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Joint Thai - U.S.

Military Research Development Center

Bangkok, Thailand

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MILITARY RESEARCH AND DEVELOPMENT CENTER

QUARTERLY REPORT
1 October - 31 December 1963
QRT-1

11045

T. W. Brundage
Director
OSD/ARPA R&D Field Unit

S. Menasuta
Singchai Menasuta
Major General
Commanding General, Military Research and Development Center

CONTENTS

INTRODUCTION

MRDC MISSION

The Military Research and Development Center, Thailand (MRDC) is a joint Thai-U.S. organization established to undertake research, development, test and evaluation activities in support of the Royal Thai Armed Forces, with special emphasis on strengthening Thai counterinsurgency capabilities.

MRDC is established within the Thai Ministry of Defense Supreme Command Headquarters under the leadership of Major General Singchai Menasuta, Director, and Mr. Thomas W. Brundage, Deputy Director. It is staffed jointly, and its work is conducted jointly, by officers of the Royal Thai Armed Forces and officers and civilians assigned from the U. S. Department of Defense. Representation from the United Kingdom Ministry of Defence has also been provided. Scientific, technical, and military operations experience are represented on the staff. The U. S. component of the MRDC, called the Research and Development Field Unit (RDFU), and requisite financial and materiel support, are provided through the Advanced Research Projects Agency, Office of the Secretary of Defense as part of ARPA's program of research in Remote Area Conflict (Project AGILE).

Primary emphasis in Thailand is placed on research and development effort of a long term nature in fields such as communications, surveillance, mobility, and operations research. Much of the work is theoretical and experimental, and for the time being, is mainly non-hardware oriented. It is felt that fundamental studies in fields such as the foregoing will provide the basis for and eventually lead to specific improvements in the capabilities of Thai forces, and that the basic information acquired in Thailand can often be applied to similar problems facing other U. S. allies.

FORMAT

Insofar as is possible, the format and nomenclature used in this Quarterly Report follows that used in the ARPA Project AGILE Quarterly Report series. Readers are reminded that the ARPA Quarterly Report contains summaries of Project AGILE research tasks conducted in CONUS and South Vietnam as well as in Thailand. The MRDC Quarterly Report is concerned with field tasks conducted in Thailand only.

As announced in the last Quarterly Report in Recognition of the long-term nature of MRDC research tasks, it has been decided that the Monthly Letter Report previously sent by MRDC to OSD/ARPA will be discontinued. Henceforth, the primary periodic reporting document for MRDC will be the Quarterly Report. Commencing with this Report, MRDC Quarterly Reports will be serialized and numbered for ease of reference. This Report is identified as QRT-1.

CHANGE IN UNIT NAME

By decision of the Thai Ministry of Defense, the name of the Combat Development and Test Center (CDTC) has been changed to Military Research and Development Center (MRDC), effective 14 November. Correspondents are advised that CDTC papers, reports, and other documentation will bear the new MRDC designation.

GENERAL INFORMATION

During the reporting period, MRDC was pleased to host visits by two official parties from the United States. Dr. Harold Brown, Director of Defense Research and Engineering, and Mr. Willis Hawkins, Assistant Secretary of the Army, R&D, visited the Center 8-12 December, accompanied by Mrs. Brown, Mrs. Hawkins and the following Defense officials: Lt. General N. Dick, Chief of Army R&D; Mr. Jack Stempler, Assistant General Counsel, OSD; Colonel L. P. Linn, USA, Joint Staff; Colonel R. P. Campbell, USA, ODDR&E; Colonel D. D. Blackburn, USA, Army Staff; and Colonel R. Firehock, USA, CINCPAC R&D. Mr. W. H. Godel, Deputy Director (Management), ARPA, joined the group in Bangkok. Our guests had the opportunity to hold discussions with Air Chief Marshall Dawee, Chief of Staff, Supreme Command and Major General Chalerm, Director of Education and Research, Supreme Command; meet Major General Ernest Easterbrook, Chief JUSMAG; visit the Electronics Laboratory; and attend briefings by MRDC project officers on the wide range of RDT&E activities being conducted in Thailand.

During the period 6-13 November, MRDC was visited by Dr. Charles Herzfeld, Deputy Director, ARPA and Major General Robert Wienecke, USA, Executive Assistant to the Director, ARPA. Following intensive briefings by senior Thai and U. S. officials and project officers at MRDC, a field observation trip was arranged to see the Thai Meteorological Department's Seismic Research Station at Chiengmai and the Mobile Development Unit field headquarters in Sakol Nakhon and Kalasin Provinces. The communications field test site at Pakchong was inