 409—There are two sharp bends here which should be eliminated and numerous short relocations are needed in the six-mi. stretch starting at Mile 412·7.

Mile 421–Mile 431—In this section of Route VIII, starting 37 mi. south of Tavoy there are numerous bends and sharp curves which should be eliminated. It is estimated that a total of 2·5 mi. of relocation will be needed.

Mile 444—Tamok River. The road south of here, for a total distance of 2·5 mi., should be relocated to improve the curvature and eliminate the many angular turns on the route.

2. MAJOR RELOCATIONS ON NATIONAL ROUTES

In studying the methods that might be used to better the traffic and highway conditions on the national routes, investigations were made of several locations where the general alignment and profile were restrictive, especially to heavier vehicles. These portions should be redesigned and relocated. In other locations major by-passes should be constructed. These major relocations and by-passes are described and explained as follows:

Route II (Rangoon–Mandalay, west)

(a) **Taungdwingyi Kyaukpadaung.** In order to permit through traffic to avoid delays in passing through Magwe and Yenangyaung it is proposed that a major by-pass be constructed. This relocation, using the roadbed of the westerly portion of the abandoned rail line between Kyaukpadaung and Pyinmana, via Natmauk, will reduce the total length of Route II by 32 mi. The proposal is discussed later, under major relocations, and is shown on Plate 13.

With the present alignment at Magwe, there are several sharp bends, especially at the south end of the city. These could be eliminated if a by-pass of limited length were constructed instead of the major project just mentioned. The limited by-pass would consist of the improvement of 1·7 mi. of the district road running generally north and south, and located east of the city. With this short by-pass, the existing highway should also be improved by minor alignment changes for the ten-mi. stretch to the north of Kadaung Chaung. A major structure, 1,300 ft. in length, would be required at this chaung.

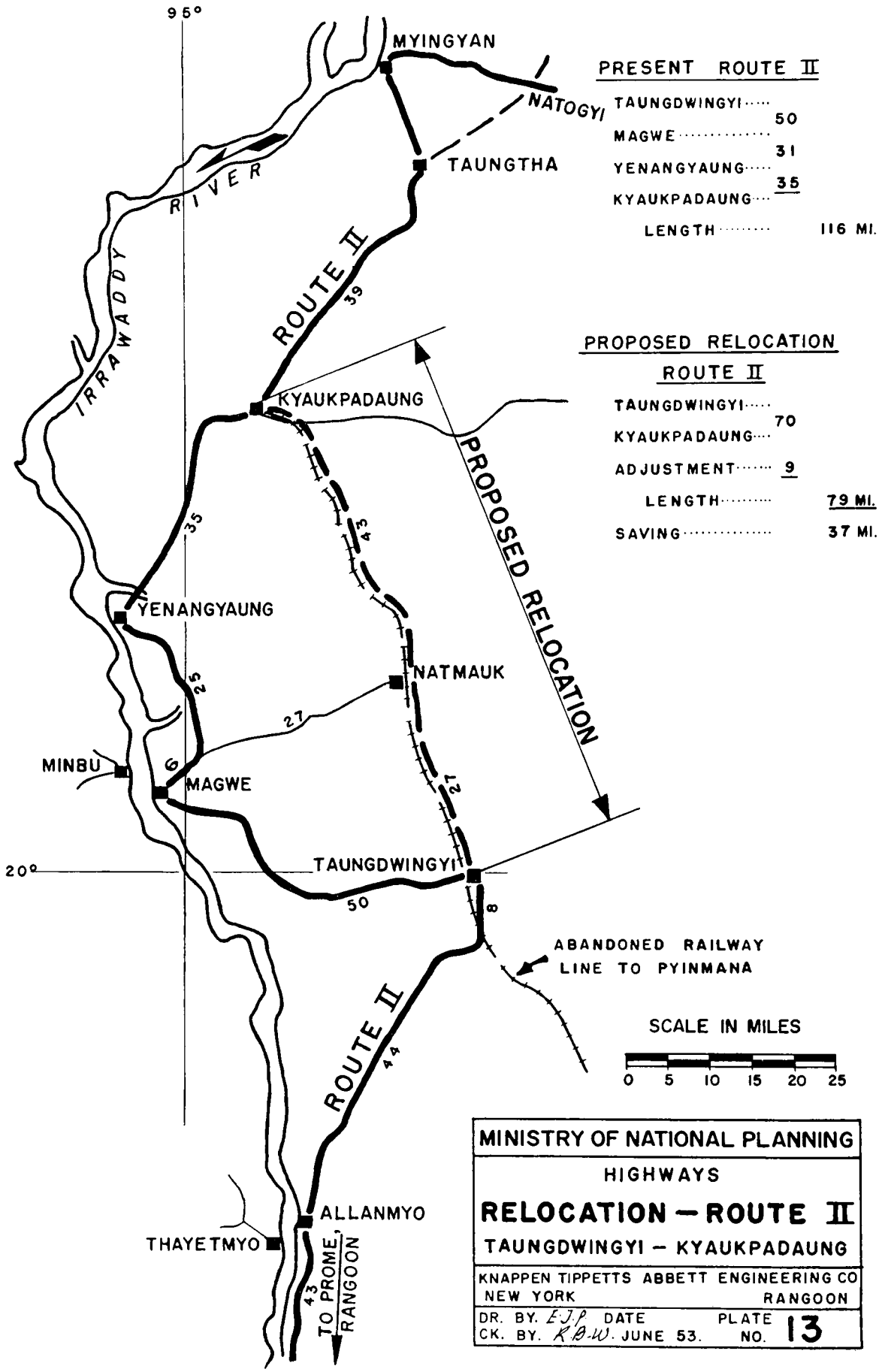
Instead of the major by-pass recommended to take through traffic out of both Magwe and Yenangyaung, it would alternatively be possible to construct a local by-pass for Yenangyaung, located about two mi. east of town. It would depart from the existing Route II about two mi. east of Nyaunghla village and proceed generally north for a distance of approximately four mi., to rejoin the existing route at Twingon village. There would be 1·3 mi. of new construction, the remaining 2·7 mi. being improvement of the line and grades of existing district and dry-weather roads.

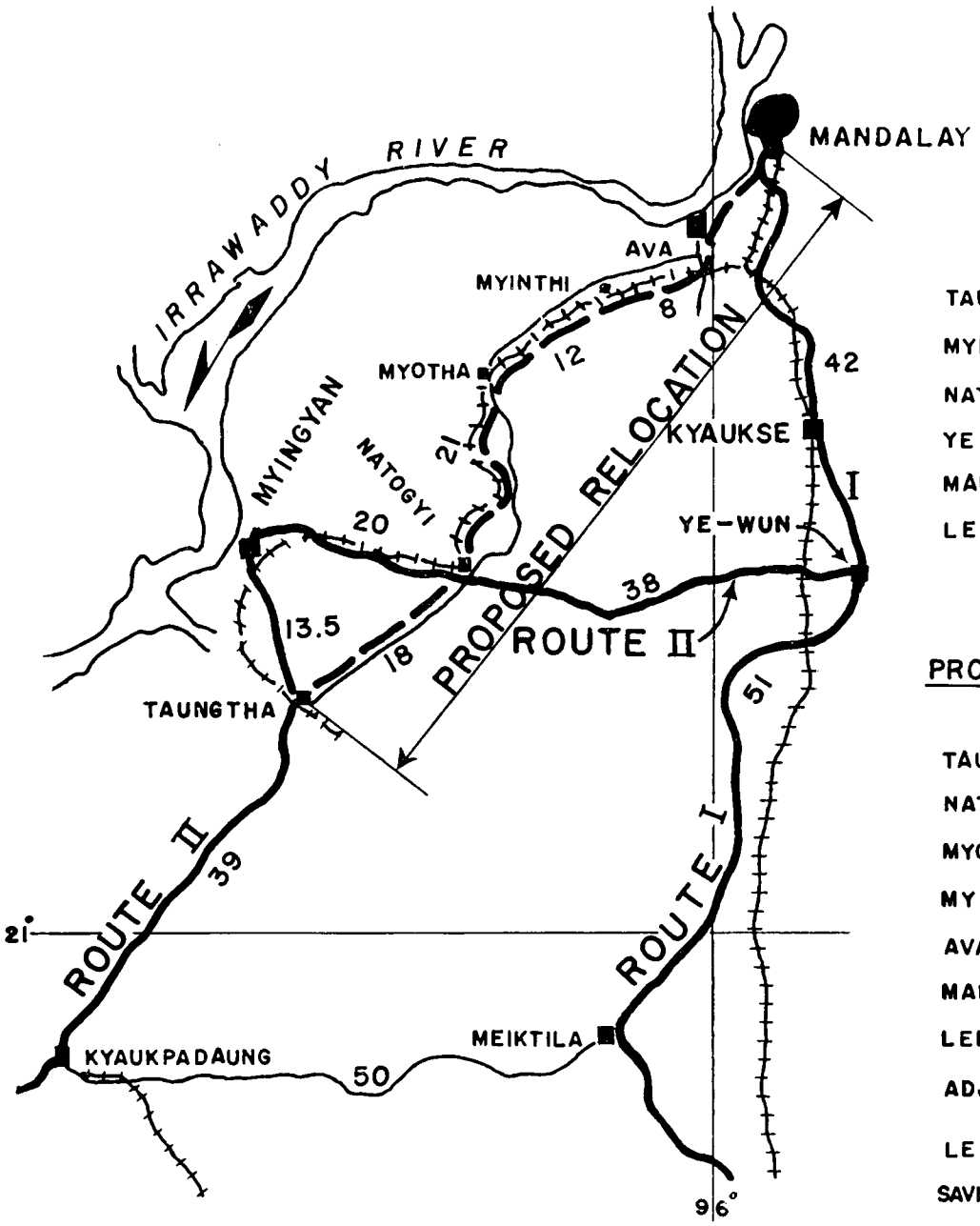
With this improvement of the route, the 750-ft. ford at the Pin River crossing near Obo would have to be replaced with a permanent structure, and the sharp curves one mi. south of Mindaung, and at Gwekyo should be eliminated. It is recommended that the major relocation shown on Plate 13 be adopted.

(b) **Taungtha–Mandalay.** Based upon similar studies in the Taungtha–Myingyan–Mandalay section of Route II, it is recommended that a second major relocation be planned and constructed on Route II to direct the through traffic from Taungtha into Mandalay without becoming involved in the local traffic in and around Myingyan. The proposal, which includes the use of 41 mi. of the abandoned Railways road bed north of Natogyi and into Ava, will save more than 26 mi. in travel to Mandalay, as compared to the present routing of Highway II, through Ye-Wun, and thence north on Route I. The relocation is shown on Plate 14.

Route III (Mandalay–Lashio)

(a) Going eastward from Mandalay on Route III, there begins at Mile 167 a very tortuous and steeply profiled road. The section climbs from an elevation of approximately 400 ft. to one of 2,450 ft. in a distance of a little more than nine mi. The grades are steep, the maximum rates being up to 20%. There are 22 switch-


95°
MYINGYAN
NATOGYI
TAUNGTHA
RIVER
IRRAWADDY
ROUTE II
39
KYAUKPADAUNG
PROPOSED RELOCATION
35
43
YENANGYAUNG
NATMAUK
25
27
MINBU
6
MAGWE
12
20°
TAUNGDWINGYI
50
8
ABANDONED RAILWAY
LINE TO PYINMANA
ROUTE II
44
ALLANMYO
THAYETMYO
43
TO PROME, RANGOON
PRESENT ROUTE II
TAUNGDWINGYI
50
MAGWE
31
YENANGYAUNG
35
KYAUKPADAUNG
LENGTH 116 MI.
PROPOSED RELOCATION
ROUTE II
TAUNGDWINGYI
70
KYAUKPADAUNG
ADJUSTMENT 9
LENGTH 79 MI.
SAVING 37 MI.
SCALE IN MILES
0 5 10 15 20 25
MINISTRY OF NATIONAL PLANNING
HIGHWAYS
RELOCATION — ROUTE II
TAUNGDWINGYI — KYAUKPADAUNG
KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK
RANGOON
DR. BY. EJP DATE
CK. BY. RBW. JUNE 53.
PLATE NO. 13



PRESENT ROUTE II

TAUNGTHA	
MYINGYAN	13.5
NATOGYI	20
YE-WUN	38
MANDALAY	42
LENGTH	113.5

PROPOSED RELOCATION ROUTE II

TAUNGTHA		
NATOGYI	18	
MYOTHA	21	
MYINTHI	12	
AVA	8	
MANDALAY	12	
LENGTH	71	
ADJUSTMENT	8	
LENGTH		79
SAVING IN LENGTH		34.5

41 MILES ON RAILWAY EMBANKMENT FROM NATOGYI TO AVA

SCALE IN MILES

0 5 10 15 20 25

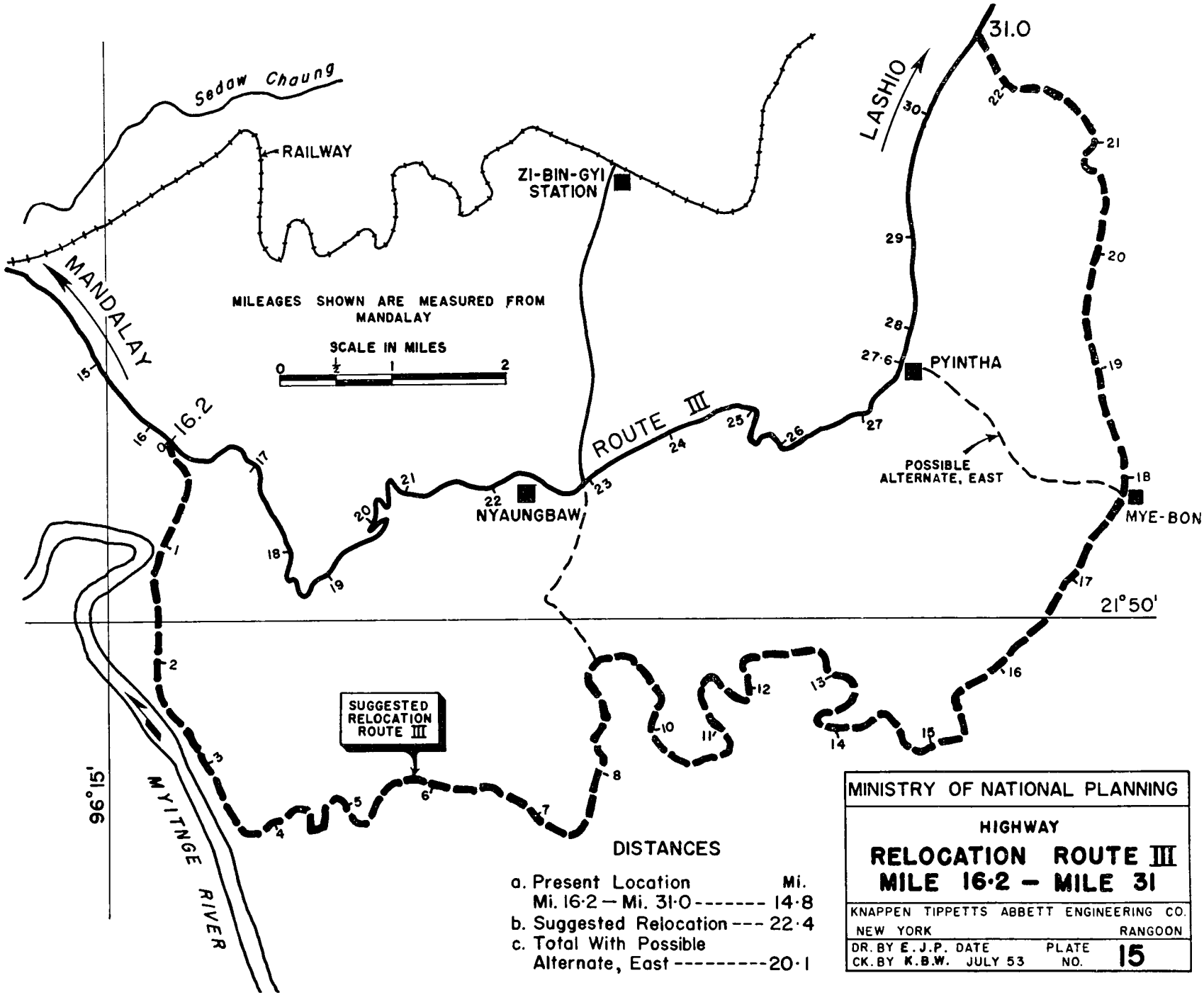
MINISTRY OF NATIONAL PLANNING

HIGHWAYS

RELOCATION, ROUTE II
TAUNGTHA - MANDALAY

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE MAY 53 PLATE NO. 14
CK. BY. K.B.W.


Sedaw Chaung
RAILWAY
ZI-BIN-GYI STATION
LASHIO
31.0
MANDALAY
16.2
MILEAGES SHOWN ARE MEASURED FROM MANDALAY
SCALE IN MILES
0 ½ 1 2
ROUTE III
PYINTHA
27·6
POSSIBLE ALTERNATE, EAST
NYAUNGBAW
MYE-BON
21°50'
96°15'
MYITNGE RIVER
SUGGESTED RELOCATION ROUTE III
DISTANCES
a. Present Location Mi.
Mi. 16·2 — Mi. 31·0 ------- 14·8
b. Suggested Relocation --- 22·4
c. Total With Possible Alternate, East ---------20·1
MINISTRY OF NATIONAL PLANNING
HIGHWAY
RELOCATION ROUTE III
MILE 16·2 — MILE 31
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON
DR. BY E.J.P. DATE
CK. BY K.B.W. JULY 53
PLATE NO. 15

backs, and with such curvatures that the process is practically continuous. As to combined profile and alignment effect, Miles 18–21 and Miles 24·5–26 are especially severe. This portion of the road as now located will always prove to be a severe, dangerous and even impossible barrier to the flow of heavy trucks under expanded traffic. The alignment should be improved, and the ruling grade should be reduced to something in the magnitude of 7%.

The major relocation shown on Plate 15 was therefore investigated. The new portion of the route extends from Mile 16·2 to Mile 31 of the existing route, a present distance of 14·8 mi. The design and adoption of this location are recommended.

(b) **Mile 80–Mile 92.** Over this 12-mi. distance of Route III, the alignment and grade conditions are very unsatisfactory at present. The road descends from an elevation of 2,800 ft. into the deep gorge of the Goteik River, and at once rises again to an elevation of about 2,500 ft. The route includes 35–36 switchback curves, which are dangerous even under good conditions. At these sharp curves, the paving has not been widened, and remains only 10–12 ft. in width. The maximum grade must be reduced, too, from the present 14–15% to a maximum of 7% to permit the use of the road by heavily loaded transport trucks.

Mile 81–Mile 83 and Mile 86–Mile 87·5 (where the present road passes close to Pangpao Station on the railway) portions are especially tortuous and unsafe.

A very rough plan for the relocation of this section has been laid down upon existing topography maps, for estimating purposes, but it is recommended that aerial surveys, at large scale, be made of the area in order that a proper and detailed study may develop the best relocation possible through this rugged terrain.

3. LOCAL IMPROVEMENT PROGRAM

As outlined in some detail in Section D, Traffic, a program of basic improvements in the Union and district highway systems within local communities should be undertaken. The planning and execution of such program should be a joint project between the planning group of the newly constituted Department of Roads and the local and district highway authorities. The development of detailed standards for the program, following the general design standards proposed in Section F of the Report, should be the basic responsibility of the planning group. The carrying out of the program will require much cooperation between the Road Department and the local authorities, to whom the concept and procedures will be new. Pilot projects should be undertaken in several of the districts of the Union early in the program to develop the techniques and procedures.

With the mechanization of the major construction and maintenance operations of the Department of Roads, as recommended elsewhere in the Report, the labor force now engaged upon hand operations can be used upon certain operations in connection with the local improvements. Additional personnel will also be required, if this work is to be carried out at the rate that is called for by the over-all program. The introduction of new methods and concepts will require that a training program be carried out, and the guidance for this will also have to come from the experienced staff of the Department of Roads.

In order to determine the scope of local improvements, studies have been made as to the extent of such work required in and around the various cities, towns and villages in all parts of the Union. The results of these preliminary studies, expressed as miles of improvements upon national routes and local streets are shown in Table XVI–22 (*see next page*) and summarized in Table XVI–23 (*see p. 456*). Studies have also been made for local improvements in district and secondary roads. These are listed in Table XVI–24 and Table XVI–25 (*p. 456*) and summarized in Table XVI–26 (*see p. 461*).

It will be noted that no recommendations have been made for a program of local improvements in Rangoon. This is a major project, and should be worked out cooperatively by the Department of Roads and the Corporation. As an initial project, however, it is recommended that the intersection of Sule Pagoda Road and Bogyoke Street be reconstructed to ease the flow of traffic and to reduce the number of traffic police necessary to control the intersection. The existing traffic circle should be eliminated and turning movements should take place in the quadrants of the intersection. Restricted crossing areas should be provided for the protection of pedestrians. Suitable traffic-control signals and directional signs will also be necessary. The existing conditions at this location are described in detail in Section D, paragraph 2–b of this chapter.

Maps for those projects which are recommended for "pilot" purposes are given on Plates 16 (Local Improvements, Pyinmana), 17 (Local Improvements, Prome), 18 (Local Improvements, Shwebo) and 19 (Local Improvements, Henzada). Further studies and similar maps should be made for each of the communities listed in the program, and this work should proceed as rapidly as funds and the availability of trained personnel permit.

It will bc noted that in Table XVI–27 (*see p. 462*), in which a budget is proposed for the first-year highway program, funds are included for local improvements in five cities on national routes (totaling 23·5 miles and with an estimated cost of 28,50,000 kyats) and in eight communities in the district road system (totaling 28·5 miles and with an estimated cost of 24,00,000 kyats).

TABLE XVI – 22

LOCAL IMPROVEMENT PROGRAM
COMMUNITIES ON UNION ROUTES

City or Town	1953 Population	Mileage to be Improved: On National Roads, In City	On National Roads, Outside	On Streets
ROUTE I				
Mandalay*	182,367	4·5	2·0	9·0
Pegu*	45,941	2·5	1·4	1·5
Toungoo*	31,180	2·0	1·1	2·1
Pyinmana	22,025	2·8	1·8	—
Meiktila*	19,474	2·0	1·1	0·5
Yamethin*	11,167	1·3	0·8	—
Pyu*	10,444	1·9	0·6	—
Kyaukse*†	8,668	1·1	0·7	—
Subtotal, cities and towns over 10,000		— 18·1	— 9·5	— 13·1
Daik-U	97‡	1·4		0·6
Hlegu	67	1·2		0·3
Kanyutkwin	55	2·0		0·6
Kyauktaga	60	0·6		0·2
Kywebwe	31	1·0		0·5
Lewe	58	0·6		0·2
Myohla	33	0·5		0·2
Myitnge	39	0·5		0·2
Nyaungchidauk	19	0·4		—
Nyaunglebin	19	0·7		0·3
Nyaungbintha	17	0·5		—
Oktwin	37	0·5		—
Payagyi	37	0·4		—
Peinzalok	37	0·8		0·2
Penwegon	55	0·6		—
Pyinbongyi	29	0·5		0·2
Pyuntaza	95	1·1		0·7
Pyawbwe	95	0·9		0·4
Shwemyo	10	0·8		0·2
Swa	15	0·7		—
Tatkon	27	0·6		0·2
Wundwin	23	0·4		0·2
Yedashe	45	1·0		0·6
Zeyawadi	70	0·6		0·2
Subtotal, cities and towns under 10,000		— 18·3		— 6·0
Total, Route I		36·4	9·5	19·1

City or Town	1953 Population	Mileage to be Improved: On National Roads, In City	On National Roads, Outside	On Streets
ROUTE II				
Prome*	36,762	2·9	1·6	2·6
Myingyan*	36,439	2·7	1·5	2·1
Insein*	28,672	1·1	—	0·8
Yenangyaung	24,430	4.2	—	2·0
Paungde	17,188	0·8	0·2	1·7
Taungdwingyi	16,248	0·9	—	0·7
Allanmyo	15,702	1·2	0·2	0·3
Letpadan	15,635	1·7	—	0·8
Thonze	14,149	0·6	—	0·4
Magwe*	12,229	2·9	0·3	1·8
Tharrawaddy*†	7,637	1·0	—	1·5
Subtotal, cities, and towns over 10,000		— 20·0	— 3·8	— 14·7
Gyobingauk	98‡	0·8	—	1·0
Hmawbi	51	1·5	—	—
Kyaukpadaung	55	1·4	—	0·6
Natoggyi	41	0·6		0·2
Nattalin	87	1·0		0·5
Shwedaung	90	1·0		2·0
Taikkyi	87	1·1		0·3
Taungtha	54	1·0		0·5
Zigon	89	0·8		0·2
Subtotal, cities and towns under 10,000		— 9·9	—	— 5·3
Total, Route II		29·2	3·8	20·0
ROUTE III				
Mandalay*	182,367	3·7	—	with I
Maymyo	21,483	1·8	0·4	0·6
Subtotal, cities and towns over 10,000		— 5·5	— 0·4	— 0·6
Hsipaw	56‡§	1·8	0·6	0·8
Lashio	64§	0·8	0·5	0·3
Hsenwi	41§	1·0	0·2	0·3
Kutkai	23§	0·5	—	0·2
Subtotal, cities and towns under 10,000		— 4·1	— 1·3	— 1·6
Total, Route III		9·6	1·7	2·2

* District capital.
† Included in list, as district capital.
‡ Population, if under 10,000 to nearest one hundred.
§ 1953 estimated from earlier years.

TABLE XVI – 22—(*continued*)

LOCAL IMPROVEMENT PROGRAM
COMMUNITIES ON UNION ROUTES

City or Town	1953 Population	Mileage to be Improved: On National Roads, In City	On National Roads, Outside	On Streets
ROUTE IV				
Meiktila*	19,474	0·4	0·2	with I
Taunggyi	14,500§	1·6	0·8	1·1
Subtotal, cities and towns over 10,000		— 2·0	— 1·0	— 1·1
Thazi	75†	1·0	0·4	0·3
Kalaw	47	1·1	0·3	0·6
Ho-Pong	21§	0·6	—	—
Loilem	28§	0·7	—	0·4
Kunhing	31§	0·4	—	0·3
Keng-Tung	70§	1·4	0·6	0·8
Subtotal, cities and towns under 10,000		— 5·2	— 1·3	— 2·4
Total, Route IV		7·2	2·3	3·5
ROUTE V				
Toungoo*	31,180	0·6	—	with I
Subtotal		— 0·6	—	
Bawlake	28†§	0·4		0·2
Loikaw	61§	0·7		0·4
Mawchi	18§	0·2		—
Subtotal, cities and towns under 10,000		— 1·3		— 0·6
Total, Route V		1·9		0·6
ROUTE VI				
Myitkyina*	12,382	2·6	0·4	0·8
Bhamo*	9,821	2·0	—	2·7
Total, Route VI		— 4·6	— 0·4	— 3·5
ROUTE VII				
Shwebo*	17,827	3·0	3·5	2·0
Sagaing*	15,382	3·0	0·2	1·3
Amarapura	11,268	1·4	—	0·6
Subtotal, cities and towns over 10,000		— 7·4	— 3·7	— 3·9
Kin-U	32†	1·0	—	0·7
Kalewa	22	0·7	—	0·9
Mogok	83	0·6	—	0·3
Tamu	17	0·4	—	—
Ye-U	53	0·7	—	0·5
Zigon	23	0·4	—	0·3
Subtotal, cities and towns under 10,000		— 3·8	—	— 2·7
Total, Route VII		11·2	3·7	6·6
ROUTE VIII				
Moulmein*‡	101,720	4·8	1·0	2·5
Tavoy*	40,066	2·5	—	1·7
Thaton*	38,211	2·3	0·6	1·5
Mergui*	33,604	1·8	0·4	0·9
Mudon	20,136	1·3	—	1·0
Kyaikto	13,174	1·5	—	0·6
Ye	12,852	1·3	0·2	0·6
Subtotal, cities and towns over 10,000		— 15·5	— 2·2	— 8·8
Bilin	52†	1·0	—	0·5
Palaw	56	0·8	—	0·4
Paung	69	2·5	—	—
Waw	70	0·9		0·4
Subtotal, cities and towns under 10,000		— 5·2		— 1·3
Total, Route VIII		20·7	2·2	10·1

* District capital.
† Population, if under 10,000, to nearest one hundred.
‡ Including Martaban.
§ 1953 estimated from earlier years.

TABLE XVI – 23

SUMMARY OF LOCAL IMPROVEMENTS ON UNION ROUTES

	Mileage to be Improved			
	On National Routes		*On Streets (miles)*	*Total (miles)*
	Inside Cities (miles)	*Outside (miles)*		
Route I	36·4	9·5	19·1	65·0
Route II	29·2	3·8	20·0	53·0
Route III	9·6	1·7	2·2	13·5
Route IV	7·2	2·3	3·5	13·0
Route V	1·9	—	0·6	2·5
Route VI	4·6	0·4	3·5	8·5
Route VII	11·2	3·7	6·6	21·5
Route VIII	20·7	2·2	10·1	33·0
Total	120·8	23·6	65·6	210·0

TABLE XVI – 24

LOCAL IMPROVEMENT PROGRAM ON DISTRICT AND SECONDARY ROADS CITIES AND TOWNS OVER 10,000†

City or Town	*1953 Population*	*Mileage*	
		On District and Secondary Roads	*On Local Streets*
Bassein*	77,382	2·3	1·5
Henzada*	60,666	2·9	2·3
Akyab*	41,589	1·9	1·3
Pakokku*	29,824	2·0	1·5
Monywa*	26,279	1·3	1·1
Myaungmya*	24,252	2·0	1·5
Chauk	23,916	1·5	1·0
Maubin*	23,442	1·8	0·6
Bogale	23,200	1·8	0·7
Kamayut	22,734	1·2	0·6
Kanbe	21,005	1·0	0·3
Wakema	19,319	1·4	0·7
Pyapon*	19,180	2·0	1·5
Thingangyun	18,129	1·6	0·8
Moulmeingyun	17,055	—	1·4
Kyaiklat	15,790	1·8	0·6
Nyaunglebin	15,557	1·1	0·4
Syriam	15,292	1·9	1·4
Yandoon	15,281	0·9	0·7
Labutta	12,982	1·0	0·6
Thayetmyo*	11,679	1·3	0·4
Myanaung	11,165	1·9	0·4
Kayan	10,906	1·9	0·2
Thongwa	10,784	1·6	0·2
Minbu*	9,093	1·5	1·3
Katha*	7,648	1·8	0·4
Kyaukpyu*	7,241	0·8	0·6
Sandoway*	5,175	0·9	0·7
Mawleik*	2,993	0·9	0·3
Total, cities and towns over 10,000 (29)		44·0	26·0
		70·0	

* District capital. † Capitals under 10,000 also listed.

TABLE XVI – 25

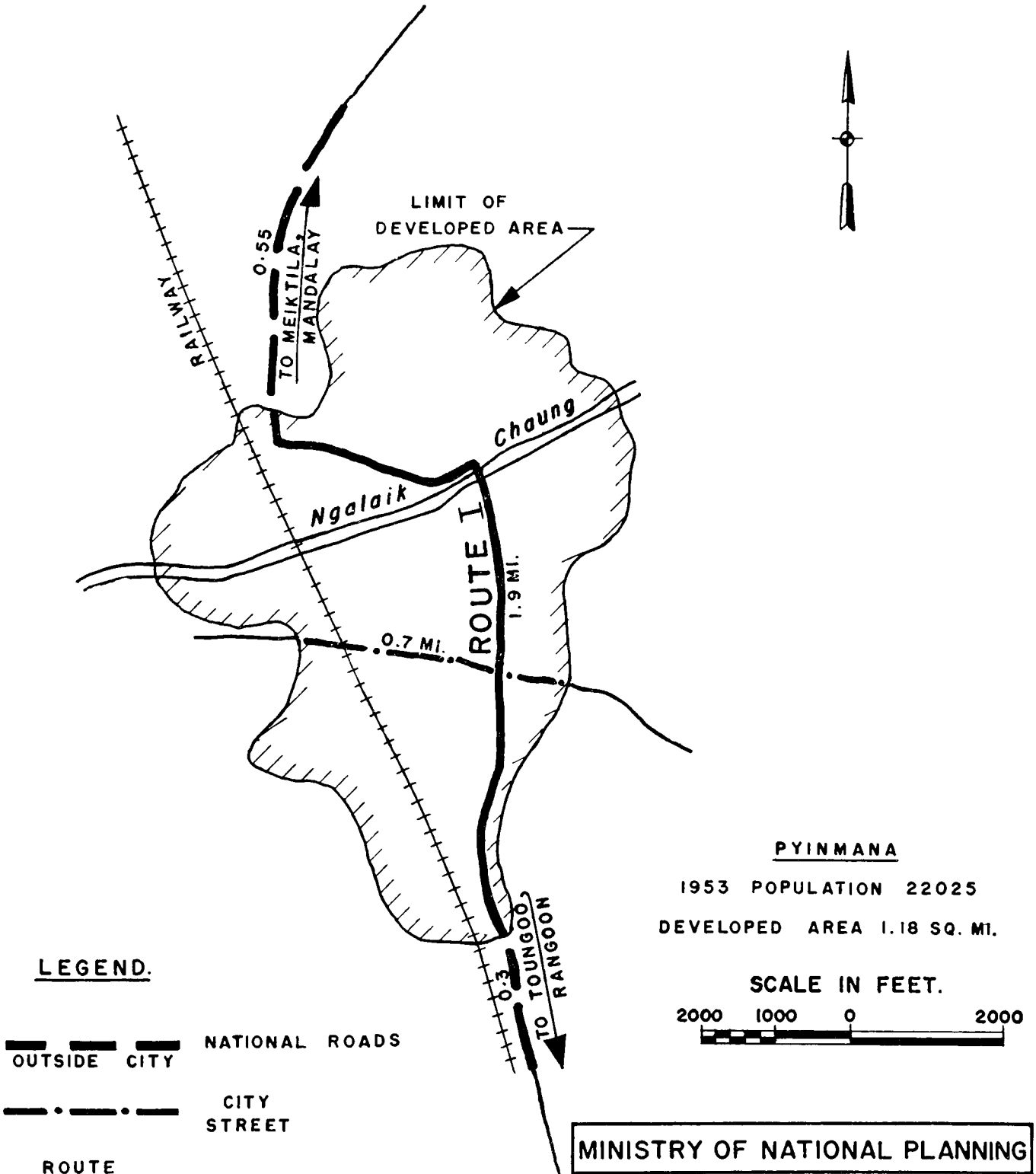
LOCAL IMPROVEMENT PROGRAM ON DISTRICT AND SECONDARY ROADS TOWNS AND VILLAGES UNDER 10,000

Town or Village	*1953 Population to Nearest Hundred*	*Mileage*	
		On District and Secondary Roads	*On Local Streets*
Amherst	60	1·0	0·6
Athok	48	0·9	0·2
Dedaye	78	1·3	0·3
Kanaung	41	1·3	0·3
Kawa	23	1·0	0·2
Kungyangon	49	1·0	—
Kyangin	60	0·6	0·3
Kyauktan	38	1·0	0·2
Kyidaunggan	40	0·9	—
Kyonmange	96	—	1·6
Kyonpyaw	53	0·7	0·3
Mahlaing	65	1·8	1·0
Minhla	47	0·6	—
Minywa	41	0·7	0·1
Mokpalin	34	1·0	0·4
Monyo	50	0·6	0·2
Myittha	42	0·8	0·6
Neikban	19	1·4	0·6
Ngathainggyaung	81	1·3	0·3
Okpo	44	0·6	0·2
Padaung	34	3·0	—
Padigon	17	0·5	—
Pagan	28	0·6	0·2
Pantanaw	47	1·0	0·2
Paukkaing	32	0·6	—
Paungdale	27	0·5	0·2
Paung-We	65	0·8	0·5
Sagu	51	1·7	0·4
Sinbaungwe	32	0·6	0·2
Tantabin	37	0·7	0·3
Thanatpin	51	0·9	0·2
Twante	69	1·5	0·1
Wettikan	21	0·4	—
Total, towns and villages under 10,000 (34)		31·9	9·8
Other towns and villages (91) 1,000–10,000		76·1	27·2
		108·0	37·0

R. GENERAL RECOMMENDATIONS

1. ORGANIZATION

As presently organized the Buildings and Roads Department of the Ministry of Public Works and Rehabilitation has two major functions: (*a*) the construction and maintenance of public buildings and governmental housing not otherwise provided for by the organizations in the several ministries and departments; and (*b*) the maintenance and construction



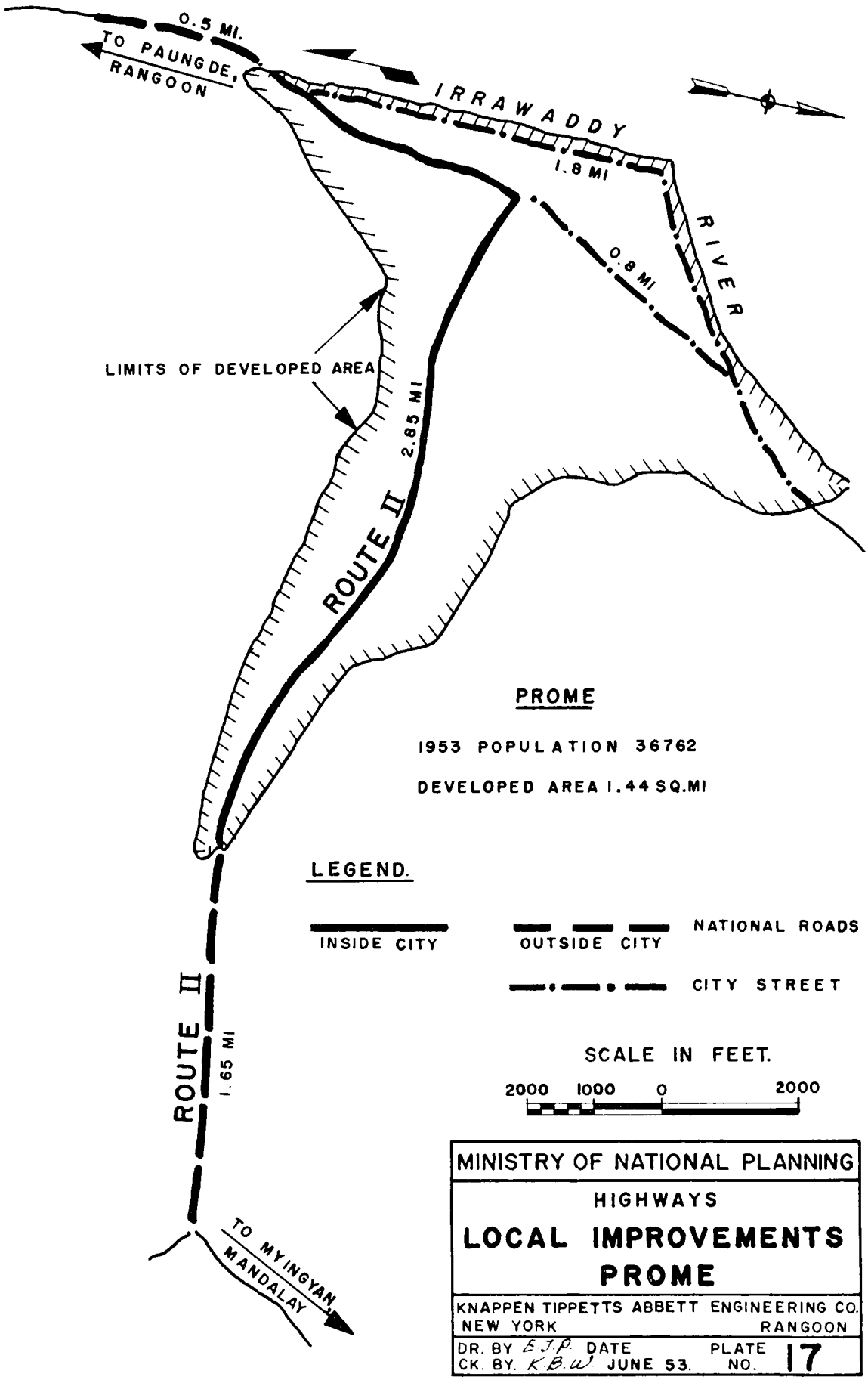
MINISTRY OF NATIONAL PLANNING

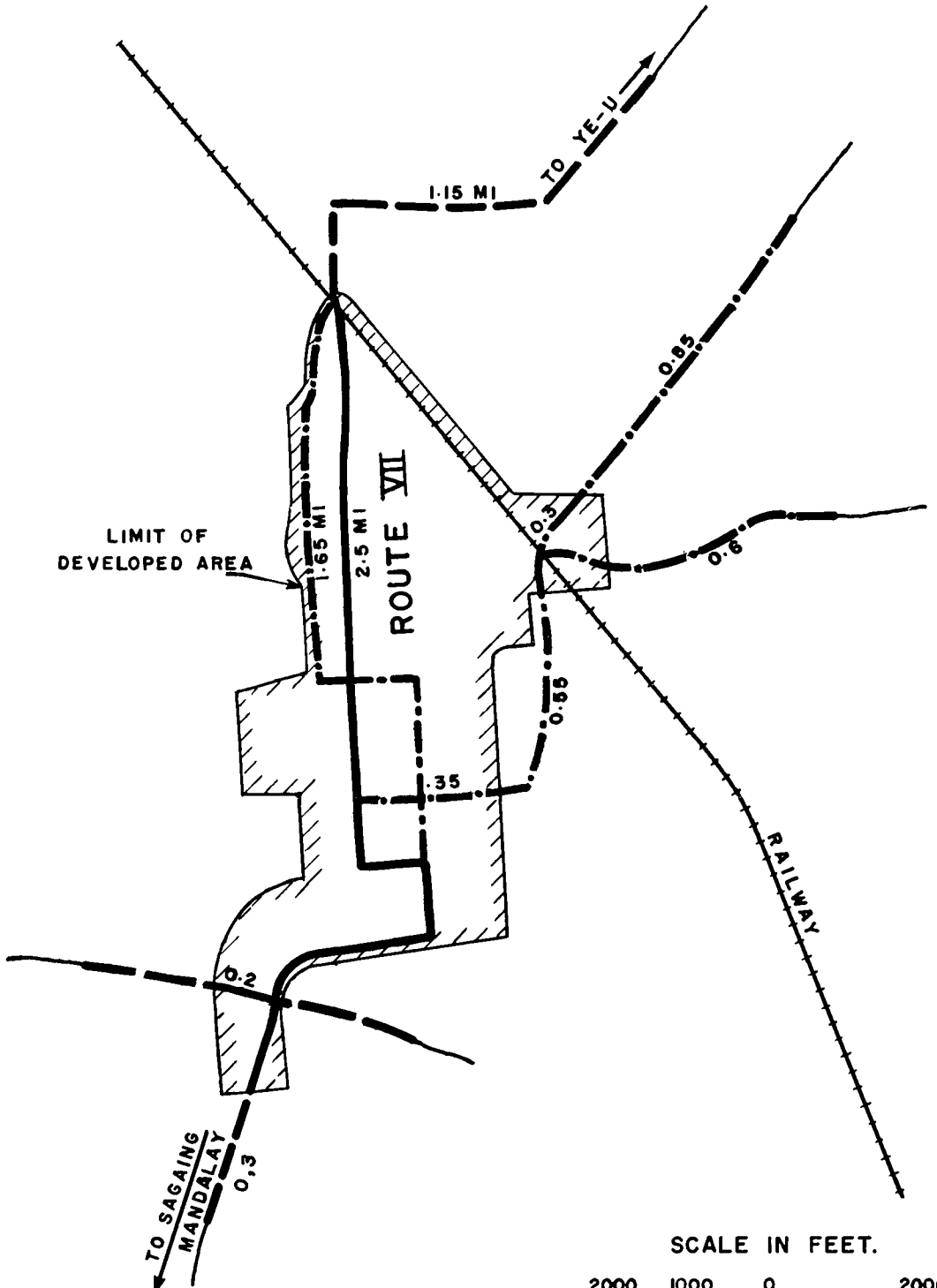
HIGHWAYS

LOCAL IMPROVEMENTS
PYINMANA

KNAPPEN TIPPETTS ABBETT ENGINEERING CO
NEW YORK RANGOON

DR. BY. E.J.P. DATE
CK. BY. K.B.W. JUNE 53.
PLATE NO. 16


0.5 MI.
TO PAUNGDE, RANGOON
IRRAWADDY
1.8 MI
RIVER
0.8 MI
LIMITS OF DEVELOPED AREA
2.85 MI
ROUTE II
PROME
1953 POPULATION 36762
DEVELOPED AREA 1.44 SQ.MI
LEGEND.
INSIDE CITY
OUTSIDE CITY
NATIONAL ROADS
CITY STREET
ROUTE II
1.65 MI
SCALE IN FEET.
2000 1000 0 2000
TO MYINGYAN, MANDALAY
MINISTRY OF NATIONAL PLANNING
HIGHWAYS
LOCAL IMPROVEMENTS
PROME
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON
DR. BY E.J.P. DATE
CK. BY. K.B.W. JUNE 53.
PLATE NO. 17



SCALE IN FEET.

2000 1000 0 2000

SHWEBO

1953 POPULATION 17827

DEVELOPED AREA — 0·86 SQ. MI.

LEGEND

INSIDE CITY — OUTSIDE CITY — NATIONAL ROADS

CITY STREET

MINISTRY OF NATIONAL PLANNING	
HIGHWAYS	
LOCAL IMPROVEMENTS SHWEBO	
KNAPPEN TIPPETTS ABBETT ENGINEERING CO. NEW YORK	RANGOON
DR. BY. E.J.P DATE JUNE, 53. CK. BY. KBW	PLATE NO. 18

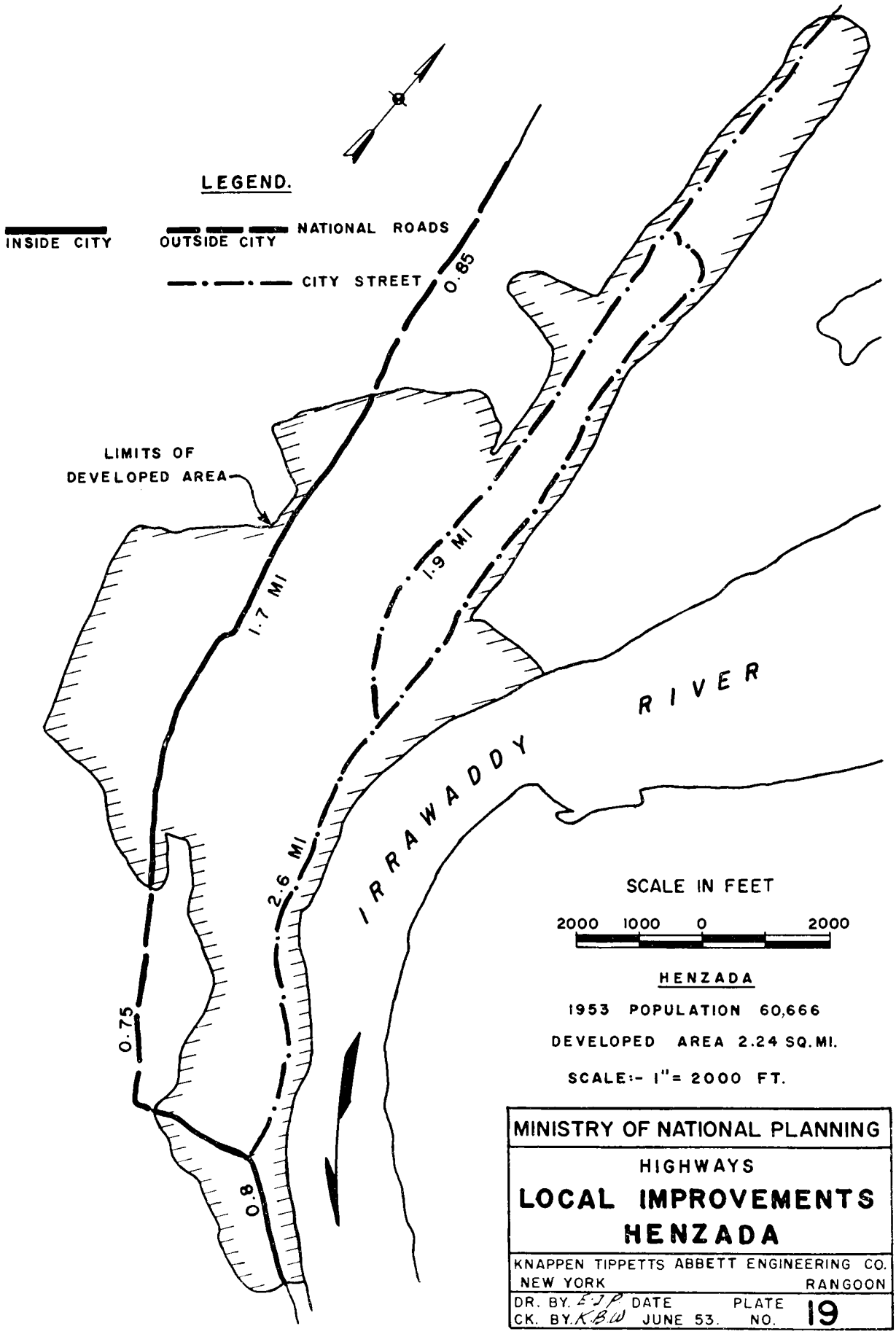

LEGEND.
INSIDE CITY
OUTSIDE CITY
NATIONAL ROADS
CITY STREET
LIMITS OF DEVELOPED AREA
0.85
1.9 MI
1.7 MI
2.6 MI
0.75
0.8
IRRAWADDY RIVER
SCALE IN FEET
2000 1000 0 2000
HENZADA
1953 POPULATION 60,666
DEVELOPED AREA 2.24 SQ.MI.
SCALE:- 1" = 2000 FT.
MINISTRY OF NATIONAL PLANNING
HIGHWAYS
LOCAL IMPROVEMENTS
HENZADA
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON
DR. BY. E.J.P. DATE
CK. BY. K.B.W. JUNE 53.
PLATE NO. 19

TABLE XVI – 26

SUMMARY OF LOCAL IMPROVEMENTS ON DISTRICT AND SECONDARY ROADS*

	No. Communities	Mileage to be Improved		
		On Distr. and Secondary Roads	On Local Streets	Total
Cities and Towns Over 10,000	29	44	26	70
Towns and Villages under 10,000	125	108	37	145
Total		152	63	215

* In addition to the 34 towns and villages with populations under 10,000, as listed in Table XVI–25, there are other towns and villages of this size for which it is not possible at the present time to make an accurate estimate of the necessary local road and street improvement needs. As the general program develops, and as detailed surveys and planning get under way throughout the Union, it will be possible to extend the local improvement program to include work in each of these communities.

These smaller communities for which plans and estimates have not been prepared at present have populations from 10,000 down to 1,000. The total number of these is 90, of which 50 have a population of 3,000 or less.

It is estimated that for the 90 towns and villages 76 miles of district and secondary roads and 27 miles of town streets should be improved.

of the Union highway system. The principal function of the Department is that of constructing and maintaining buildings and the major portion of the budget for the past several years has been devoted to these activities. Roads have received approximately 10% of the budget and comparatively little attention from the Department. As a result no significant rehabilitation program has been undertaken or planned, and maintenance forces are not organized or equipped to cope with the rapid deterioration. During the next three decades a major reconstruction of the highway system must be carried out, and the proportions of the task will require the full attention of a well-staffed organization. It is recommended that a new Department of Roads be set up in the Ministry of Public Works or in the proposed new Ministry of Engineering Services and that the existing organization continue as the Department of Buildings. It is further recommended that this Department of Roads be staffed and equipped for actively pursuing a reconstruction program along the lines previously outlined in this chapter.

2. EQUIPMENT PROCUREMENT

The task of reconstruction ahead of the Department of Roads cannot be carried out expeditiously, if at all, by the traditional practices now being used in the limited road-work activities of the Department. The program ahead must be performed using sufficient road equipment to permit progress in highway rehabilitation, construction and maintenance to keep pace with the needs of the country. This equipment should not be procured prior to a thorough analysis of the needs of the rehabilitation program and the adoption of a schedule of progress.

After this has been done the equipment should be procured to fit the projects included in the plan and to carry out the work at the rates of progress adopted. Careful planning is necessary as a first step in any construction program, particularly when new practices and procedures are to be followed as would be the case when changing from manual to mechanical methods. To make the change successfully, it is not enough that the Department be furnished with machines; they must be the right machines for the work intended.

As previously recommended, and as shown in Table XVI–27, First Year Highway Program—Budget Requirements (*see next page*), it is proposed that the initial equipment purchases include two portable rock-crushing plants and an asphalt plant, together with the necessary laying equipment. It is also recommended that the Department workshops be enlarged and modernized, since this will be necessary in order to properly service the road-construction equipment. Also, work should be started on the materials laboratory, and funds have also been alloted for this purpose.

3. EQUIPMENT POLICY

It is recommended that the Department adopt as a general policy the use of road equipment to supplant hand labor in most of the work of grading and surfacing roads and building road structures.

4. PROGRAMMING

It is further recommended that the program be planned in detail before selecting the equipment and that the Department employ experienced advisers to assist in planning the work, procuring the equipment and putting it to use. The argument has been raised that the use of equipment will replace labor to the extent of creating technological unemployment. In this situation the work ahead of the Department is of such large proportions that it will use all present employees and many more for a considerable period of time. The general aspects of technological unemployment have been discussed in Chapter II.

5. UNION ROAD SYSTEM

It is recommended that work on the Union road system numbered routes be undertaken as promptly as possible by beginning with specific project planning

TABLE XVI – 27

FIRST YEAR HIGHWAY PROGRAM—BUDGET REQUIREMENTS

(all costs in (000) K)

	Total Program	*Miles*	*Total Costs*	*Local Costs*	*Foreign Costs*
General Projects	1,25,00		32,65	10,75	21,90
(*a*) Surveys—aggregate sources, soils stabilization, aerial surveys, traffic studies, etc.			7,25	3,95	3,30
(*b*) Planning			3,60	2,40	1,20
(*c*) Materials Testing Laboratory			50	40	10
(*d*) PWD Work Shops—enlargement and modernization			1,25	70	55
(*e*) Portable rock-crushing plants (2)			9,05	2,80	6,25
(*f*) Asphalt plant and laying equipment			11,00	50	10,50
Union Road System (3,135 mi.)	27,00,00		1,11,50	77,50	34,00
(*a*) Routes I and II rehabilitation and relocations		45	70,00	50,00	20,00
(*b*) Route III relocations		6	8,00	5,50	2,50
(*c*) Local improvements, 5 cities		23·5	28,50	20,00	8,50
(*d*) Patrol graders		—	5,00	2,00	3,00
		Say 75			
District Road System (6,750 mi.)	28,70,00		68,40	52,00	16,40
(*a*) Mandalay Division		45	18,00	14,40	3,60
(*b*) Magwe Division		30	11,90	9,10	2,80
(*c*) Pegu Division		40	14,50	10,50	4,00
(*d*) Local improvements, 8 cities		28·5	24,00	18,00	6,00
		Say 145			
Farm-to-market Roads (3,650 mi.)	20,00,00		90,00	75,00	15,00
(*a*) Grading, drainage		300	80,00	71,00	9,00
(*b*) Structures		—	10,00	4,00	6,00
Other Roads	5,00,00		30,00	25,50	4,50
(*a*) Loikaw–Pyinmana		50	15,00	12,75	2,25
(*b*) Access to Lough Keng Project		25	5,00	4,25	75
(*c*) ,, ,, Pegu Project, Dam Sites (3)		40	10,00	8,50	1,50
Total, 1953–54 Program			3,32,55	2,46,45	86,10
Total, Entire Program	81,95,00				

for the routes outlined in Table XVI–27 "First Year Highway Program—Budget Requirements." The initial work should include the rehabilitation and rebuilding where necessary of drainage structures, the rehabilitation of shoulders, and the widening of the paved surface, all to the standards outlined in Section F. This program should be extended from year to year until the full length of the 3,231 miles of numbered routes has been rebuilt. The yearly program must take cognizance of traffic requirements, and the work should be performed on the portions of the routes where traffic demands are the greatest. In Section Q, certain relocations are recommended which must be surveyed and estimated before making a decision as to whether to rehabilitate the existing road or to construct the new one.

6. DISTRICT ROAD SYSTEM

It is recommended that work on the district roads be undertaken as outlined and budgeted in Table

XVI–27. Rehabilitation should be performed to the standards outlined in Section F. Surveys must be made and planning for this work completed before any construction is undertaken. The total length of district roads is estimated to be 6,750 miles. This program should be continued from year to year to the ultimate completion. District roads are not subject to the traffic of those of the Union system; consequently are not as substantially surfaced. The traffic-bound surface will require well-organized maintenance after the newly built road has been put into operation or deterioration will occur.

7. FARM-TO-MARKET ROAD SYSTEM

The program for the first year for the entire system is shown in Table XVI–27. It is recommended that a planning program for the rebuilding of existing farm-to-market roads and the construction of new roads of this type be undertaken. These roads can be built with a relatively small amount of equipment, and progress in grading will be rapid under the supervision of an experienced grading foreman. The standards recommended are shown in Section F. Farm-to-market roads will be required in the irrigated areas, and should be planned in connection with the irrigation distribution system. The total length of this type of road estimated to be required is 3,650 miles and it is proposed that the initial construction total 300 miles, as budgeted in Table XVI–27. The maintenance of these roads could be arranged to be provided by the cultivators served, if surfacing rock is stockpiled at intervals along the roads and patrol graders are furnished periodically.

8. LOCAL IMPROVEMENT PROGRAM

As recommended in Section Q, a program of local improvements has been developed, after preliminary study, for cities, towns and villages on the national routes and the district routes. The details are listed in Tables XVI–22 to XVI–26, and the budgetary requirements for the first year are included in the totals on Table XVI–27.

9. ACCESS ROADS

Other roads will have to be constructed in conjunction with new development work, such as access to project sites, mines and sources of raw materials in the forests and other locations. These will all involve new locations and construction. The tentative estimate of the required length of these roads is 1,400 miles. Most of them will be planned as a part of the project to which they give access, but will later be incorporated into the highway system. It is recommended that these highways which are to serve specific projects be planned jointly by the Department of Roads and the agency concerned with the project, and that during the construction of the project they be maintained by project forces. Upon project completion, maintenance and administration should be turned over to the Department of Roads. The standard to which they must be built will depend on the hauling anticipated during the project construction.

10. CONSTRUCTION METHODS

As recommended in Section G, studies should be undertaken to adopt the "road mix" and "plant mix" methods of modern highway construction to use in the Union of Burma. "Road mix" techniques are of special value in the construction of roads for low-density traffic.

11. MOTOR VEHICLE CODE

It is recommended that a Motor Vehicle Code following the general outline given in Section N be adopted.

12. SHOPS AND YARDS

It is recommended that the Department of Roads establish equipment yards and shops for the storage, repair and overhaul of construction and maintenance equipment, and that it modernize the existing facilities. The first shop should be established at Rangoon, and as the work program develops shops should be established at the district headquarters. The shops should be laid out by an equipment man experienced in handling and repairing road equipment.

13. CONTRACTS AND TRAINING

It is recommended that the initial construction contracts for the road program be awarded to foreign contractors experienced in highway construction. The contracts should contain specific provisions for training local superintendents, supervisors and equipment operators in the use and repair of highway equipment and in construction organization and procedures for road construction. Local contractors should be employed on subcontracts on the program, that they may become familiar with modern road construction methods and, as the program progresses, gain experience to enable them to carry on the larger contracts. The contract should provide for the submission and approval of specific training programs and schedules affording specific hours and methods of instruction for specified categories and numbers of personnel.

14. BUDGET REQUIREMENTS

The cost estimates for the recommended program of highway construction and rehabilitation have been summarized for the entire project, and developed in detail for the first year of the program. The totals, and items upon which early work should be undertaken, are shown in Table XVI–27.

While the program may have to be modified from year to year, as the overall economy and industrial potential of the Union develop, it is believed to be balanced.

Measured in terms of previous development of highways in Burma, this is an ambitious program. It is, however, one which is necessary if highway transport is to take its proper place beside rail, air and water.

CHAPTER XVII

AIRWAYS

A. INTRODUCTION

1. GENERAL

A farm-to-market country road will not satisfy express highway motor-freight traffic requirements. A cow-pasture landing strip will not support aircraft designed today for commercial passenger and freight traffic. The traveling public is as much, if not more, concerned in safe takeoff and landing as in safety of the aircraft in travel. The degree of acceptance of air travel is closely related to the appearance of the airstrip, airfield and facilities. The safe operation of aircraft is directly dependent upon the characteristics of many designs. For this reason, the International Civil Aviation Organization was set up by the United Nations to establish safe criteria for airports and aircraft maintenance and operation. The ICAO has established its minimal standards called "Recommendations for the Safe Design of Airports," basing these recommendations on the all-up weight and single wheel-load of aircraft. To achieve acceptably efficient and safe performance, the operations of Civil Air Transport by the Union of Burma Airways (UBA), and controls and designs by the Office of the Director of Civil Aviation (DCA) should comply with the recommendations of the ICAO.

2. PURPOSE AND SCOPE

This Report is concerned not only with the safe design of airports, but with the safe and economic operation of aircraft; the economic transportation of passengers and air freight, both air and land-borne; the accommodation of the traffic demand; and the development of the entire system of foreign and domestic airways serving Burma.

3. BACKGROUND INFORMATION

The following basic information will be helpful prior to discussing the structure and operations of Burma Airways:

(*a*) The Union of Burma Airways, hereafter referred to as the UBA, is the operating body of civil aviation in Burma.

(*b*) Internal civil aviation is a complete government monopoly.

(*c*) UBA has had sole control at all times of its freight and passenger rates, of its scheduling and operations, and of its routing.

(*d*) UBA chartered planes, not having aircraft to meet the need for service in the years ending October 1, 1949 and 1950, and was forced to pay the astounding sum in charter fees of 240 lakhs of Kyats. Had the chartered aircraft been available and been purchased, the fleet, even after depreciation, would be a very large asset today.

(*e*) UBA has had from its first operations the advice and guidance of technical experts of good repute.

Independence of the Union of Burma on January 4, 1948, found the new Government faced with many problems, among which communications and transport were of major importance. During the war all seaports had been mined at their entrances. Most of the important highway and railroad bridges had been destroyed, and the actual roadbeds devastated for great stretches. Air transport necessarily became of vital importance, and the airports and adjacent towns were made strongpoints by the Government. The airports have thus served both military and civil aviation, and continue to do so.

Civil Air Transport, UBA, has been privileged in this role and has materially benefited therefrom. Statements have been made that upon the complete cessation of hostilities Civil Aviation will fail. This has not been true in any other country, and should not be true in Burma. The natural mountain ranges lying nearly due north and south are an impediment to other than air travel east and west. In addition, a fast means of handling passenger and freight traffic the length of the country will always be in demand.

That civil aviation in Burma should be operated to throw the full cost upon the user is not entirely equitable, as the benefits of operation are both political and social; for example, the benefits of mail and express are shared by the entire country. The various ministries and district officials have been the UBA's best sources of revenue, so that not all the cost has been thrown directly upon the general public. That UBA expands into every district is desirable both for the solidarity of the Union and to meet economic needs.

The Director of Civil Aviation plans at least a temporary terminal at every airport, to be followed by permanent construction after cessation of active insurgency.

4. HISTORY AND ORGANIZATION

The Union of Burma Airways Board was originally constituted on March 23, 1948, and was reorganized on March 29, 1950. The Board was charged with the following duties:

(*a*) To provide rapid communication within Burma, and externally to adjacent countries.

(*b*) To speed the carriage of mails, essential supplies and urgent freight.

(*c*) To foster airmindedness.

(*d*) To develop a national air transport organization for both domestic and foreign operations.

Governmental administration of the Union of Burma Airways Board is under the Ministry of Transport and Communications. The Board's present composition is as follows:

Chairman.
General Manager.
Secretary, Ministry of Transport and Communications.
Secretary, Ministry of Finance and Revenue.
Director of Civil Aviation.

The first two are the operations chiefs of UBA who control the airline, the shops, the terminals, passenger and freight handling, transport to terminals from airports, rate fixing, accounting and fiscal and statistical matters. The fifth, the DCA, has no actual operations responsibility of or for the Union of Burma Airways.

The office of the DCA is a technical and administrative group responsible for the establishment and maintenance of the airports of Burma; the establishment of technical criteria for the loading, maintenance and operation of nonmilitary aircraft over and in Burma; the licensing of aircraft, pilots and aircraft mechanics and supervisors; the operation of the communication system for aircraft controls and signals; and the investigation of all nonmilitary aircraft accidents. The Meteorological Bureau supplies weather data for flight control and records of wind directions throughout Burma for use in orientation of new airstrips. The DCA, through contracts with the Public Works Departments of the various districts and with the Buildings and Roads Department, has programmed the continuous improvement and expansion of airports and their facilities.

Construction of the international airport and terminal facilities for Mingaladon at Rangoon is being accomplished by the Mingaladon Aerodrome Construction Committee under the direct supervision of the Ministry of Transport and Communications. The airstrip is newly completed and is serviceable for the largest transcontinental planes. It has attracted considerable new traffic from international airlines. The UBA operates a bus and freight service from its main terminal building in Rangoon to the airport.

The UBA and the international airlines contract the fueling of the planes to the Burmah Oil Corporation. The UBA maintains its own aircraft, handles all its bookings and freight shipments, and has responsible charge of all domestic and its own foreign service. The foreign service operates a total of ten flights weekly to Calcutta, Chittagong, Bangkok, Penang and Singapore.

B. INTERNATIONAL SERVICE

1. NEW CONSTRUCTION

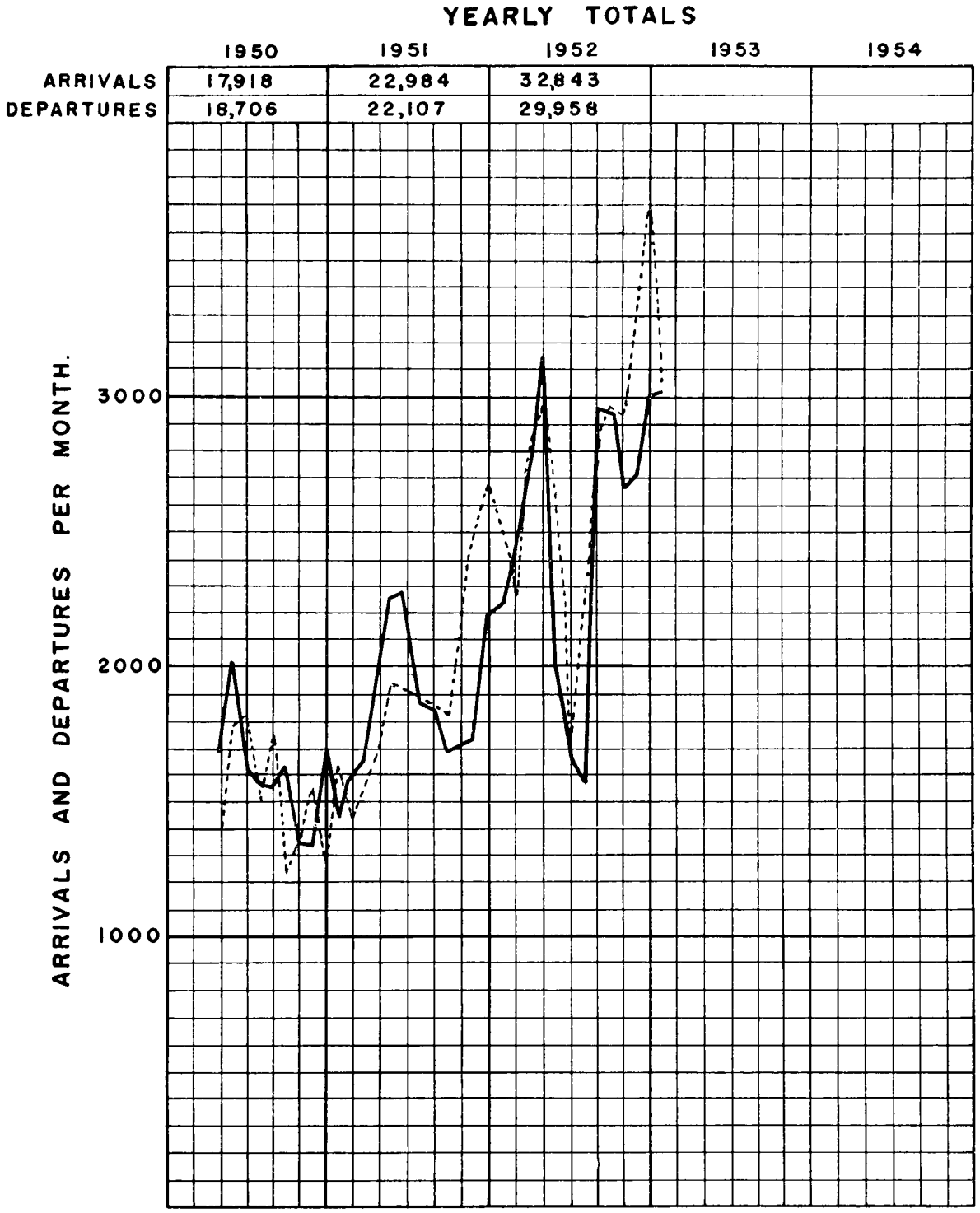
The enabling laws creating and reorganizing airways operations in Burma stressed the requirement that international service be established and fostered. Accordingly, Mingaladon Airport at Rangoon has been reconstructed with a new main airstrip of concrete, 8,200 ft. by 200 ft., and an adjacent parallel taxiway, 8,200 ft. by 100 ft., also of concrete. A new airport operations building is now under construction. It is to be fully air-conditioned and is of the latest design. International air service is also flown to Mergui and Akyab, but only by UBA. These two airports are under reconstruction and new operations buildings are planned for immediate construction.

2. PRESENT OPERATIONS

The following is the list of airlines furnishing international service to and from Burma. The first four listed are world airline services while the second four are confined to Asian service only.

	Operations Weekly
1. British Overseas Airways Corporation (BOAC)	9
2. Royal Dutch Airlines (KLM)	6
3. Pan American World Airways Incorporated (PAA)	2
4. Scandinavian Airlines System (SAS)	2
5. Union of Burma Airways (UBA)	10
6. Indian National Airways Limited (INA)	7
7. Thai Airways Company, Limited (THAI)	4
8. Orient Airways Limited (ORIENT)	3

Forty-three flights weekly into and out of Burma provide fast mail, passenger and freight service to nearby countries as well as round the world. BOAC is now operating a Comet jet-liner service which permits a passenger to depart at 12.45 on Saturdays from Rangoon, rest 12 hours at London Airport Sunday, and then, via its Monarch Service stratocruiser, arrive at 9 a.m. Monday in New York City. However, KLM,



LEGEND

ARRIVALS SHOWN - - - - - - - -

DEPARTURES SHOWN ————

MINISTRY OF NATIONAL PLANNING

MONTHLY INTERNATIONAL AIR PASSENGER TRAFFIC BURMA.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. E.P.T. MAY, 53. NO. 1

without the use of jet liners, furnishes three flights easterly and westerly from Rangoon weekly, departing westerly at 11, 10 and 8.30 a.m., permitting six- to eight-hour rests at Amsterdam the following day, and arriving at noon in New York City the second day after departure. PAA have three flights weekly each way through the Far East, flying from New York City around the world to San Francisco in six days, and from San Francisco to New York City around the world in seven days because of international date-line time change. One flight per week each way calls at Rangoon and two flights overfly. When the service demands warrant, these over-flights will stop at Rangoon. Plate 1, showing monthly air passenger traffic through customs service from May 1950 through February 1953, indicates a steady growth of international air passenger traffic.

The UBA has recently acquired three Marathon Mark I aircraft primarily for international service. These planes make ten flights weekly. On Tuesdays and Fridays they fly a round trip from Rangoon to Bangkok, Thailand. Round-trip flights are made on Monday, Wednesday and Saturday from Rangoon via Akyab to Chittagong, East Pakistan. Round-trip flights from Rangoon via Akyab to Calcutta, India, are made on Tuesday, Thursday, Friday and Saturday. On Wednesday UBA has a flight to Singapore via Mergui and Penang which returns via these stops on Thursday.

3. SERVICE DELAYS

Delays in clearance of air freight may be attributed to dilatory handling of individual clearances by airways agents and to changes from scheduled flight departures. This sometimes results in freight being allowed to lie at intermediate terminals for as long as 12 days. This last condition applies to air mail as well to air freight and, although London is but 36 hours and New York 48 hours by air travel, mail takes 7 to 12 days. The Rangoon Post Office closes its air pouches to reception of air mail as much as 48 hours before departure time, while Mingaladon Airport is but 25 minutes driving time from the central Post Office. Also, air mail deposited in Mingaladon is returned to the central Post Office before being loaded aboard aircraft.

4. RECOMMENDATIONS

It is recommended that:

(*a*) The airlines establish an agency to prepare the necessary papers to clear air freight through customs. This service should be free to their air freight customers.

(*b*) Additional air freight and air mail franchises be granted to permit expeditious handling to and from all parts of the world.

(*c*) The Rangoon Post Office close its air pouches not sooner than two hours before departure time.

TABLE XVII – 1

POTENTIAL SUPPORT, VARIOUS BURMA DISTRICTS JUNE 6, 1948

District	*Division*	*Total Area Division (sq. mi.)*	*Area of District (sq. mi.)*	*1948 Acres in Cultivation in 1,000 Acres*
Akyab	Arakan	17,422	5,252	723
Arakan Hills Tract			3,228	456
Kyaukpyu			4,793	9
Sandoway			4,149	163
Rangoon	Pegu	20,221	85	27
Pegu			4,114	697
Tharrawaddy			2,782	576
Hanthawaddy			1,927	701
Insein			1,903	430
Prome			2,953	388
Toungoo			6,457	403
Bassein	Irrawaddy	13,580	4,149	754
Henzada			2,809	659
Maungmya			2,835	592
Maubin			1,642	410
Pyapon			2,145	433
Salween	Tenasserim	31,588	2,577	27
Thaton			4,872	691
Amherst			7,410	553
Tavoy			5,404	146
Mergui			11,325	169
Thayetmyo	Magwe	27,977	4,626	192
Minbu			3,602	263
Magwe			3,724	566
Pakokku			5,350	551
Chin Hills			10,675	NA
Mandalay	Mandalay	12,494	2,113	178
Kyaukse			1,241	194
Meiktila			2,232	488
Myingyan			2,707	687
Yamethin			4,201	416
Bhamo	Sagaing	72,911	4,180	23
Myitkyina			29,723	71
Shwebo			7,605	626
Sagaing			1,870	572
Katha			5,723	165
Upper Chindwin			10,599	114
Lower Chindwin			3,673	584
Naga Hills			9,535	NA
Northern Shan Sts.	Federated Shan Sts.	65,596	24,682	NA
Southern Shan Sts.			36,408	NA
Karenni States			4,506	NA
Total		261,789		

NA—Not available.

TABLE XVII – 2

UNION OF BURMA AIRWAYS

TIME TABLE

(Effective Wednesday, February 4, 1953)

DOMESTIC SCHEDULE SERVICES

DAKOTA (Free Baggage: Domestic 44 lbs.) DEP.: MINGALADON		*DOVE (Free Baggage: 25 lbs.)* DEP.: MINGALADON	
Monday			
1. Mandalay Bhamo–Myitkyina–Bhamo Mandalay	0600	1. Bassein	0700
2. Sandoway–Kyaukpyu Akyab–Kyaukpyu–Sandoway	0645	2. Henzada	0705
3. Moulmein	0715	3. Myaungmya	0915
4. Mandalay	1000	4. Bassein	1130
5. Tavoy Mergui–Tavoy	1015		
Tuesday			
1. Pakokku–Gangaw–Pakokku–Monywa–Mandalay	0630	1. Bassein	0700
2. Magwe Lanywa–Meiktila–Mandalay–Meiktila–Lanywa–Magwe	0645	2. Myaungmya	0915
3. Moulmein	0715	3. Bassein	1130
4. Loikaw–Heho Mandalay–Heho–Loikaw	0730		
5. Mandalay–Anisakan–Mandalay	1000		
Wednesday			
1. Sandoway–Kyaukpyu–Akyab–Kyaukpyu–Sandoway	0645	1. Bassein	0700
2. Mandalay–Lashio–Mandalay–Monywa–Mandalay	0710	2. Henzada	0705
3. Moulmein–Tavoy–Mergui–Tavoy–Moulmein	0730	3. Thayetmyo–Magwe–Thayetmyo	0900
4. Mandalay	1000	4. Myaungmya	0915
		5. Bassein	1130
		6. Moulmein	1400
Thursday			
1. Mandalay–Bhamo–Myitkyina–Putao–Myitkyina–Bhamo–Mandalay	0600	1. Bassein	0700
2. Mandalay–Monywa–Kalemyo–Monywa Mandalay	0710	2. Myaungmya	0915
(Fortnightly extension to Singaling Khamti from Kalemyo w.e.f. 29-1-53)	0605	3. Bassein	1130
3. Moulmein	0715		
4. Heho–Keng Tung–Heho	0800		
5. Mandalay	1000		
Friday			
1. Magwe–Meiktila–Magwe	0600	1. Bassein	0700
2. Pakokku–Pauk–Kyauktu–Pauk–Pakokku–Gangaw–Pakokku	0630	2. Myaungmya	0915
3. Moulmein	0715	3. Bassein	1130
4. Heho–Mandalay–Shwebo–Momeik–Shwebo–Mandalay	0730	4. Thaton	1400
5. Mandalay–Anisakan–Mandalay	1000		
6. Moulmein–Tavoy–Mergui–Tavoy–Moulmein	1015		
7. Kyaukpyu–Akyab–Kyaukpyu	1230		
Saturday			
1. Moulmein	0715	1. Bassein	0700
2. Heho–Mandalay–Lashio–Mandalay–Heho	0730	2. Henzada	0705
3. Mandalay–Monywa–Mandalay	1000	3. Thayetmyo Magwe–Thayetmyo	0900
4. Tavoy–Mergui–Tavoy	1015	4. Myaungmya	1915
		5. Bassein	0130
Sunday			
1. Mandalay–Monywa–Kalemyo–Monywa–Mandalay	0700	1. Moulmein	0800
2. Moulmein–Tavoy–Mergui–Tavoy–Moulmein	0730		
3. *Loikaw–Heho–Mandalay	0830		

* Return Trip—Mandalay–Rangoon—purely freight service.
Note: This is "dry season" schedule and shows scheduled flights to all airports served.

C. DOMESTIC SERVICE

1. HISTORY

The UBA operates to 32 airports from Mingaladon, with some daily and some weekly and fortnightly flights. The service cannot be considered adequate as fast transport of passenger, mail, freight and news service is needed for both public and private purposes. Many districts, encompassing great areas of the country, are without any airline service. The valley of the Irrawaddy, for a distance of 200 miles between Mandalay and Bhamo, is without an airport. The valley of the Chindwin between Kalemyo and Singaling Khamti, a distance of 300 miles, is unserved. The northern, southern and eastern Shan States with a total area in excess of 60,000 square miles, 25% of the total area of the Union, have but one airport each. To be sure, some unserved areas are under insurgent control or are otherwise presently unsafe for operations. The entire valley of the Salween River, a distance of 650 miles north from Moulmein to the Yunnan, China, border, is unserved by UBA because of these hostilities. Lumbering operations are nearly at a standstill on this river, and mining and quarrying operations entirely so. At some airstrips, the villages immediately across the river are insurgent-controlled, with the airstrip held by GUB military. Until these conditions are relieved, any plan for improved service must be accompanied by a suitable security plan.

2. FLIGHT SCHEDULES AND FARES

Table XVII–2 presents a weekly schedule of domestic flight operations and Plate 2 shows the flight operations to individual airports. The schedule of fares, single and round trips, excess baggage rates, and freight rates charged by UBA on its domestic system are shown in Tables XVII–3 and XVII–4. Table XVII–5 presents the areas, airports and numbers of flights for the border and northern states.

3. DEFICIENCIES

Frequent flights over the UBA system, coupled with a study of all available data, lead to the following observations:

(*a*) The balance-sheet (see Table XVII–15, p. 484) indicates that the rates set by UBA are adequate and are needed to support the large program of airport reconstruction and equipment replacement, construction of new airports in the border states, and increase in aircraft fleet.

(*b*) UBA is operating with insufficient aircraft and as a consequence is unable to give the frequency of service needed and handle the full traffic volume. Two illustrations drawn at random illustrate this situation. On February 3, 1953, on a return flight from the airstrip at Tavoy ten would-be passengers for Rangoon had to be left behind. On February 19, 1953, five military personnel and one civilian were refused booking from Heho to Keng Tung because the all-up weight was at the limit. There is only one flight per week between Heho and Keng Tung.

(*c*) The lack of radio at certain airports and the consequent lack of information on seats available makes it necessary for the UBA representatives at these airports to wait until the flight is in before accepting bookings. In other words, the average passenger has no knowledge, until the last several minutes, as to whether he will or will not be sold a ticket.

(*d*) As indicated by Table XVII–5, 127,300 of the 262,000 square miles of Burma have very poor air service.

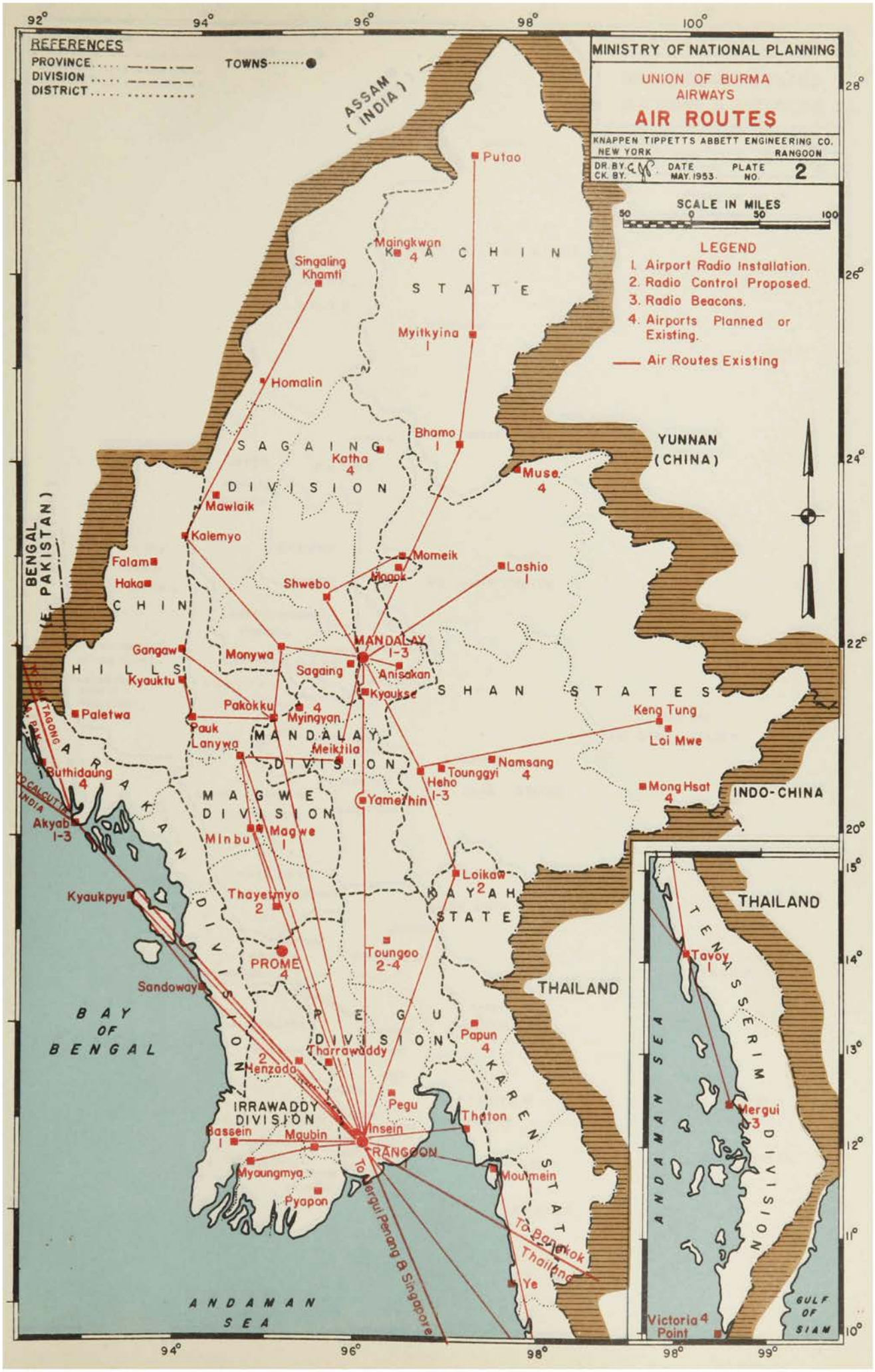
TABLE XVII – 3

UBA—FARES, BAGGAGE AND FREIGHT RATES

Rangoon to:	*Single Fares (kyats)*	*Return Fares (kyats)*	*Excess Baggage per lb. (kyats)*	*Freight Rates per lb. (kyats)*
Akyab	95.00	180.50	0.40	0.30
Anisakan	105.00	199.50	0.45	0.40
Anisakan via Mandalay	120.00	228.00	0.50	0.45
Bassein	35.00	66.50	0.20	0.20
Bhamo	170.00	325.00	0.75	0.65
Gangaw	115.00	218.50	0.50	0.45
Heho	85.00	161.50	0.40	0.30
Henzada	30.00	57.00	0.20	0.20
Kalemyo	140.00	266.00	0.65	0.55
Keng Tung	135.00	256.50	0.65	0.55
Kyaukpyu	75.00	142.50	0.30	0.25
Kyauktu	105.00	199.50	0.45	0.40
Lanywa	90.00	171.00	0.40	0.30
Lashio	140.00	266.00	0.65	0.55
Loikaw	70.00	133.00	0.30	0.25
Magwe	75.00	142.50	0.30	0.25
Mandalay	105.00	199.50	0.45	0.40
Meiktila	85.00	161.50	0.40	0.30
Mergui	115.00	218.50	0.50	0.45
Monywa	110.00	209.00	0.50	0.45
Moulmein	35.00	66.50	0.20	0.20
Myaungmya	30.00	57.00	0.20	0.20
Momeik	150.00	285.00	0.75	0.65
Myitkyina	195.00	370.50	0.90	0.75
Pakokku	100.00	190.00	0.45	0.40
Pauk	100.00	190.00	0.45	0.40
Putao	241.00	457.90	1.05	0.90
Sandoway	51.00	96.90	0.30	0.25
Shwebo	122.00	231.80	0.50	0.45
Tavoy	80.00	152.00	0.40	0.30
Thaton	30.00	57.00	0.20	0.20
Toungoo	40.00	76.00	0.20	0.20

4. RECOMMENDATIONS

(*a*) Test flights, advertised in advance, should be made to the airports presently served, to obtain an indication of whether an increase in traffic will result.


MINISTRY OF NATIONAL PLANNING
UNION OF BURMA AIRWAYS
AIR ROUTES
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON
DR. BY. C.W.P.
CK. BY.
DATE MAY. 1953.
PLATE NO. 2
SCALE IN MILES
50 0 50 100
LEGEND
1. Airport Radio Installation.
2. Radio Control Proposed.
3. Radio Beacons.
4. Airports Planned or Existing.
Air Routes Existing
REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
ASSAM (INDIA)
YUNNAN (CHINA)
INDO-CHINA
THAILAND
BENGAL (E. PAKISTAN)
BAY OF BENGAL
ANDAMAN SEA
GULF OF SIAM
KACHIN STATE
SAGAING DIVISION
CHIN HILLS
SHAN STATES
MANDALAY DIVISION
MAGWE DIVISION
PEGU DIVISION
IRRAWADDY DIVISION
KAYAH STATE
KAREN STATE
TENASSERIM DIVISION
ARAKAN
Putao
Maingkwan
Singaling Khamti
Myitkyina
Homalin
Bhamo
Katha
Muse
Mawlaik
Kalemyo
Momeik
Lashio
Falam
Haka
Shwebo
Gangaw
Monywa
MANDALAY
Sagaing
Anisakan
Kyauktu
Kyaukse
Pakokku
Myingyan
Paletwa
Pauk
Lanywa
Meiktila
Keng Tung
Loi Mwe
Buthidaung
Toungyi
Namsang
Heho
Mong Hsat
Akyab
Yamethin
Minbu
Magwe
Loikaw
Kyaukpyu
Thayetmyo
PROME
Toungoo
Sandoway
Papun
Tharrawaddy
Henzada
Pegu
Thaton
Bassein
Maubin
Insein
RANGOON
Myaungmya
Moulmein
Pyapon
Ye
Tavoy
Mergui
Victoria Point
To Calcutta India
To Chittagong E. Pak.
To Mergui Penang & Singapore
To Bangkok Thailand


MINISTRY OF NATIONAL PLANNING
MAP SHOWING STATES, DIVISIONS & DISTRICTS.
KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK
RANGOON
DR. BY. CK. BY.
DATE MAY. 1953.
PLATE NO. 1-2
SCALE IN MILES
50 0 50 100
REFERENCES
PROVINCE
DIVISION
DISTRICT
TOWNS
ASSAM (INDIA)
YUNNAN (CHINA)
BENGAL (E. PAKISTAN)
INDO-CHINA
THAILAND
BAY OF BENGAL
ANDAMAN SEA
GULF OF SIAM
KACHIN STATES
NAGA HILLS
KATHA
UPPER CHINDWIN
SHWEBO
LOWER CHINDWIN
MANDALAY
NO. SHAN STATES
SAGAING
PAKOKKU
MYINGYAN
MEIKTILA
EA. SHAN STATES
SO. SHAN STATES
AKYAB
MINBU
MAGWE
YAMETHIN
THAYETMYO
KAYAH STATE
PROME
TOUNGOO
SANDOWAY
THARRAWADDY
HENZADA
PEGU
SALWEEN
INSEIN
THATON
BASSEIN
MAUBIN
RANGOON
HANTHAWADDY
MYAUNGMYA
PYAPON
AMHERST
TAVOY
MERGUI
PUTAO
MYITKYINA
BHAMO
LASHIO
LOI MWE
TAUNGGYI
LOIKAW
FALAN
HAKA
CHIN HILL
SPECIAL DIVISION OF THE CHINS
ARAKAN HILL TRACTS
PALETWA
MAWLAIK
KYAUKSE
KYAUKPYU
SANDOWAY
PAPUN
MOULMEIN
YE

TABLE XVII – 4

UBA—FARES AND EXCESS BAGGAGE RATES

(*Intermediate Stations*)

Effective July 1, 1952.

From/To	*Single (kyats)*	*Return (kyats)*	*Excess Baggage per lb. (kyats)*	*Freight Rate per lb. (kyats)*
Akyab–Kyaukpyu	22.00	41.80	0.20	0.20
Bassein–Henzada	25.00	47.50	0.20	0.20
Bassein–Myaungmya	13.50	25.65	0.20	0.20
Bhamo–Mandalay	65.00	123.50	0.30	0.25
Bhamo–Myitkina	26.00	49.40	0.20	0.20
Bhamo–Putao	70.00	133.00	0.40	0.25
Gangaw–Kyauktu	20.00	38.00	0.20	0.20
Gangaw–Pakokku	35.00	66.50	0.20	0.20
Gangaw–Pauk	30.00	57.00	0.20	0.20
Gangaw–Lanywa	35.00	66.50	0.20	0.20
Gangaw–Monywa	45.00	85.50	0.25	0.20
Gangaw–Mandalay	65.00	123.50	0.30	0.25
Heho–Loikaw	25.00	47.50	0.20	0.20
Heho–Mandalay	35.00	66.50	0.20	0.20
Heho–Keng Tung	60.00	144.00	0.30	0.25
Heho–Lashio	70.00	133.00	0.40	0.30
Heho–Toungoo	40.00	76.00	0.20	0.20
Heho–Momeik	80.00	152.00	0.45	0.40
Kalemyo–Mandalay	48.00	91.20	0.25	0.20
Kalemyo–Monywa	35.00	66.50	0.20	0.20
Keng Tung–Loikaw	65.00	123.50	0.30	0.25
Kyauktu–Pauk	12.50	23.75	0.20	0.20
Kyauktu–Gangaw	20.00	38.00	0.20	0.20
Kyauktu–Pakokku	30.00	57.00	0.20	0.20
Kyauktu–Lanywa	19.00	36.10	0.20	0.20
Katha–Rangoon	170.00	323.00	0.75	0.65
Katha–Mandalay	55.00	104.50	0.30	0.25
Katha–Meiktila	80.00	152.00	0.45	0.40
Katha–Myitkyina	40.00	76.00	0.20	0.20
Lanywa–Mandalay	40.00	76.00	0.20	0.20
Lanywa–Meiktila	25.00	47.50	0.20	0.20
Lanywa–Pakokku	20.00	38.00	0.20	0.20
Lashio–Mandalay	40.00	76.00	0.20	0.20
Loikaw–Mandalay	55.00	104.50	0.25	0.20
Magwe–Mandalay	45.00	85.50	0.20	0.20
Magwe–Meiktila	25.00	47.50	0.20	0.20
Magwe–Lanywa	25.00	47.50	0.20	0.20
Mandalay–Anisakan	15.00	28.50	0.20	0.20
Mandalay–Meiktila	25.00	47.50	0.20	0.20
Mandalay–Monywa	25.00	47.50	0.20	0.20
Mandalay–Momeik	45.00	85.50	0.30	0.25
Mandalay–Myitkyina	95.00	180.50	0.40	0.30
Mandalay–Shwebo	19.00	36.10	0.20	0.20
Mandalay–Pakokku	30.00	57.00	0.20	0.20
Mandalay–Putao	125.00	237.50	0.50	0.45
Mandalay–Toungoo	65.00	123.50	0.30	0.25
Meiktila–Pakokku	25.00	47.50	0.20	0.20
Meiktila–Toungoo	45.00	85.50	0.20	0.20
Meiktila–Myitkyina	120.00	228.00	0.50	0.45
Mergui–Moulmein	93.00	176.70	0.40	0.30
Mergui–Tavoy	40.00	76.00	0.20	0.20
Momeik–Bhamo	35.00	66.50	0.20	0.20
Momeik–Myitkyina	55.00	104.50	0.30	0.25
Monywa–Meiktila	30.00	57.00	0.20	0.20
Moulmein–Tavoy	55.00	104.50	0.25	0.20
Moulmein–Thaton	15.00	28.50	0.20	0.20
Myitkyina–Putao	40.00	76.00	0.20	0.20
Pakokku–Pauk	25.00	47.50	0.20	0.20
Pauk–Lanywa	25.00	47.50	0.20	0.20
Pakokku–Monywa	25.00	47.50	0.20	0.20
Shwebo–Momeik	30.00	57.00	0.20	0.20

TABLE XVII – 5

FLIGHT DATA FOR BORDER AND NORTHERN STATES

District or State	*Area (sq. mi.)*	*Airport*	*Flights Weekly*
Southern Shan States	25,000	Heho	4
Eastern Shan States	19,900	Keng Tung	1
Northern Shan States	16,200	Lashio and Momeik	1
Myitkyina	29,700	Putao and Myitkyina	2
Naga Hills	9,500	Singaling Khamti	*
Upper Chindwin	10,600	Kalemyo	1
Katha	5,700	Katha	0
Special Division of the Chin Hills	10,000	None	0
Total Area	127,300		

* Fortnightly.

Table XVII–1, showing the potential support value of the various districts, and Plate 1–2, showing the district locations, together indicate which of the present airfields most need increases in service.

(*b*) An airstrip should be constructed at Homalin, approximately halfway between Singaling Khamti and Kalemyo, to serve the valley of the Chindwin.

(*c*) Immediately upon securing the area, the Papun airstrip should be developed and flights scheduled.

(*d*) A survey should be made of the special division of the Chin Hills to determine the most advantageous location for an airstrip from the viewpoints of population and business. Immediate programming of the construction should follow this survey.

D. PERSONNEL

The personnel organization of the various departments is presented in Tables XVII–6 through XVII–10.

1. OBSERVATIONS

(*a*) Less than 5% of the entire organization is non-national, this group consisting of most of the pilots and department heads of the Flight Operations and Maintenance Departments.

(*b*) Table XVII–6 (*see next page*) presents the organization for UBA as originally presented in the Preliminary Report. No changes are recommended.

(*c*) Table XVII–7 presents the organization for the Operations and Maintenance Departments of UBA.

(1) *The Operations Department* presently has a staff of 42, headed by the Chief Pilot. There are 12 pilots, 13 co-pilots, and 13 radio operators to operate the fleet, which consists of eight Dakotas, three Doves, three Marathons, and two Consuls, 16 planes in all. It would appear that 25% of the fleet is grounded at all times.

TABLE XVII – 6

ORGANIZATION CHART
UNION OF BURMA AIRWAYS

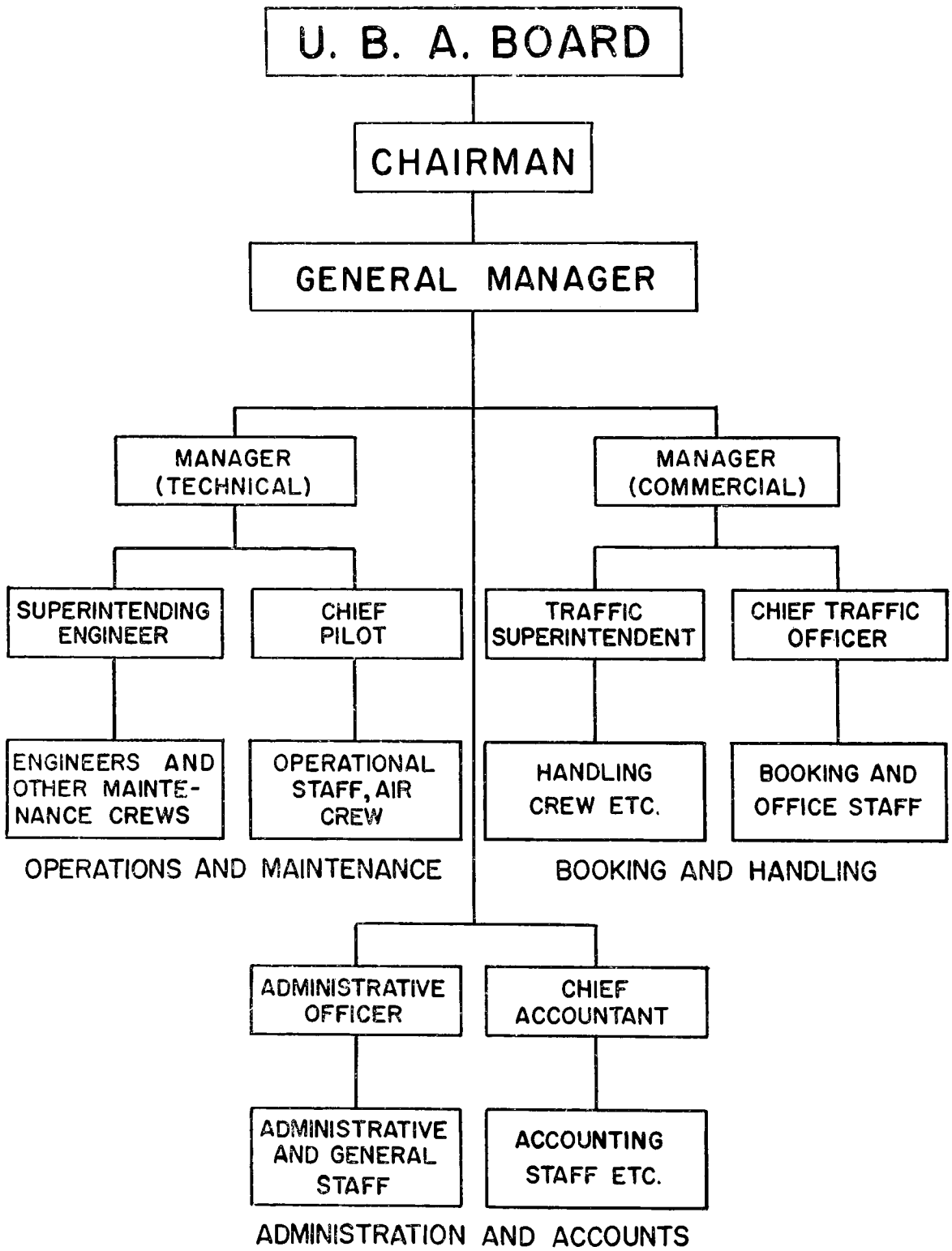
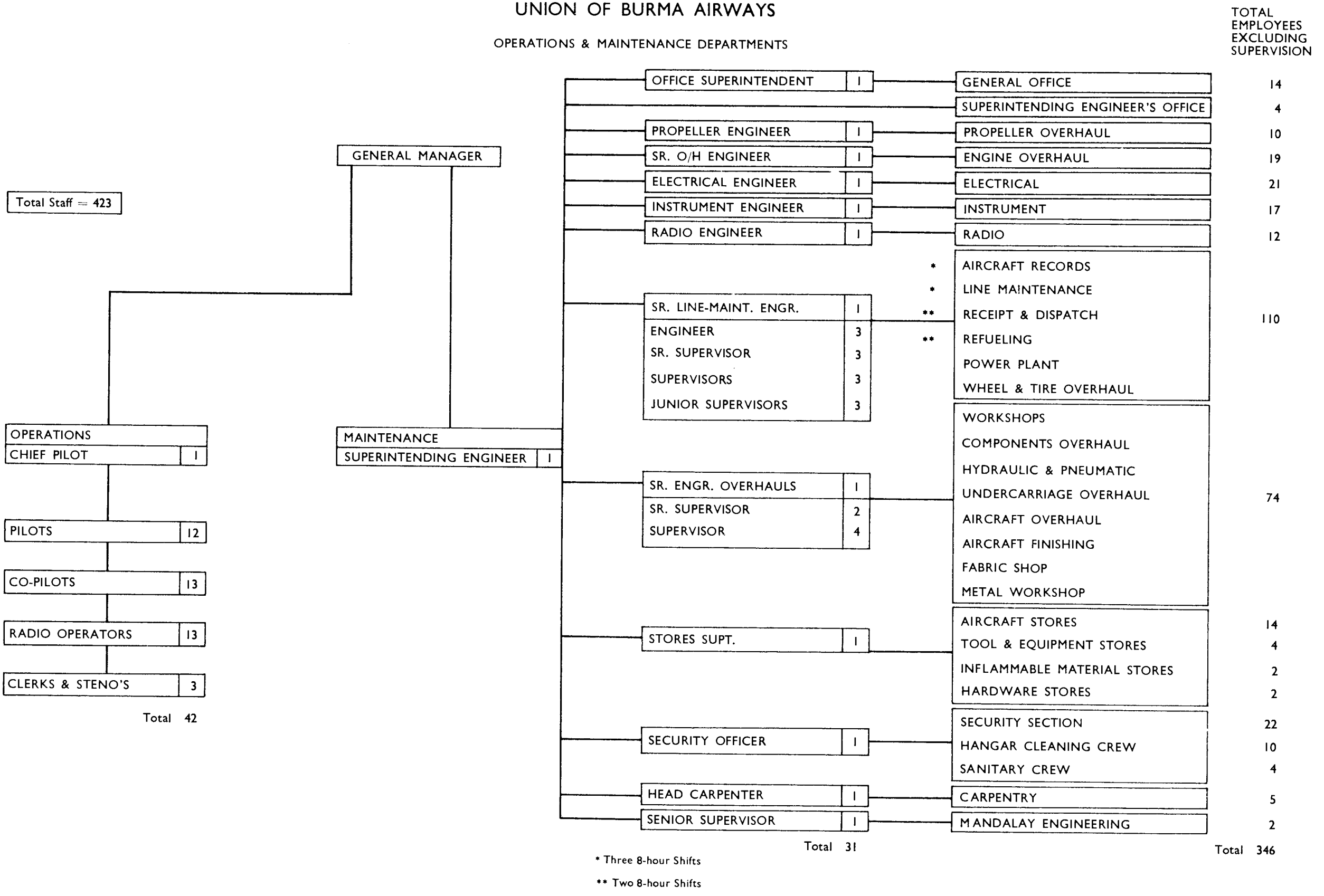


TABLE XVII-7

ORGANIZATION CHART

UNION OF BURMA AIRWAYS

OPERATIONS & MAINTENANCE DEPARTMENTS



Pilots are paid a bonus for all flying over 60 hours per month. At present, pilots are averaging 120 hours or more each month. An excerpt from the Pacific-Alaska Operations Manual of Pan-American Airlines, covering basic flight-time limitations for pilots and flight engineers is included for information. The Manual is based on CAA Regulations which should be used as a standard for comparison with UBA Regulations.

EXTRACTS FROM PAA OPERATIONS MANUAL

FLIGHT-TIME LIMITATIONS FOR PILOTS AND FLIGHT ENGINEERS

1. *CAR* 41.54 *Aircraft having a Crew of One or Two Pilots*

A. A pilot may be scheduled to fly eight hours or less during any 24 consecutive hours without a rest period during such eight hours. If a pilot is scheduled to fly in excess of eight hours during any 24 consecutive hours, he shall be given an intervening rest period at or before the termination of eight scheduled hours of flight duty. Such rest period must equal at least twice the number of hours flown since the last preceding rest period and in no case will such rest period be less than eight hours. During such rest period, the pilot must be relieved of all duty with the air carrier.

B. When a pilot has flown in excess of eight hours during any 24 consecutive hours, he must receive at least 18 hours of rest before being assigned any duty with the air carrier.

C. A pilot shall not fly in excess of 32 hours during any seven consecutive days. Relief from all duty for not less than 24 consecutive hours must be provided for and given to a pilot at least once during any seven consecutive days.

D. A pilot shall not fly as a member of the crew more than 100 hours during any one month.

E. A pilot shall not fly as a member of the crew more than 1,000 hours in any 12-month period.

2. *CAR* 41.55 *Aircraft having Two Pilots and One Additional Flight Crew Member*

A. A pilot may not be scheduled to fly a total of more than 12 hours during any 24 consecutive hours.

B. When a pilot has flown 20 hours or more during any 48 consecutive hours, or 24 hours or more during any 72 consecutive hours, he must receive at least 18 hours of rest before being assigned to any duty with the air carrier. In any case, each pilot shall be relieved from all duty for not less than 24 consecutive hours during any seven consecutive days.

C. A pilot shall not fly as a member of the flight crew more than 120 hours in any 30 consecutive days or 300 hours in any 90 consecutive days.

D. A pilot shall not fly as a member of the flight crew more than 1,000 hours in any 12-month period.

3. *CAR* 41.56 *Aircraft Having Three or More Pilots and an Additional Flight Crew Member*

A. Flight hours shall be scheduled in such a manner as to provide for adequate rest periods on the ground while the pilot is away from his base. Adequate sleeping quarters on the aircraft must be provided in all cases where a pilot is scheduled to fly more than 12 hours during any 24 consecutive hours.

B. A pilot, upon return to his base from any flight or series of flights, shall receive a rest period of not less than twice the total number of hours flown since the last rest period at his base and during such period will not be required to perform any duty for the company. When the required rest period exceeds seven days, that portion of the rest period in excess of seven days may be given at any time before the pilot is again scheduled for flight duty on any route.

C. A pilot shall not fly as a member of the flight crew more than 350 hours in any 90 consecutive days.

D. A pilot shall not fly as a member of the flight crew more than 1,000 hours in any 12-month period.

4. *CAR* 41.76 *Flight-time Limitations—Flight Engineers*

When one flight engineer is required, flight-time limitations of 41.55 apply. When two or more flight engineers are required, flight-time limitations of 41.56 apply.

The UBA has a training program and recruits nationals to meet its requirements for new pilots. The students attend flying schools in England, transportation and pay being provided by UBA. Twelve students have returned and are serving their pilots' apprenticeship (2,500 hours) as co-pilots.

Consideration is being given by the UBA to sending another 12 students to UK for pilot training, as none are now in training. The training period of three years is to be reduced to one year as the students taking the 3-year training course received only one hundred and fifty flying hours. The Ministry of Education selects the trainees by rigid methods and all students who were previously sent for training completed the course. The training of radio operators is discussed in paragraph G–3–e of this chapter.

Bad feeling exists because of the differences in wages of the nationals and non-nationals who have service contracts. In consideration of the fact that pilots, co-pilots and radio operators' prospective years of service are limited by the natural and unavoidable changes in the tension to which they are subject, a higher premium should be placed on their services. A retirement program should also be developed.

(2) *The Maintenance Department* presently has a staff of 378, headed by the Superintending Engineer. In this department, training is given as a routine matter along with work performed. When the apprentice has acquired skill, he is upgraded and given a license.

Burma having orginally no trained aircraft maintenance mechanics and supervisors, UBA was forced to recruit non-nationals on service contracts. These men will be replaced as trained nationals acquire the necessary experience and skill. The Maintenance Department not only handles maintenance of the aircraft, but also maintains the buses, trucks, suburbans and cars of the Transportation Department together with its own flight crew, hangar and automotive vehicles. The four new Bedford coaches are maintained and serviced by an outside contractor, but this is extremely expensive and it should be stopped.

It is estimated that approximately a 20% increase in total staff is required to return the planes and other vehicles to service promptly. Any increase in the number of planes and vehicles will require a further proportionate increase in maintenance personnel.

(*d*) *The Traffic and Transportation Department and Accounting and Statistical Department* are staffed entirely with nationals (see Tables XVII–8 and XVII–9). The Traffic Department has further curtailed its operations by contracting the booking and freight handling at 26 terminal airports and at four foreign airports to agents at an average rate of 7% of the passenger and freight bookings out of these airports. At the domestic airports of Burma it has been noted that inexperienced labor is used by the agents in unloading and loading freight and frequently the pilot and stewards of the aircraft are forced to assist this inexperienced labor. While on the ground, the flying crew would ordinarily expect to be relieved of any duties and should be free to walk about and relax. These conditions should be corrected.

(*e*) Table XVII–10 shows the organization for the Office of the Director of Civil Aviation. As indicated, the positions of senior Flying Control Officer and Supervising Engineer are vacant, the Deputy Director presently performing the duties of these offices. The officers under the Deputy Director do not have assistants qualified to understudy them. For example, the Chief Aerodrome Officer, in addition to his other duties, is responsible for the implementation of the airport development program, described in paragraph I of this chapter. It is beyond the capabilities of one man unassisted to supervise construction at over 30 airports that will cost as much as 800 lakhs of kyats over a four-year period. The Office of the DCA has a program for expansion of its organization but is holding it in abeyance.

Table XVII–10 does not include the Aerodrome Officers and radio crews at the airports. The Aerodrome Officers are responsible for management and maintenanee at the airfields, but need instruction and assistance. On the inspection flight to Pauk on February 20, 1953, the pilot came in for a landing twice, only to have to overfly cattle on the landing strip. At Akyab the Aerodrome Officer employs two

TABLE XVII – 8

UNION OF BURMA AIRWAYS
TRAFFIC AND TRANSPORTATION DEPARTMENT

Manager—Commercial 1

Chief Traffic Officer 1

Rangoon
Transportation Section

Movements Officer	1
,, Assistants	4
Upper Division Clerk	1
Lower ,, ,,	1
Drivers	43
Cleaners	7

Traffic Officer—Agent	1
Traffic Officer OSD	1
Traffic Officer—Claims	1

Traffic Officer—Freight	1
In-freight	2
Out-freight	5
Acceptances	1
Newspapers	4
Freight Shed	2

Traffic Officer—External	1
Passage Bookings	2
Freight Bookings	2
Passenger Handling	5

Traffic Officer—External Handling	1
Booking Cashier	1
External Baggage	—
Sales Girls	5
Airport Cashiers	2
Sales Statements	1
Refunds	1
General Assistant	1

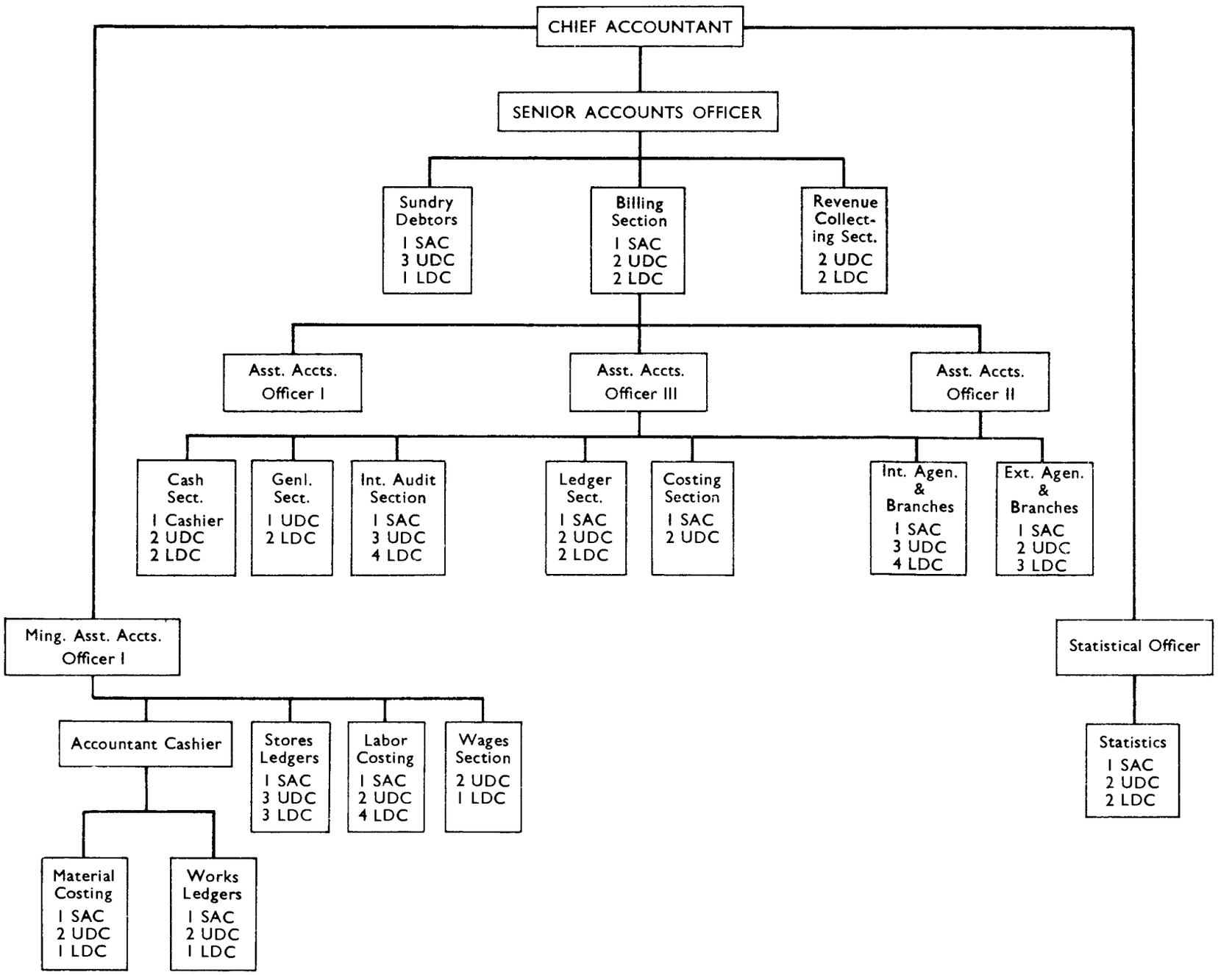
Traffic Superintendent	1
Airport Assistants	4
Traffic Handling	5
Traffic Handling	10
Flight Duties	7

Traffic Officer	1
,, ,,	1
Sr. Traffic Assistant	1
Jr. ,, ,,	1
Traffic Clerk	1
,, ,,	1
Mandalay	10
Akyab	3
Bassein	2
Lanywa	1
Sandoway	1
Thayetmyo	1

TABLE XVII-9

UNION OF BURMA AIRWAYS

ACCOUNTING AND STATISTICAL DEPARTMENT



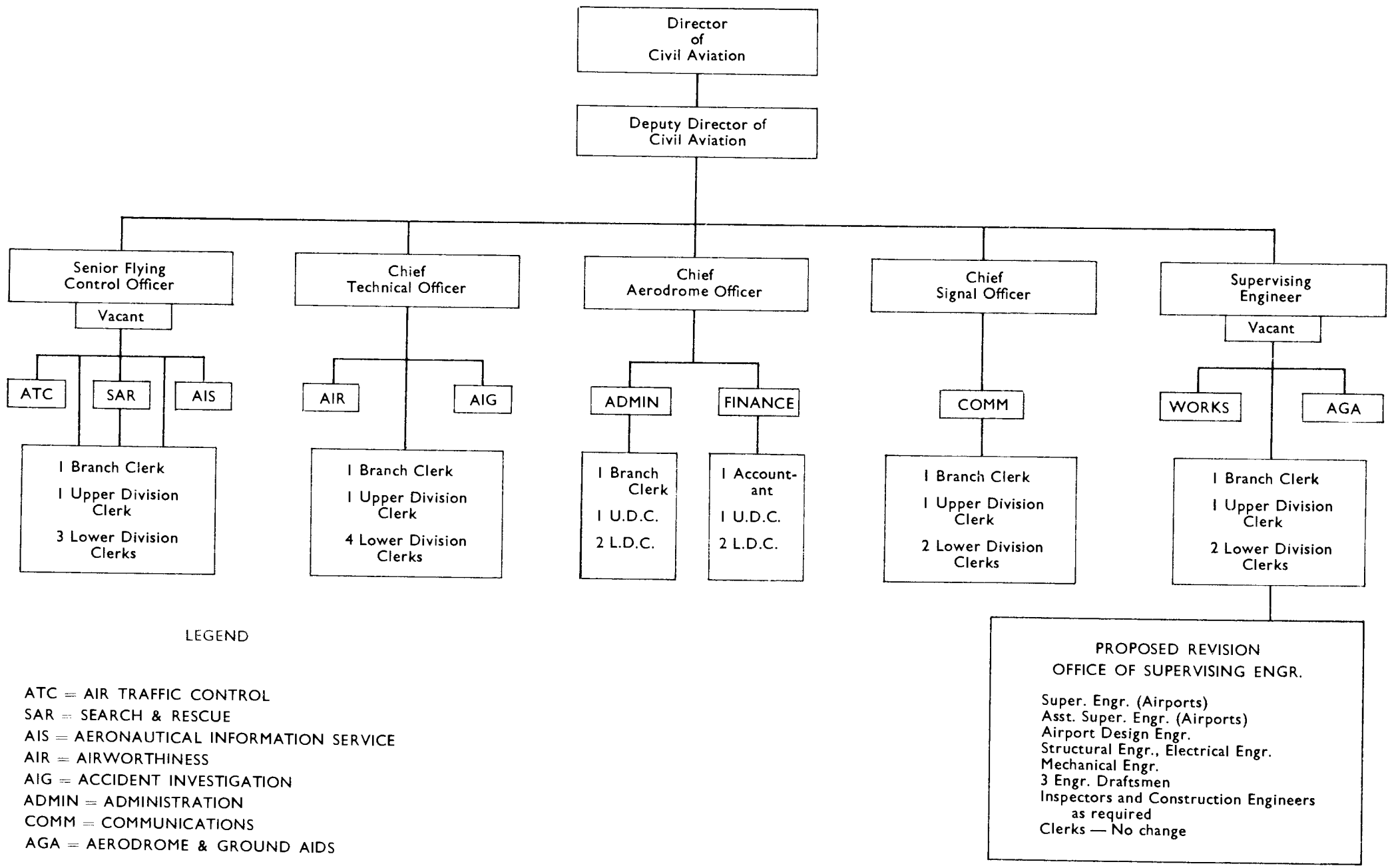
Note: SAC = Senior Accounts Clerk
UDC = Upper Division Clerk
LDC = Lower Division Clerk

TABLE XVII-10

GOVERNMENT OF THE UNION OF BURMA

CIVIL AVIATION DEPARTMENT

OFFICE OF THE DIRECTOR OF CIVIL AVIATION



LEGEND

ATC = AIR TRAFFIC CONTROL
SAR = SEARCH & RESCUE
AIS = AERONAUTICAL INFORMATION SERVICE
AIR = AIRWORTHINESS
AIG = ACCIDENT INVESTIGATION
ADMIN = ADMINISTRATION
COMM = COMMUNICATIONS
AGA = AERODROME & GROUND AIDS

laborers by the year to keep cattle off the paved runway and 30 laborers to cut the grass. A tractor-drawn mowing machine, which would amortize its initial cost in the first year of operation, could replace the 30 men. A five-strand barbed-wire fence or a single-strand electrified fence could keep the cattle off the field. The maintenance crew could be cut to three whose duties would be to operate and maintain the tractor and keep the fence in repair.

2. RECOMMENDATIONS

(*a*) The number of pilots, co-pilots and radio operators should be increased to 24. This will permit adequate rotation of the crew in the operation of the present fleet of 16 planes and reduce the probability of accidents due to crew fatigue.

(*b*) The pilot-training program should be placed on a continuing basis.

(*c*) Foreign crew members should be replaced as soon as the training program permits.

(*d*) A retirement program, financed by GUB, should be initiated at once for all UBA employees, particularly crew members.

(*e*) The personnel of the Maintenance Department should be augmented as recommended by the Superintending Engineer. The increase in personnel for the present work load should not be more than about 75 employees (20%).

(*f*) The agents who have contracted to handle booking and freight should be required to use experienced labor in handling freight.

(*g*) In DCA, the positions of Senior Flying Officer and Supervising Engineer should be filled by qualified individuals. The Supervising Engineer should be assisted by an engineering section capable of preparing plans and specifications for and supervising the construction and heavy maintenance of airfields.

The Office of the Supervising Engineer should be charged with all construction and improvements to airfields and with the preparation of estimates and reports. Five engineers and three engineering draftsmen should be provided in addition to the Supervising Engineer. One of the engineers should be from the civil field, experienced primarily in airfield pavements, airfield drainage and the application of soil mechanics to airfield pavement design. One should be a structural engineer familiar with airfield structures. Another should be an electrical engineer experienced in airfield lighting, navigation aids and power supply for the various maintenance shops and mobile equipment at the airfield. The fourth should be a mechanical engineer experienced in all phases of air conditioning, heating and ventilating as applied to airport construction. The Assistant Supervising Engineer should be a civil engineer, understudy to the Supervising Engineer. All should be qualified for temporary assignment to the field on supervision of construction.

(*h*) The Aerodrome Officers employed at the various airports should be engineering graduates and should receive training under both the Chief Aerodrome Officer and the Supervising Engineer prior to appointment.

E. AIR SAFETY, AIRCRAFT AND WORKSHOP

1. AIR SAFETY

a. Safety Record

UBA has a notable air safety record for the four and one half years since its formation. It is estimated that in excess of 120 million passenger miles have been flown, with a total of 11 fatalities, or 11 million passenger miles per individual fatality.

One Dove aircraft was lost to insurgents, one burned off its gas as it skidded on a collapsed landing gear. In neither of these accidents were lives lost. One Dakota aircraft, upon attempting to land at Mergui, was dropped by a cool thermal, had a wing sheared by tree tops in the approach zone, and spun in on the overshot zone outside the threshold of the airstrip. The passengers and crew left the plane safely before a slow fire burned out this aircraft. The cause of the loss of the de Havilland Dove aircraft XY–ABO on March 14, 1949, could not be determined by the Board of Inquiry. This aircraft was seen from shore to fall and sink in the Gulf of Martaban offshore from the mouth of Myitkyina Creek. Nine passengers and two crewmen are presumed to have been drowned, and there were no survivors. As no airport radio installation was then at Moulmein it was only the failure of the aircraft to return to Rangoon which inspired search efforts. The Board of Enquiry recommended "radio facilities be installed at all stopping places for internal service."

b. Safe Operating Procedures

In order that the record of safety be maintained, the UBA exercises vigilance in every phase of operations. The Superintending Engineer, the Chief Pilot, the Chief Signals Officer, and the Duty Officer, who changes daily and is normally a co-pilot, all have certain requirements prerequisite to a scheduled or non-scheduled flight before any aircraft is given departure clearance.

(1) Continuing Airworthiness of Aircraft

Certificates for continuing airworthiness of aircraft are renewed periodically at intervals not exceeding 12 months and cover a complete overhaul including: removal of all components of the aircraft even to the entire removal of all paint upon the airframe to check

for cracks or fissures; overhaul of propellers with appropriate tests; overhaul of the fuel system, testing for flow rates, vapor lock, fuel-feed system arrangement, tank strength, construction and installation, and checking fuel indicators, flowmeters, fittings, valves and accessories, and fuel-jettisoning systems; testing the oil systems, cooling power plant instruments and controls, exhaust systems, induction systems, firewalls and cowling, and fire protection. All tests are made under the supervision of properly qualified certificated mechanics.

(2) Operations of Aircraft

Conformance with recommendations of ICAO is generally attempted by UBA, which is a primary reason for the continuing record of safety of the airline. Exact records are kept of all aircraft conditions during flight, and the flight plans are prepared to avoid conflict with advice of Air Traffic Control, the Meteorological Bureau, and Communication Service. Weight limitations are carefully followed as to crew, fuel, passengers, baggage and freight. The conditions of the airstrips limiting weights are also watched for safe landing-load. All aircraft in UBA are provided with an operation manual, a maintenance manual, a maintenance release and a journey log-book. Non-compliance, however, was noted to the requirement that before a pilot acts as pilot-in-command on a route he has never flown he shall be certified for the route by a pilot who has previously proven his knowledge of the route. The importance of adherence with this recommendation cannot be overstressed.

2. AIRCRAFT

a. Observations

Service is inadequate especially for the transportation of perishable freight. UBA is unable to accept charters at all times; to provide search at all times; or to spare planes from the line for minor repairs or major overhaul. Necessity for minor repairs to planes grounded elsewhere than at Mingaladon frequently finds UBA without a plane in reserve to take the needed mechanics and parts to the airport. Curtailment of schedules and the consequent loss of revenue would result should several of the Dakotas, the workhorses of the fleet, be in the shops at the same time. To serve the numerous small airfields in the vicinity of Mandalay which are substandard for Dakotas, a shuttle service based at Mandalay and equipped with the lighter-weight Doves should be instituted.

The service performance of the Dakotas has been so excellent for so long it is difficult to recommend any change other than that more consideration be given to the use of the lighter Doves on the numerous short hauls and low income producing routes. The low fuel consumption of the Dove on short flights up to 45 minutes permits it to complete such a flight on an amount of fuel equivalent to that used by the Dakota for taxiing and warm-up prior to departure. The comparison of operational aircraft given in Tables XVII–11, 12 and 13, illustrates these character-

TABLE XVII – 11

AIRCRAFT WEIGHT ANALYSIS

	Dove I	*Dakota III*
	(all weights in lbs.)	
1. Structure weight	2,390	8,830
2. Power plant and systems weight	2,160	5,620
3. Operating equipment weight	830	2,340
4. Passenger equipment weight	440	1,740
5. Empty weight	5,820	18,530
6. Cockpit crew	400	600
7. Cabin crew	—	200
8. Fixed stores	—	250
9. Unusable fuel	50	170
10. Basic weight	6,270	19,750
11. Maximum oil capacity	130	430
12. Equipped weight	6,500	20,180
13. Maximum usable fuel capacity	1,160	4,750
14. Corresponding payload	940	3,120
15. Usable fuel with capacity payload	—	—
16. Capacity payload	2,100	7,870
17. Disposable load	2,100	7,870
18. Gross weight	8,500	28,050
19. Preflight fuel allowances	7	50
20. Maximum take-off weight	8,500	28,000
21. Maximum landing weight	8,500	26,000

TABLE XVII – 12

BASIC PERFORMANCE DATA

	Units	*Dove I*	*Dakota III*
1. Total take-off power	e.p.h.	690	2,400
2. Meto-power	e.p.h.	570	2,100
3. Cruise power assumed (mean)	e.p.h.	414	1,050
4. Per cent of meto-power assumed for cruise	per cent	71·5	72·5
5. Cruising height at start of flight regime	ft.	8,000	8,000
6. Cruising height at end of flight regime	ft.	8,000	8,000
7. Assumed average cruising fuel consumption	lb. hr.	194	470
8. Assumed specific cruising fuel consumption	lb./e.p.h. hr.	0·469	0·448
9. Cruising speed at take-off weight	m.p.h.	179	166
10. Cruising speed at 85% take-off weight	m.p.h.	183	174
11. Cruising speed at 70% take-off weight	m.p.h.	187	178
12. Cruising consumption at 85% take-off weight	lb./miles	1·06	2·70
13. Air miles per gallon	a.m.p.g.	6·64	2·55
14. Theoretical still-air range at operating height (no allowances)	stat. miles	1,095	1,760
15. Estimated take-off distance to reach 50 ft. on full power at max. take-off weight	ft.	2,370	3,540

TABLE XVII – 13

AIRCRAFT OPERATIONAL ANALYSIS

Tabulated Summary of "Hour Charts"

	Dove I	*Dakota III*
1. Cruising height	8,000 ft.	8,000 ft.
2. Capacity payload	2,100 lbs.	7,870 lbs.
3. Total fuel reserves (diversion and stand-off)	333 lbs.	1,535 lbs.
4. Flight time on reserves	1·65 hrs.	3·20 hrs.
5. Distance covered in climb and descent in still air	44 miles	97 miles
6. Shortest stage block speed, still air	66 m.p.h.	97 m.p.h.
7. Payload for shortest stage	1,633 lbs.	4,277 lbs.
8. Time on shortest stage (allowances)	0·66 hrs.	1·00 hrs.
9. Max. stage distance covered with payload for shortest stage in still air	44 miles	570 miles
10. Block speed	66 m.p.h.	145 m.p.h.
11. Payload for max. stage length	940 lbs.	3,120 lbs.
12. Max. stage length no wind	650 miles	970 miles
13. Block speed	158 m.p.h.	154 m.p.h.
14. Max. stage length 30 m.p.h. headwinds	550 miles	780 miles
15. Block speed	132 m.p.h.	126 m.p.h.
16. Max. stage length 60 m.p.h. headwinds	435 miles	620 miles
17. Block speed	104 m.p.h.	99 m.p.h.
18. Max. stage length 90 m.p.h. headwinds	not computed	
19. Block speed	,,	,,

		A.U.W. (lbs.)
DOVE I	de Havilland DH104 (two 320 b.h.p. DH Gypsy Queen 70)	8,500
DAKOTA III	Douglas DC-3c (two 1,200-b.h.p. Pratt & Whitney Twin Wasp R-1830.92)	28,000

istics. The Burma Airways chart and the UBA records of freight and passengers handled on these short routes further support the adoption of a shuttle operation.

The weight of freight continuously handled to and from Rangoon and Mandalay would seem to warrant a daily freight service and by a plane better suited to receive and discharge freight than is the Dakota. Passenger comfort is given second consideration after freight, and the UBA traffic department has been found to almost extend itself to placing freight in the laps of the passengers. It is packed under the seats, in the space between provided for feet, and frequently down the aisles. The last is considered a hazard to the rapid discharge of passengers, if need arises, and is prohibited by law on most common carriers.

c. Recommendations

It is recommended that:

(1) Further study be made of the prospective passenger-traffic loads and that the passenger fleet be increased to accommodate these loads.

(2) A shuttle service be initiated between Mandalay and all airports lying north of Lanywa and Heho. The Dove aircraft should be used for this service.

(3) Daily freight service be instituted between Rangoon and Mandalay, utilizing C 47 cargo planes. The basic weight of the C–47 cargo plane is 18,000 lbs., maximum gas and oil weight is 5,284 lbs. and the recommended gross weight is 29,000 lbs. The recommended gross weight of 29,000 lbs. is within the allowable load of 30,000 lbs. for the existing airstrips. This service will add to the comfort of passengers flying with the passenger planes by relieving them of freight, and can be increased as the demand indicates.

3. WORKSHOP

Airworthiness of aircraft is dependent on the adequacy of equipment and efficiency of personnel in the maintenance and overhaul workshops. These should be stocked with every needed spare part in sufficient quantities to insure availability, and should be staffed with well-supervised, well-trained repair crews.

The recommendations of the Preliminary Report are being carried out. Until recently, the entire workshop facilities of UBA were crowded into one hangar at Mingaladon where all repairs are concentrated. The Burma Air Force, however, has turned over a second hangar to UBA, and motor assembly and checks are made in it. UBA has authorized its Superintending Engineer to end the present congestion and as a consequence inflammable materials, such as paints and remover solvents have been moved into a temporary building while a new shed is under construction. Major engine overhaul is to be moved entirely from the hangars into its own building, and the necessary line is to be tooled. A spare-parts shed is now being equipped with tagged bins for which check-in, check-out and tally cards are being cross-indexed between receiving, stock and requisition departments. A separate propeller-test area is planned. The shops are also equipped to overhaul and test radio equipment, to completely rebuild and service batteries, and to quickly remove and install aircraft engines. It is in need of machine tools and a full line of hand tools. It is in need of an entire assortment of vital spare parts now almost out of stock in the UK and available in the United States only with dollars. It is estimated that an allotment of $100,000 is required over the next several years to care for this spare stock parts need.

Mechanics are trained in the shops and the Maintenance Division closely inspects and checks all work performed. On various field trips to the shops it has been found that work is continuously in progress with no indication of idleness.

F. AIRPORTS, FACILITIES AND TERMINALS

Air inspection was made during December 1952 and February 1953 of 27 of the airports. Table XVII–14, indicates the actual conditions found. Only during the dry season of the year can UBA operate aircraft to all 33 airports, as only seven of the airports are usable in all-weather conditions. Plate 3 is a sample inspection form for an airport, based on ICAO standards, for the heaviest class of aircraft presently in use in Burma. No further comment upon the poor conditions of the actual airstrips is necessary than to state that on ICAO standards most of Burma's airfields would be condemned for commercial traffic. A digest of ICAO recommendations is to be found at the end of this chapter.

Paragraph I, Future Developments, presents the program of the office of the DCA. This program places greater emphasis on extending the system than on improvement of the various airports now served. The excellence of the safety record of UBA cannot be attributed to the character of the airports, but must be a reflection of the ability of the pilots, coupled with careful maintenance. Some of the existing airports have been programmed for improvement, but the program is phased over too long a period and does not include all of the needed work at airstrips. The conditions of the approach and departure zones, the use of rocks to define the edge of the paved strips, the narrowness of the paved and usable strips, the obstructions found in the latter, the orientation of certain of the strips, and the lack of transverse drainage all require expeditious correction. The sample inspection check sheet (Plate 3) together with the digest of ICAO recommendations should constitute the minimum in design.

Few of the airports have terminal buildings and facilities. However, the development program of the DCA includes these features at certain of the airports. The development program should encompass the entire system. As stated elsewhere, the traffic and transportation division of UBA contracts these services to private individuals at most of the airports for a commission of 7% of the passenger and freight booking originating at these airports.

The transportation fleet at Rangoon has in the previous year acquired three new Bedford coaches, and has a sizable fleet of buses and freight trucks to handle passenger and freight traffic between its central booking office on Strand Road and Mingaladon. Other than this, the transportation service between the airports and town terminals of the rest of the system is of such poor quality as to be out of keeping with the services generally expected in connection with air travel. At certain of the inland airports and seaports a high-bodied truck offers the only means of transportation, the floor being the only seating provided, and a stool the means of access. The passenger handles his own baggage. Such a condition leaves unlimited room for improvement at little cost. The town terminal building is a symbol and advertisement of the airways system. These also could be improved at little cost.

Digest of *Recommended and Standard Practices* for Engineering Design of Aerodromes—*International Civil Aviation Organization* Annex 14—Adopted May 29, 1951: Effective November 1, 1951.

The above authority recommends that design of airstrips shall be fitted to the character of the traffic expected. The Union of Burma Airways is presently using aircraft with single wheel-loads of approximately 15,000 lbs., and consequently the design required by the above authority places the airstrip in the class Code number 6 and the related Code letter F, which shows a required basic length minimum of 3,500 ft. and maximum of 4,200 ft.; which lengths are for airstrips constructed at mean sea level, temperature 59° F., pressure 29·92126 inches (1013·25 millibars) of mercury.

The recommendations for an increase in length from the minimum are as follows and are based on standard American practices.

Altitude Correction—Basic length to be increased by 7% of elevation above mean sea level.

Temperature Correction—Altitude corrected length to be further increased by 0·50% for each degree Fahrenheit which the temperature of the hottest month exceeds the standard temperature of the site.

Longitudinal Slope—The runway length be further increased to correct for runway gradient at the rate of 20% of the length corrected for density altitude for each 1% of effective runway gradient. The effective runway gradient is determined by dividing the maximum difference in runway center-line elevation by the total length of the runway.

Runway Alignment—The number of runways at an aerodrome and their orientation should be such that for as large a percentage of time as practicable but for not less than 95% there is at least one runway for which the surface wind velocity component at right angles to its longitudinal axis will not prevent the landing or taking off of aircraft that the aerodrome is intended to serve. The competent authority on design may, however, after taking into consideration the fact that aircraft designs are becoming less critical with respect to wind conditions, decide that the aerodrome is intended to serve those classes of aircraft that are capable of being operated under moderately high cross-wind conditions.

Longitudinal Slopes—It is further recommended that for code F airstrips the slope of a straight line joining the center points of the extremities of a runway should not exceed 1% and along no portion of the runway should the slope exceed 1·5%. Where slope changes cannot be avoided the transition from one slope to another should be ac-

TABLE XVII – 14

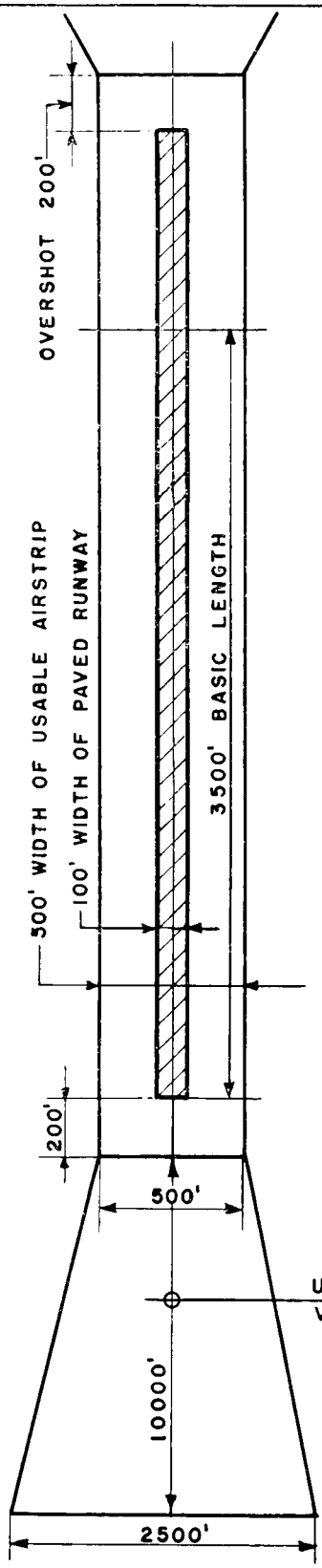
AERODROMES—INSPECTION REPORT

No.	Item	No.	Akyab	Anisakan	Bassein	Bhamo	Gangaw	Heho	Henzada	Kalemyo	Keng Tung	Kyaukpyu	Kyauktu	Lanywa	Lashio	Loikaw	Magwe	Mandalay	Myaungmya	Meiktila	Mergui	Mingaladon	Momeik	Monywa	Moulmein	Myitkyina	Pakokku	Pauk	Putao	Sandoway	Shwebo	Singaling Khamti	Tavoy	Thaton
1.	Sight-distance is full length of airstrip	1	Y	Y	Y	Y	Y	Y	HERE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	INSPECTED	Y	N	Y	Y	Y	INSPECTED	Y	INSPECTED	Y	Y	INSPECTED
2.	Alignment is oriented with the wind	2	N	N	N	N		Y		N		N		Y	Y	Y	Y	Y	N	Y	N	N		Y	N	Y							N	
3.	Longitudinal Profile	3	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y		Y	Y	
4.	Transverse Profile is full width and drains	4	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	Y	N	N	N		N		N	N	
5.	Drainage of airstrip is natural and good	5	N	N	N	N	N	Y		N	N	N	N	Y	N	N	N	Y	N	Y	N	Y		N	N	Y	N	N		N		N	N	
6.	Drainage Ditches are 250 ft. clear of centerline	6	N	N	N	N	N	N		N	N	N	N	N	N	N	N	Y	N	N	N	Y		N	N	N	N	N		N		N	N	
7.	Airstrip Paved Surface	7	N	N	N	Y	N	Y		N	*	N	*	Y	Y	N	N	Y	N	N	Y	Y		N	*	Y	N	N		N		N	N	
8.	,, ,, ,, is full 100 ft. wide	8	Y	N	N	N	N	N		N	N	Y	N	N	Y	N	N	N	N	N	N	Y		N	N	Y	N	N		N		N	N	
9.	,, ,, ,, is design length	9	Y	N	N	Y	Y	Y		N	N	Y	N	N	Y	Y	Y	N	Y	Y	Y	Y		N	Y	Y	N	Y		N		N	N	
10.	Usable width is full 500 ft.	10	N	Y	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	Y	N	N		N		N	N	
11.	Glide Angle on Approach	11	Y	Y	Y	Y	Y	Y	UNDER	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y		Y		Y	Y	
12.	On Departure	12	Y	N	Y	Y	N	Y		N	Y	Y	N	Y	N	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y		N		N	Y	
13.	Approach Zone is clear of trees and obstructions	13	N	N	N	Y	Y	Y		Y	N	N	Y	Y	N	Y	Y	Y	Y	Y	N	Y		N	N	Y	N	Y		Y		Y	Y	
14.	Departure	14	Y	N	N	Y	Y	Y		Y	N	Y	N	N	N	Y	Y	Y	Y	Y	N	Y		N	N	N	N	Y		N		N	Y	
15.	Field is protected from trespass by cattle	15	N	N	N	N	N	N		N	N	N	N	Y	N	N	N	Y	N	N	N	Y		N	N	N	N	N		N		N	N	
16.	Overshot Zone is clear and usable	16	Y	N	N	Y	Y	Y	AERODROME	N	N	Y	N	N	N	Y	Y	Y	Y	Y	N	Y		Y	Y	Y	Y	Y		N		N	Y	
17.	Runway Strength in dry weather	17	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y		Y		N	Y	
18.	Aerodrome has Radio Installation	18	Y	N	Y	Y	N	Y		N	N	N	N	N	Y	N	Y	Y	N	N	Y	Y		N	Y	Y	N	N		N		N	Y	
19.	,, ,, Radio Beacon	19	Y	N	N	N	N	Y		N	N	N	N	N	N	N	N	Y	N	N	Y	Y		N	N	N	N	N		N		N	N	
20.	,, ,, Temporary Night Lights	20	Y	N	Y	N	N	Y		N	N	N	N	N	Y	N	Y	Y	N	N	Y	N		N	Y	Y	N	N		N		N	Y	
21.	,, ,, Permanent Night Lights	21	N	N	N	N	N	N	A NEW	N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N		N		N	N	
22.	,, ,, Staff Housing	22	Y	N	Y	N	N	Y		Y	N	N	N	N	Y	N	Y	Y	N	N	Y	Y		N	Y	Y	N	N		N		N	N	
23.	,, ,, Terminal Building	23	N	N	Y	N	N	Y		N	N	Y	N	N	Y	N	Y	N	N	N	N	Y		N	Y	Y	N	N		N		N	N	
24.	,, ,, Standard Wind-sock	24	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N		N	N	N	N	N		N		N	N	
25.	,, ,, Threshold Markings	25	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N		N		N	N	
26.	,, ,, Centerline and Edge Markings	26	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	Y		N	N	N	N	N		N		N	N	
27.	,, ,, Runway Designation Markings	27	N	N	N	N	N	N		N	N	N	N	N	N	N	N	N	N	N	N	N		N	N	N	N	N		Y		N	N	
28.	,, ,, a needed Apron	28	Y	Y	N	Y	N	Y		Y	Y	Y	N	Y	Y	Y	N	Y	N	N	Y	Y		N	Y	Y	N	N		N		N	N	
29.	,, is usable in all weather conditions	29	N	N	N	N	N	Y		N	N	N	N	Y	Y	N	Y	Y	N	N	N	Y		N	N	Y	N	N		N		N	N	

DESIGNATIONS

N—Not Satisfactory. Y—Satisfactory. * Work in Progress.

Note: The Office of the Director of Civil Aviation has requested sanction of the Government to construct new Aerodromes at Victoria Point, Myingyan, Toungoo, Buthidaung, Prome and Thayetmyo.



CLASS F AIRPORTS

SINGLE-WHEEL-LOAD OF 15,000 LBS.
PAVEMENT DESIGNED FOR STATIC LOADING OF 70 LBS. PER SQUARE INCH
MAXIMUM TRANSVERSE SLOPE 1.5%
" LONGITUDINAL " 1.5%
ON THE PAVED RUNWAY AND 2%
ON THE USABLE WIDTH BEYOND
BASIC LENGTH TO BE INCREASED 7%
OF THE ALTITUDE ABOVE MEAN-SEA-LEVEL
THIS NEW LENGTH TO BE CORRECTED ADDING 0.5% FOR EACH DEGREE FAHRENHEIT BETWEEN THE HOTTEST MONTH AND THE STANDARD TEMPERATURE OF THE SITE.
THE ORIENTATION TO BE SUCH THAT 95% OF THE TIME THE STRIP SHALL BE USABLE DESPITE SURFACE WIND VELOCITY.
NOTE: SEE PRINTED INSTRUCTIONS FOR OTHER DETAILS AND FACILITIES.
LIST IMPORTANT RECOMMENDATION ON THE REVERSE SIDE OF THIS REPORT SHEET.

	EXISTING	REQUIRED
LENGTH		
PAVED WIDTH		
USABLE WIDTH		
GRADES		
DRAINAGE		
TERMINAL BLDG.		
RADIO CONTROL		
EMERGENCY POWER		
EMERGENCY LIGHTING		
STAFF QUARTERS		
ORIENTATION		
SIGHT DISTANCE		
RUNWAY STRENGTH		
STRIP MARKINGS		
OVER-SHOTS		
TRANSVERSE SLOPES		
APPROACH ZONES		
WIND SOCK		
SURFACE TREATMENT		

UNOBSTRUCTED APPROACH ZONES BOTH ENDS
VERT. TO HORIZ. 1:30

INSPECTION CHECK SHEET
AIRPORT: _____

MINISTRY OF NATIONAL PLANNING

INTERNATIONAL CIVIL AVIATION ORGANIZATION STANDARDS.
1, NOVEMBER 1951.

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY. E.J.P. DATE PLATE
CK. BY. E.P.T. MAY 53. NO. 3.

complished by a curved surface with a rate of change not exceeding 0·3% per 100 feet. This is equivalent to a minimum radius of curvature of 33,000 feet.

Sight Distances—Where slope changes cannot be avoided, they should be such that there will be an unobstructed line of sight from any point 10 feet above the runway to all other points 10 feet above the runway within a distance of at least half the length of the runway.

Distances Between Slope Changes—Frequent undulations or appreciable changes in slope located close together along a runway should be avoided. The distance between two successive transition curves measured from their points of intersection of the curve should be not less than the sum of the absolute numerical values of the corresponding grade changes multiplied by 25,000 feet.

Example: x the grade to the left, y the grade within the two points on intersection curves and z the grade to the right are successively plus 0·01, minus 0·005, and plus 0·005.

And 25,000 times (x minus y, plus, y minus z).

Therefore: x minus y — 0·015 and y minus z = 0·01.

Or 25,000 feet times (0·015 plus 0·01) equals 625.

Runway Strength—For code F airstrips (15,000 lbs. single wheel load) an associated tire pressure shall be assumed at 70 lbs. per square inch. This is ten lbs. greater than the DC-3 in use by the Union of Burma Airways.

Overshot Strip—Shall extend 200 ft. beyond the paved runway and have the required width, for class code F airports, of 250 ft. each side of the center line.

Transverse Slopes—Shall be such as to drain the surface but should not exceed 1·5%.

Width of Usable Strips—For runways other than instrument operated, the width should be 250 feet each side of the center line for code letter F runways. It is not intended that areas paralleling and outside the 500 ft. of usable strip be prepared in any way for landings but rather that they be cleared of hazards to aircraft.

Strength—Those portions of the usable strip immediately beyond the paved runway should be so prepared or constructed as to minimize hazards arising from the difference in load-bearing capacity, to an aircraft running off the paved runway.

Width of Paved Runway—For airstrips in the class code letter F the width should be 100 ft. Two parallel runways should be separated 500 ft. on their center lines.

Taxiways—Taxiways should be so provided as to permit the safe and expeditious handling of aerodrome traffic.

Aprons—Aprons should be provided as and when necessary for the reasons above stated.

Aerodromes—Lighting of aerodromes and marking of obstructions nearby should be provided as traffic demands.

Approach Zones—For airstrips in the class code letter F should be trapezoids with center lines the extension of the runway center lines, 500 ft. wide at the airstrip and 2,500 ft. wide at a distance of 10,000 ft. from the airstrip. The unobstructed glide path shall have a vertical-horizontal ratio of 1 : 30.

Horizontal Approaches—Have their inner edges at 13,000 ft. from the geometric center of the runway and are connected to the approach zone by transition slopes of vertical-horizontal ratio of 1 : 7.

Wind-direction Indicators—All aerodromes shall be equipped with at least one wind-sock so located as to be visible to approaching aircraft and unaffected by nearby structures. They should be not less than 12 ft. long and 3 ft. in diameter at the supported end. The color should be discernable at 1,000 ft. having regard for background. White or orange is preferable and but a single color should be used.

Signaling Lamp—Shall be provided at all aerodromes.

Emergency Lighting—Shall be provided at all aerodromes intended for use at night.

Aerodrome Identification Signs—Shall be provided where there is insufficient other means of identification. It should be the name of the aerodrome and in letters ten feet high.

Aerodrome Beacons Shall be provided at all aerodromes intended for use at night. For land aerodromes the color shall be green and for water aerodromes yellow. It shall have a peak intensity of 2,000 candle power and emit light at all angles in azimuth and up to at least 45° above the horizontal. They shall be on or adjacent to the aerodrome and identification characters shall be transmitted in the Morse Code at a speed of between six to eight words per minute, the corresponding range of duration of the Morse dots being from 0·20 to 0·15 seconds.

Approach Day Marking System—When in the opinion of the competent authority the system is required; a single row of markers at a minimum distance of 200 ft. and a maximum of 300 ft. apart shall be provided in the middle of the runway at its approach end. They should have a surface area of a minimum of ten square ft. and not constitute obstructions.

Threshold Markings Shall be provided at the end of the runway and shall number four across its width.

Runway Designation Markings—All runways shall be numbered with a two-digit number at each end. The number assigned shall be that whole number nearest to one tenth of the magnetic azimuth of the center-line of the runway, measured clockwise from Magnetic North when viewed from the direction of approach. Parallel runways shall be so identified by "L" and "R" for two; by "L", "C", "R", for three; and by "L", "LC", "RC", "R" for four runways.

Longitudinal Markings—Runway longitudinal markings should be displayed on all runways and should be one of several recommended designs.

Approach Lighting System—Shall be provided on all runways intended for use at night and shall comply with one of several alternate recommended designs. This applies also to runway threshold lights.

Emergency Power Supply—Shall be provided for radio and land-line communication equipment for aeronautical, mobile and fixed equipment and services and for minimum lighting necessary to enable air-traffic services personnel to carry out their duties.

G. FLIGHT CONTROL AND SIGNAL COMMUNICATION

1. FLIGHT CONTROL

There are three groups of frequencies in the v.h.f. band used for aircraft control. These are for Airfield-control, Approach-control, and Area-control. The use of these frequencies is dependent on the density of the air traffic, for if only one aircraft was in the region it would be possible to pass all instructions on one v.h.f. channel and to use the same frequency for D/F purposes. Where a number of aircraft are flying in the region of control, different frequencies are used. The division of control is then dependent on the distance of the aircraft from the controlling airfield. Airfield control is the term applied to the immediate vicinity. Approach control extends up to about 75 miles. At Mingaladon approach control applies within a radius of 115 miles and area control to the boundary of the region or the extreme range of the equipment. The International Civil Aviation organization has assigned the Government of Burma at Rangoon a region larger than Burma itself. This region is bounded by Burma land geographic boundaries and by the 92° and 100° meridian of east longitude to the 10° parallel of latitude north. Control of all aircraft is assumed upon their entry within this Region.

The present density of internal air traffic requires only two frequencies at the minor airports; i.e. airfield-control and approach-control.

(a) **Approach-control** is utilized for normal control and direction-finding facilities and its inside limit is the airfield vicinity. This means that aircraft will be in continuous contact on this frequency and that in the event of distress a series of bearings will be available for assistance to the pilot.

(b) **Airfield-control** is limited to the immediate vicinity of the airfield and is on a separate frequency so that a minimum of interference is caused to any aircraft requiring D/F assistance.

(c) **Radio beacons.** Further navigational facilities for domestic-flying aircraft are medium-powered MF beacons placed at selected airfields in order that a pilot may obtain fixes by means of the aircraft radio compass. Thus within a grid of these beacons he can plot his absolute position. These are used also for homing aircraft and facilitate landing at airstrips that are in difficult locations to approach, as at Tavoy where an adjacent mountain intrudes.

In Burma there are five radio beacons, four of which are on the coast at Akyab, Mingaladon, Tavoy and Mergui. One is at Mandalay. Because of the mountainous terrain of much of Burma, because most of the navigation is solely dependent upon visual aid during periods of high cross-winds which can carry the aircraft far off its course, and because visual navigation during these periods is often prevented by poor visibility, it is important that an internal grid of radio beacons be installed so that the aircraft position can never be lost. If aircraft radio become inoperative for reception, or if for some reason the aircraft can signal only a distress landing without being able to give its position, the VHF/DF equipment can be used to obtain azimuths of the distress signal and to furnish search and rescue information.

It is noted that the office of the DCA has budgeted requests for authorization to equip additional airports with radio. It is also noted that four years have elapsed since an accident inquiry board recommended "all airports be radio equipped," and still two thirds of Burma Airways airports are without this facility.

2. SIGNAL COMMUNICATION

(a) **Internal service R/T** is for communications between aircraft and ground stations for the purpose of passing approved messages, such as estimated arrival time, position in case of distress, number of seats available and weight of freight which can be booked. This service can be used also to inform the traffic officer at Mingaladon of any heavy traffic condition so that a non-scheduled flight can be arranged.

(b) **Radio controls and equipment** are presently provided at but 12 of the 33 airports of Burma to which service is flown. The DCA has control of all radio services at airports so equipped. A nominal charge was formerly made for each landing of aircraft at the rate of K10 for Doves and K25 for Dakotas but has been discontinued. Since January 1, 1952, the DCA has taken over control of the full operations of International Aeradio Ltd., with the exceptions of the main transmitter station at Mingaladon and operations at Mergui and Akyab. The main transmitter station at Mingaladon is to be moved to another building as the Burmese Army requires the building for its use. Repairs, adjustments and new installations of the UBA radio system are still contracted to International Aeradio Ltd. by DCA.

3. CONCLUSIONS AND RECOMMENDATIONS

(a) All airfields should be equipped with medium-powered MF beacons.

(b) As is indicated in Table XVII–14, the DCA is faced with the fact that 21 airfields to which UBA aircraft are flown are without any radio control. The initial cost to equip each station is estimated at K52,000 for apparatus and K5,000 for installation. This would provide Aerodrome Control, Internal Service R/T, VHF/DF, and Approach Control, and includes the generators and petrol engines (one stand-by). The cost of proper housing for apparatus, power,

and staff is set at a minimum of K20,000. From this can be seen that to fully equip 21 additional stations the total cost would be approximately K16·2 lakhs. The position is taken by some that, as many of these airfields have but one flight per week and several only two a month, it would be uneconomical to equip them. The opposite position is taken by crew and passengers alike when aircraft are unable to find such airports as Keng Tung somewhere below the low clouds and circled by 5,000 and 6,000-ft. peaks above the level and within ten miles of the airstrip. When the aircraft must return without making a landing, the desirability of signal controls becomes quite apparent. It is recommended that the remaining 21 airfields be equipped with radio control and that any new airfields also be so equipped.

(c) In connection with the equipment requirements of the 21 airports still without radio, it is noted that, in the past, the products of only one manufacturer have been used for all planes and stations. It is possible that costs may be out of line as a consequence. This would also apply to emergency aircraft radio with which aircraft, flying over such terrain as is generally found in Burma, should be equipped as recommended by ICAO. It is recommended that the performance data and costs for the equipment of competing manufacturers be examined in order to obtain the best equipment at the least cost.

(d) It is recommended that the flight crew of all commercial aircraft include a qualified licensed radio operator.

(e) The Preliminary Report recommended that radio operators and maintenance technicians be given training in schools in Burma to be established by GUB. It is now considered advisable that the DCA establish a radio operators' and technicians' school. This school would be available also to the Radio Telecommunications system, the entire GUB military establishment, and the Shipping Board as well as to Civil Aviation. It can be seen that the broader needs of all GUB indicate the continued need of such a school. The DCA is giving training to operators at present but the scope of this training is limited. A good radio operator of any worth should know his equipment well enough to be able to install any part subject to failure. This ability is not acquired from station training, nor are the station operators authorized and qualified by experience to make adjustments and repairs. It is therefore recommended that GUB establish a radio operators' and technicians' school to serve all agencies.

H. ACCOUNTING AND STATISTICS

The financial statement of the UBA for the fiscal year ending September 30, 1951, together with a profit and loss statement, are presented on Table XVII 15 (*see next page*). Comparable figures for the years 1949 and 1950 are shown on the table. The net cash worth of UBA has improved each year. There is now no outstanding indebtedness, and the present gross worth is entirely earned.

Plates 4, 5 and 6 show Comparative Sources of Revenue; Comparative Operating Expenses; and Revenue, Expenditure and Profit. From a study of Table XVII–16, Monthly Traffic Records (*see p. 488*), and Plates 4, 5 and 6, the following can be deduced:

1. Although passenger travel dropped 28% from 1951 to 1952, the revenue dropped only 4%, due mainly to an increase in rates.

2. For the years 1949 and 1950, A/C charter fees exceeded the income from passenger travel.

3. Monthly Traffic Records indicate that passenger traffic has decreased with the decrease in services flown per month, but not in as great a proportion. This tabulation also shows a decrease in route miles per month but not in proportion to the decrease in flight services. This is also true of totals for baggage freight and mail weights handled. The most important conclusion is that the actual flight operations costs have been considerably reduced by better loadings per aircraft and flight. However, the crowding of aircraft with freight to the discomfort of passengers is not consistent with the objectives of providing better services. Nearly a four-to-one heavier loading of passengers and a three-to-one heavier loading of freight occurred in 1952 than in the first six months of 1951.

The accounting and statistical records for UBA, kept at the control terminal building on Strand Road, Rangoon, comply with GUB requirements and are subject to interim and yearly audit of the Accountant-General's office. From the organization chart (Table XVII 9), the department appears to have sufficient personnel to perform its duties. However, the year-end report is delayed too long before issuance. It is recommended that a study be made of the Accounting, Fiscal and Statistical Department, to determine means to increase its efficiency.

I. FUTURE DEVELOPMENTS

Elsewhere in this chapter the following major developments have been mentioned as in progress or planned:

1. Operation of the airport radio by the DCA, as proposed by the Preliminary Report, has been taken over from International Aeradio Ltd.

2. The training of pilots in Burma has been determined uneconomical in comparison with the cost in the United Kingdom and it is planned to send another twelve students there.

TABLE XVII – 15

UNION OF BURMA AIRWAYS

OPERATING ACCOUNT FOR THE PERIOD FROM OCTOBER 1, 1950, TO SEPTEMBER 30, 1951

Rupees in Lakhs 1948–49	1949–50		Details 1950–51	Total 1950–51
		To OPERATING EXPENSES		
8·01	20·22	Flying Operation	49,40,257 5 3	
2·10	4·46	Ground Operation	18,12,691 6 1	
5·22	8·81	Traffic, Passengers, Freight Services	8,11,632 0 2	
101·69	138·67	Charter Fees (Leased A/c)	Nil	
117·02	172·16			75,64,580 11 6
40·67	80·54	To Gross Profit transferred to Profit & Loss account		54,54,767 12 9
157·69	252·70			1,30,19,348 8 3

Rupees in Lakhs 1948–49	1949–50		Details 1950–51	Total 1950–51
		BY OPERATING REVENUE		
47·73	84·73	Passage	89,72,062 10 3	
20·16	60·54	Freight	18,75,872 15 5	
2·69	4·52	Excess Baggage	3,63,003 3 0	
2·25	3·61	Carriage of Mails	4,24,897 2 7	
84·86*	99·30*	Income from charter (own)	13,83,512 9 0	
				1,30,19,348 8 3
157·69	252·70	*(Income from own and leased aircraft)		1,30,19,348 8 3

PROFIT AND LOSS ACCOUNT FOR THE PERIOD FROM OCTOBER 1, 1950, TO SEPTEMBER 30, 1951

Rupees in Lakhs 1948–49	1949–50		Details 1950–51	Total 1950–51
1·80	2·98	To General Administration Expenses		6,22,997 13 3
		To DEPRECIATION		
5·24	8·14	On aircraft, fleets, spares (Dove and Dakota)	13,92,850 2 9	
0·10	0·28	On Plant, Machinery, Ground Equipment	32,941 9 4	
0·57	0·85	On Motor Vehicles	1,03,694 0 0	
0·32	0·22	On Furniture, Fixtures, Office Equipment	41,269 14 0	
		On Buildings and Structures	16,599 3 8	
6·23	9·49			15,87,354 13 9
2·00	2·00	To Reserve for losses due to obsolescence of a/c spares		2,00,000 0 0
2·00	—	Unforeseen Liabilities		Nil
2·32	—	To Loss of aircraft XY-ABP to insurgents		Nil
1·92	1·45	Interest paid on loan received from Government	1,643 13 0	
		Interest paid to Indonesian Airways	160 9 0	
				1,804 6 0
0·50	—	Bad and Doubtful Debts		Nil
0·30	0·30	Proportion of Prel. Expenses written off		29,843 12 0
24·13	64·90	Balance being net profit for the period carried forward to Balance Sheet		30,98,830 12 8
41·20	81·12			55,40,831 9 8

Rupees in Lakhs 1948–49	1949–50		Details 1950–51	Total 1950–51
40·67	80·54	By Profit transferred from Operating A/c Incidental Revenue		54,54,767 12 9
0·05	0·06	Booking Cancellation Fees	7,966 13 0	
0·27	0·26	Sundry Receipts	29,799 2 10	
0·32	0·32			37,765 15 10
0·21	0·10	Engineering Job Receipts		
		Interest recd. on Investment Account		8,524 2 0
—	0·04	3 years T. Bonds at 2½% = Rs. 18,78,000	12,784 9 5	
—	0·12	3 months T. Bills at 1% = Rs. 25,00,000	26,989 1 8	
—	0·16			39,773 11 1
41·20	81·12			55,40,831 9 8

BALANCE SHEET AS OF SEPTEMBER 30, 1951

Liabilities

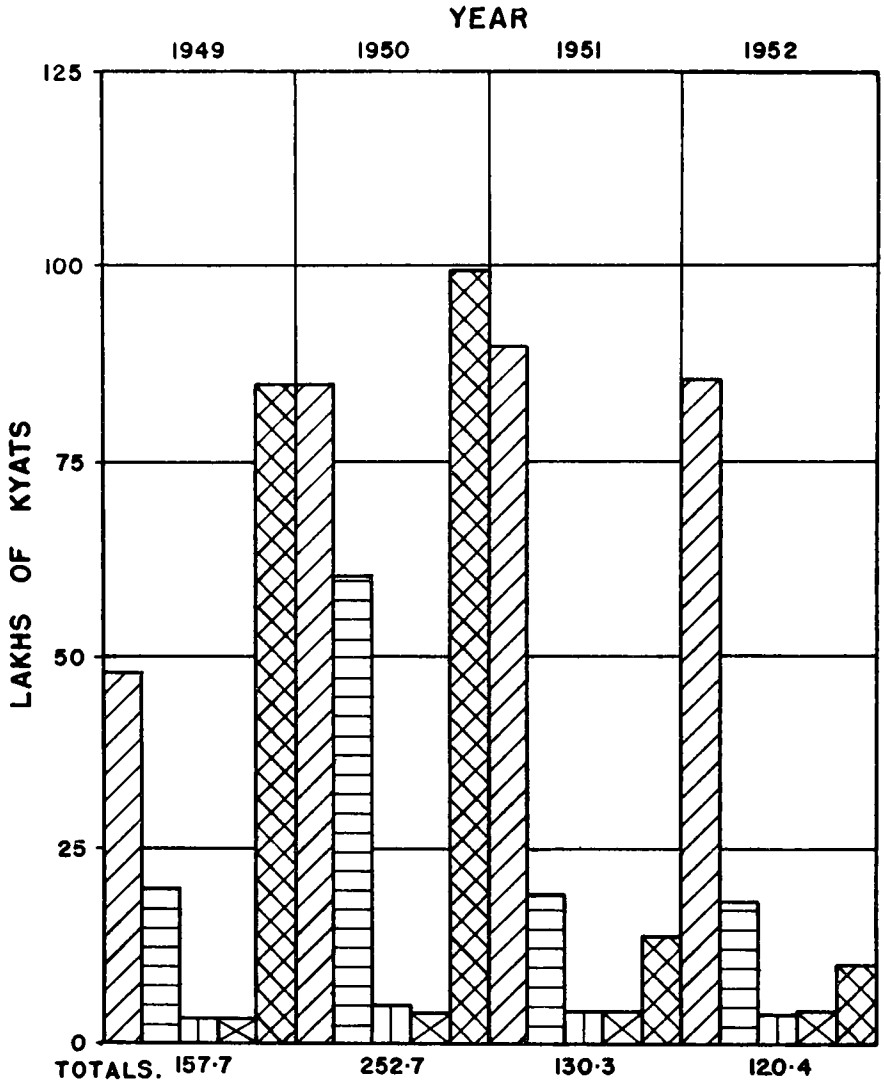
Rupees in Lakhs 1948–49	1949–50		Details 1950–51	Total 1950–51
		SANCTIONED CAPITAL		50,00,000 0 0
50·00	25·00	Loan Capital (Balance)	25,00,000 0 0	
		Repayment during 1950–51	25,00,000 0 0	Nil

Assets

Rupees in Lakhs 1948–49	1949–50		Details 1950–51	Total 1950–51
		FLEET ACCOUNT AT COST AT 30/9/51		
10·85	10·85	De Havilland Dove Aircraft*	8,14,679 4 6	

		Reserve Account			
—	25·00	Capital Reserve			25,00,000 0 0
4·51	12·54	Depreciation on Aircraft, Aircraft spares, etc. (Last Balance 12,53,774 1 3+ This year 12,47,995 3 4)	25,01,769 4 7		
0·10	0·38	Depreciation Plant, Machinery, W/shop Equipment (Last Balance 37,615 1 2+ This year 32,941 9 4)	70,556 10 6		
0·42	1·27	Depreciation Motor Vehicles (Last Balance 1,27,345 9 4+ This year 1,03,695 0 0)	2,31,040 9 4		
—	—	Buildings and structures	16,599 3 8		
0·26	0·48	Depreciation Furniture Fixture, Office Equipment (Last Balance 47,873 1 8+ This year 41,269 14 0)	89,142 15 8		
5·29	14·67				29,09,108 11 9
2·00	4·00	Reserve for losses on obsolescence of Aircraft and Stores including reserve of Rs. 2,00,000/- made during the year	6,00,000 0 0		
1·92	1·45	Reserve for interest	Nil		
0·15	0·37	Reserve Audit Fees	18,400 0 0		
2·00	1·78	Reserve unforeseen liabilities (Last Balance 1,78,606 8 3—			
0·50	0·50	This year 32,380 5 0)	1,46,226 3 3		
6·57	8·10	Reserve Bad Debts	50,000 0 0		
					8,14,626 3 3
		Sundry Creditor/Credit Bal.			
10·25	6·53	Sundry Creditors (Trade)	5,07,444 6 8		
1·44	0·72	Sundry Credit Balances	7,38,596 10 4		
11·69	7·25				12,46,041 1 0
0·62	0·45	Sundry Revenue Received in Advance			1,31,884 15 7
—	24·13	Profit and Loss Account as per last Balance Sheet	64,33,193 2 10		
—	0·30	Add: Prior year Rev. Account	64,678 1 7		
—	24·43		64,97,871 4 5		
—		Less: Prior year Expense A/c	1,31,729 1 9		
—	24·43		63,66,142 2 8		
24·13	64·90	Add: Net Profit for the year as per accompanying Profit and Loss Account	30,98,830 12 8		
24·13	89·33		94,64,972 15 4		
—	25·00	Less Transferred to Capital Reserve Account	Nil		
24·13	64·33				94,64,972 15 4
98·30	144·80				1,70,66,633 14 11

—	11·91	Field Aircraft Services Dakota Aircraft. 1949–50 11,90,513 15 2 1950–51 Purchase 4,38,124 2 6	16,28,638 1 8	
10·85	22·76	(*Last Balance 10,85,124 10 0 This year 2,70,445 5 6)		24,43,317 6 2
4·60	7·23	Aircraft Spares, Power Units Engine, Airframe, Propeller Radio, etc. (Dove and Dakota) at cost at 30/9/51	15,70,386 7 9	
0·59	1·12	Plant Machine, i.e. Ground and W/shop Equipment at cost at 30/9/51	1,29,854 12 6	
1·27	2·68	Motor Vehicles at cost at 30/9/51	3,23,269 7 0	
0·90	1·31	Furniture, Fixtures, Office Equipment at cost at 30/9/51	2,09,412 1 2	
—	—	Building at cost at 30/9/51	9,55,286 9 0	
1·83	3·61	Stock of stores, spares on hand as at 30/9/51	75,000 5 3	
—	—	Stock of Fuel Oil on hand as at 30/9/51	11,323 3 6	
0·08	0·18	Stock of Stationery on hand as at 30/9/51	9,189 12 1	
9·27	16·13			32,83,722 10 3
		Sundry Debtors/Debt Bal.		
32·30	23·75	Sundry Debtors (Trade)	26,43,318 14 7	
4·14	10·42	Sundry Debit Balances	10,02,848 2 5	
1·09	1·31	Insurance Prepaid	2,12,488 0 7	
—	0·40	Prepaid Expenses	1,88,005 9 0	
37·43	35·88			40,46,660 10 7
0·60	0·30	**Preliminary Expenses**	29,843 12 0	
—	—	Less (1950–51) written off Suspense cash lost (case pending in BSI Court)	29,843 12 0	Nil
				37,486 12 0
		Investments		
—	9·29	3 years T. Bonds bearing 2½% per annum	18,78,000 0 0	
—	50·00	3 month T. Bills bearing 1% interest per annum	25,00,000 0 0	
—	59·29			43,78,000 0 0
		Cash Balance		
35·62	9·43	On current account with the Union Bank, Rangoon	28,12,234 9 11	
4·53	1·01	Office Cash/Cheques	65,211 14 0	
40·15	10·44			28,77,446 7 11
98·30	144·80			1,70,66,633 14 11



PASSENGERS ----------
FREIGHT ----------
EXCESS BAGGAGE -------
MAIL ----------
INCOME FROM CHARTER ---

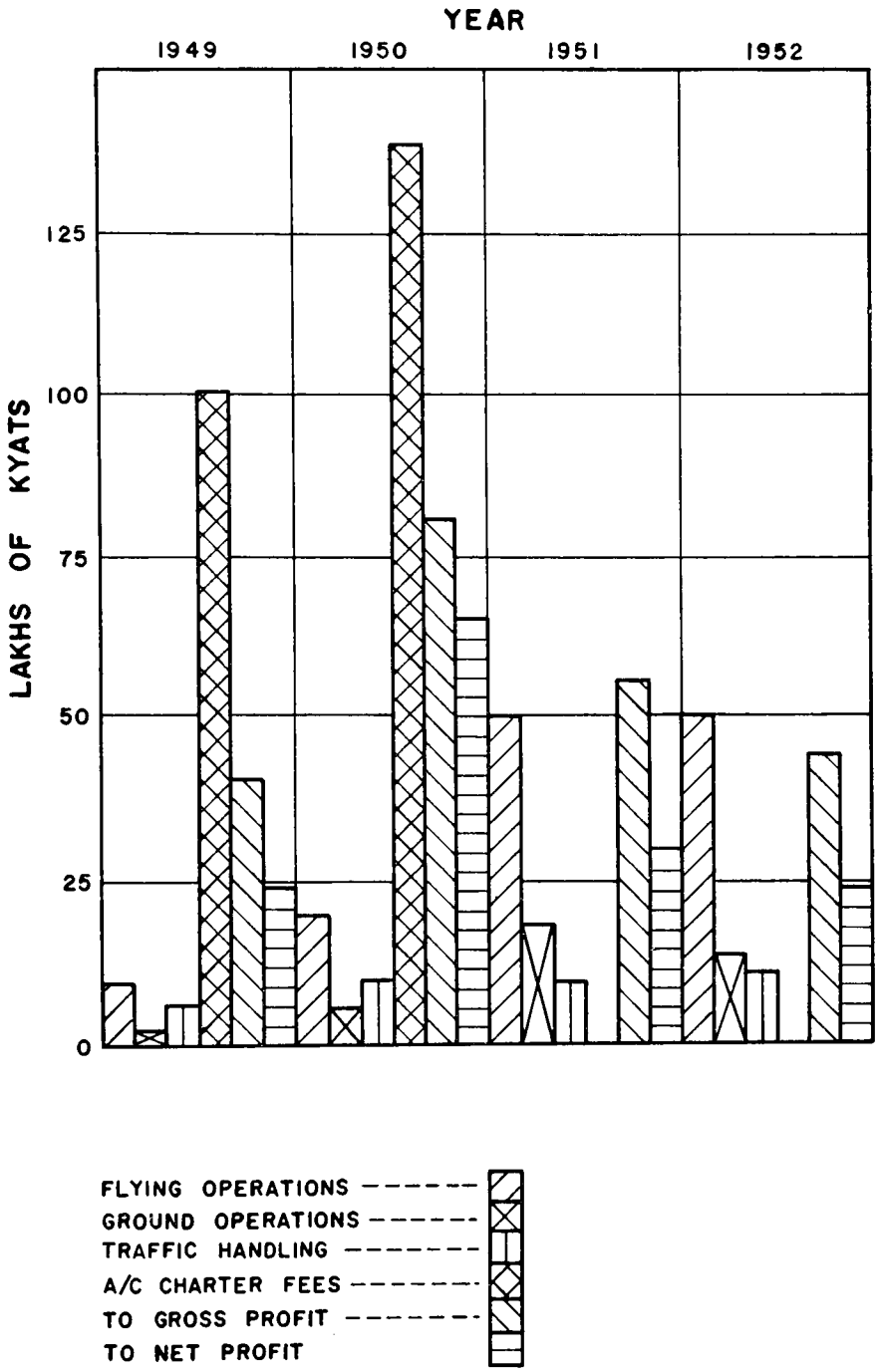
MINISTRY OF NATIONAL PLANNING

UNION OF BURMA AIRWAYS

COMPARATIVE SOURCES OF REVENUE

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY EJP DATE PLATE
CK. BY EPT MAY 53 NO. 4



MINISTRY OF NATIONAL PLANNING

UNION OF BURMA AIRWAYS

COMPARATIVE OPERATING EXPENSES

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

DR. BY E.J.P. DATE PLATE
CK. BY E.P.T. MAY 53 NO. 5.

TABLE XVII – 16

UNION OF BURMA AIRWAYS

TRAFFIC RECORDS

MONTHLY OPERATIONS

Date	*Flights*	*Passengers*	*Baggage (lbs.)*	*Freight (lbs.)*	*Mail (lbs.)*	*Total Wt. (lbs.)*	*Miles*
January 1951	940	15,271	94,934	596,369	32,956	724,259	160,854
February	1,023	15,721	102,285	807,787	31,410	941,482	175,270
March	1,026	17,587	118,835	682,997	39,102	840,934	165,735
April	1,136	19,319	117,015	724,974	32,176	874,165	179,628
May	1,217	20,219	138,027	738,834	34,680	911,541	189,075
June	1,041	13,550	124,460	609,315	33,325	767,100	155,851
July	869	11,721	95,194	612,517	34,295	742,006	138,157
August	725	12,614	92,173	636,904	43,034	772,111	111,755
September	644	11,502	88,931	737,934	35,586	862,451	111,490
October	229	11,114	79,097	527,631	22,743	629,471	129,499
November	272	12,163	84,185	590,073	23,250	697,508	160,819
December	262	11,347	74,415	561,031	26,168	661,614	134,937
Total	9,384	172,128	1,209,551	7,826,366	388,725	9,424,642	1,813,070
January 1952	250	10,482	66,031	542,107	23,994	632,132	118,180
February	263	12,009	58,697	605,613	25,031	689,341	135,088
March	265	12,837	63,207	537,081	23,100	623,388	146,081
April	312	13,092	58,544	383,544	21,491	463,579	150,607
May	267	12,078	70,658	444,309	22,798	537,765	142,929
June	191	8,706	71,216	432,262	22,934	526,412	111,780
July	238	9,132	52,995	463,295	24,820	541,110	126,655
August	243	8,991	51,011	559,402	23,728	634,141	127,499
September	225	7,935	52,293	434,533	21,448	508,274	84,648
October	263	10,002	61,048	487,824	22,154	571,026	124,825
November	255	7,820	59,397	524,351	23,984	607,732	135,020
December	296	11,472	80,503	740,670	25,527	846,700	155,609
Total	3,068	124,556	745,600	6,154,991	281,009	7,181,600	1,558,921

3. Funding of the purchase of new aircraft is approved at the rate of K25 lakhs per year for the next four years.

4. The enlargement of the maintenance shops at Mingaladon is in progress, an additional main hangar has been released by the BAF to UBA, and machine tools are being installed.

5. As proposed in the Preliminary Report UBA is now starting maintenance service of BAF aircraft, having been assigned seven for full servicing.

6. An increase in personnel of not less than 20% is contemplated in the maintenance division.

7. The office of the DCA has prepared, or caused to be prepared, estimates for the program of airport development and improvement. The work at the airports indicated below is to be included in the program for 1953–54 construction.

Work	*Cost Estimate (kyats)*
Akyab. The construction of an all-weather permanent runway. The sanction of the Government to undertake this work will be applied for on receipt of estimates of costs from the PWD at Akyab.	10,00,000
Victoria Point. The construction of an all-weather permanent runway. The sanction of the Government to undertake this work has been requested.	10,00,000
Thayetmyo. The construction of an all-weather permanent runway. The sanction of the Government to undertake this work has been requested.	5,60,000
Mergui. The extension of runway. The PWD at Mergui is preparing a detailed estimate.	2,00,000
Kyaukpyu. Improvements. The EE (B & R) Kyaukpyu Division, reports that the estimate of this work will be submitted after the Superintendent Engineer, Maritime Circle, has determined transverse gradients and paving thickness.	7,50,000
Tavoy. The construction of an all-weather macadam runway. Sanction of the Government to undertake this work has been requested.	3,75,000

Myingyan. The construction of a new airstrip with work to start during 1953–54.	4,20,000
Bassein, Magwe and Heho. Resurfacing. Work at Heho to be carried on during the current 1952–53 season, and Magwe and Bassein during 1953–54.	9,00,000
Momeik. Tar and stone screenings. Sanction of the Government to undertake this work has been requested.	2,64,000
Controlled Airfields. Barbed-wire fencing. Sanction of the Government has been requested.	2,00,000
Controlled Airfields. Provision of labor staff quarters. Sanction of the Government has been requested.	1,17,000
Toungoo, Henzada, Loikaw and Thayetmyo. Radio telecommunications buildings. Sanction of the Government has been requested.	80,000
Sandoway (Mazin). Construction of permanent staff and W/T building. Sanction of the Government has been requested.	30,000
Total	58,96,000

8. Development and improvements are in progress at the following eight airports.

Carry-on Work	*Cost Estimate (kyats)*
Akyab. A new modern terminal building. With construction completion to be by the end of 1954.	3,00,000
Mandalay. A new modern terminal building. With construction completion to be by the end of 1954.	3,00,000
Buthidaung. A new civil aerodrome at this site. Salvaged pierced-steel plank at Akyab has been taken over by the Pyidawtha Committee for this work. This airstrip is near the site of the proposed Saingdin Falls Hydroelectric Project.	3,00,000
Sandoway (Mazin). The construction of a permanent all-weather airstrip. Sanction of the Government has been received. Completion is contemplated in 1954.	7,60,000
Henzada. The construction of an entirely new airfield has been started against an allotment of K50,000 for 1953 with ultimate completion in 1954.	16,00,000
Prome. The construction of a new airfield.	22,23,000
Singaling Khamti. An all-weather runway is under construction with K1,00,000 authorized for 1953 and completion in 1954.	5,04,000
Moulmein. A second seal coat has been started with completion estimated in 1954.	81,000
The estimated total cost of this carry-on work is	60,68,000
The total costs for items 7 and 8 above is the sum of	1,19,64,000

9. *Additional improvements.* The above estimates on close study disclose no re-orientation to windrose directions, no extensive fills or cuts to provide 500-ft. usable widths, and especially no clearing in the approach and departure zones for a distance of two miles from the airstrip. They provide for no transverse drainage. The conditions of the airstrips to which the UBA are scheduling flights are such that on ICAO requirements 27 of the 33 would be condemned.

The cost of the foregoing demand work for the next 12 months is estimated at	K30,00,000
The increase of 100% in the UBA fleet	K60,00,000
Total—Item 9	K90,00,000
Total—Items 7 and 8	K1,19,64,000
Total Budget	K2,09,64,000

J. CONCLUSIONS AND RECOMMENDATIONS

1. PRELIMINARY REPORT RECOMMENDATIONS

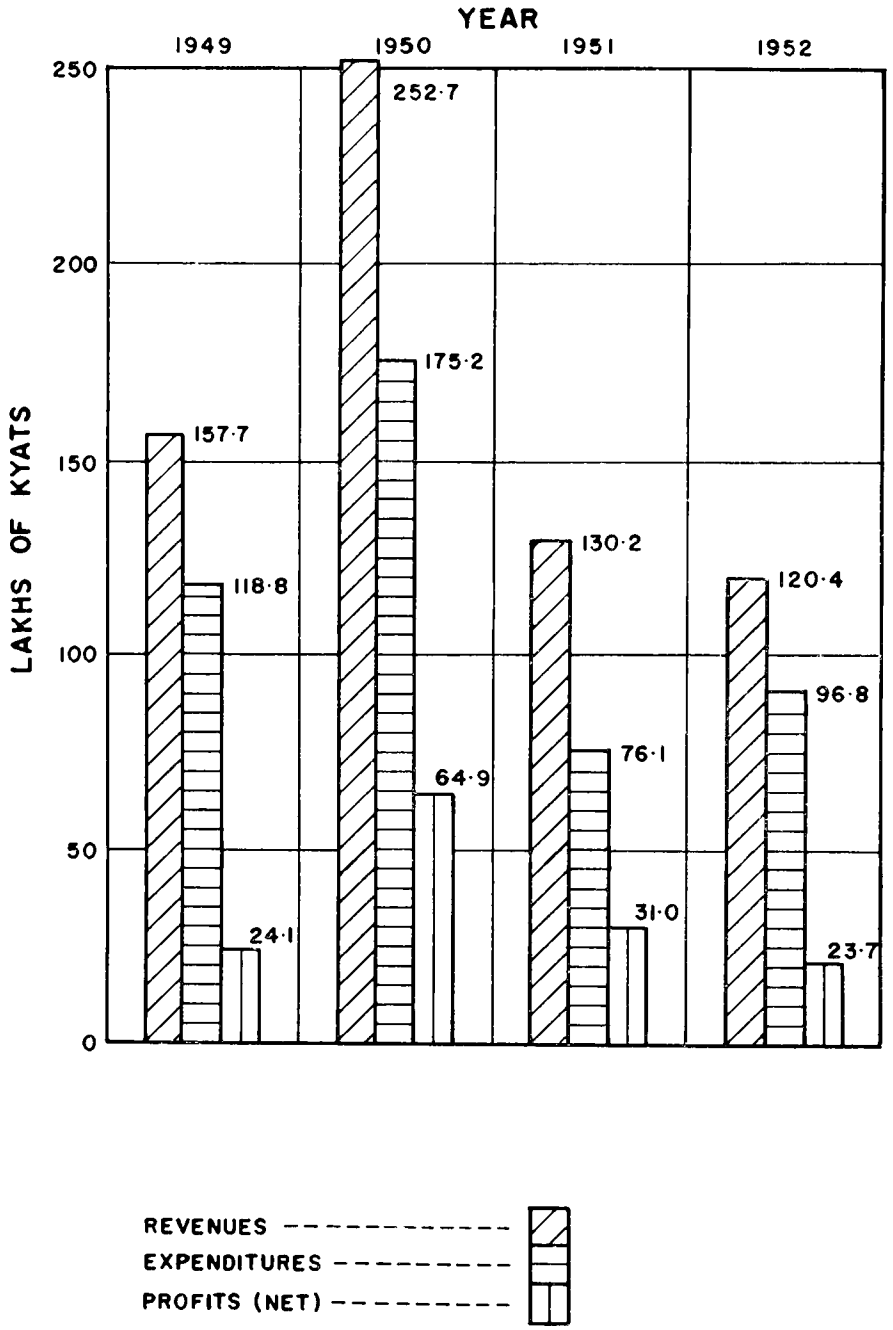
The Preliminary Report reviewed the organization, plant and facilities, traffic flight control, and the fiscal situation of the UBA, and presented certain recommendations. Subsequently, these recommendations were considered by an advisory board on Civil Aviation and Airways on behalf of the subcommittee on Transportation and Communications. This board was composed entirely of Burma Airways and civil aviation officials.

Regulatory commission. The first recommendation of the Preliminary Report found under Section VIII, Transportation, urged the establishment of a regulatory commission to control the four major transport divisions; i.e., railroads, highways, waterways and airways. The advisory board of March 21, 1952, voted against such a regulatory commission. However, although Airways rates are less directly competitive than those of the other transportation systems, a properly representative regulatory body would take all such factors into account and would insure a balanced structure and proper safety practices for the country as a whole.

Maintenance and training. The coordination and improvement of the administrative functions of personnel training, workshop maintenance and a spare-parts supply for civil and military aircraft was considered by the Advisory Board and action thereon is in progress. At present, UBA is maintaining seven BAF aircraft and has obtained a second hangar badly needed to remove repairs from exposure to weather. The BAF, however, is reluctant to discontinue entirely its own maintenance and is presently recruiting mechanics and training them. This may well be justified for military reasons, and no further comment is offered.

Operations training. The Preliminary Report recommended training of pilots, radio operators and maintenance technicians in formal schools to be established in Burma. The advisory board rejected this on the presumption that the need for pilots is very limited. However, it should be noted that pilots of military aircraft must receive an entirely different type training from that received by commercial pilots, the first being taught risk-taking, the second being taught risk-avoidance. Radio operators are more easily obtained, and maintenance technicians are soon shop-trained.

Radio Operation. The Preliminary Report recommended that the operation of the radio and signal network be by the DCA. This is now the case and the expansion of the system is in progress, with the installation of radio at Tavoy and Keng Tung now com-



MINISTRY OF NATIONAL PLANNING

UNION OF BURMA AIRWAYS

REVENUE EXPENDITURE AND PROFIT

KNAPPEN TIPPETTS ABBETT ENGINEERING CO.
NEW YORK RANGOON

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pleted, and of radio beacons at Tavoy, Keng Tung, Heho and Lashio in progress. Also an auxiliary beacon is to be located about 100 miles north of Rangoon on the Prome Road.

Aircraft replacement. The Preliminary Report recommended the establishment of a fund for the phased replacement of aircraft. Steps have been taken by the UBA to set aside these funds and the sum of K25 lakhs is annually to be allocated. The purchase of three Marathon, Mark I aircraft late in 1952 was not, however, from these funds.

2. COMPREHENSIVE REPORT RECOMMENDATIONS

For convenience, the various recommendations presented in this chapter are summarized below. It is recommended that:

(*a*) An airlines agency be established to prepare the necessary papers to clear air freight through customs. This service should be rendered free of charge.

(*b*) The Rangoon Post Office close its air pouches not sooner than two hours before departure time.

(*c*) Test flights, advertised in advance, should be made to the airports presently served to determine whether an increase in traffic will result.

(*d*) An airstrip should be constructed at Homalin, approximately half-way between Singaling Khamti and Kalemyo.

(*e*) The Papun airstrip should be developed and flights scheduled immediately upon securing the area.

(*f*) A survey should be made of the Special Division of the Chin Hills to determine the most advantageous site for an airstrip.

(*g*) The number of pilots, co-pilots and radio operators should be increased to 24, and the number of available crews kept at 150% of the number of available planes.

(*h*) The pilot-training program should be made a permanent part of UBA.

(*i*) Non-national crew members should be replaced as soon as the training program permits.

(*j*) A retirement program, financed by GUB, should be initiated for all UBA employees, especially crew members.

(*k*) The personnel of the Maintenance Division, UBA, should be increased up to 20% as recommended by the Superintending Engineer.

(*l*) The agents who have contracted to handle booking and freight for UBA should be required to use experienced labor in handling freight.

(*m*) In DCA, the positions of senior Flying Officer and Supervising Engineer should be filled by qualified individuals. In addition, the Supervising Engineer should be provided with an engineering staff.

(*n*) The aerodrome officers employed at the various airports should be engineering graduates and receive training under the chief aerodrome officers and the Supervising Engineer.

(*o*) Further study be made of the prospective passenger-traffic loads and that the passenger fleet be increased to accommodate these loads.

(*p*) A shuttle service utilizing Dove aircraft should be initiated between Mandalay and all airports lying north of Lanywa and Heho.

(*q*) Daily freight service utilizing C-47 aircraft should be instituted between Rangoon and Mandalay, to be followed by a completely separated freight service for the full system of airports.

(*r*) An inventory of machine tools, hand tools and spare parts should be made, and the necessary tools and spare parts purchased.

(*s*) A program should be prepared and implemented to correct the deficiencies existing at the airfields, as indicated in Table XVII–14, and work should proceed immediately.

(*t*) All airfields, existing and proposed, should be equipped with complete radio control.

(*u*) The performance data and costs for the radio equipment of competing manufacturers should be examined in order to obtain the best equipment at the least cost.

(*v*) The flight crews of all commercial aircraft should include a qualified licensed radio operator.

(*w*) GUB should establish a radio operators' and technicians' school.

(*x*) A study of the systems, supervision and related responsibilities of the accounting department should be made.

(*y*) The system of airports should be enlarged to better serve the outlying districts. Ministers and other officials of these districts should be called upon to assist in locating the new airports.

(*z*) DCA exercise more rigid supervision of the handling of traffic, both by UBA personnel and agents.

(*aa*) A Safety Engineer, reporting only to the Minister of Transport and Communications, be employed to check on the strict compliance with the standard safety recommendations of the ICAO.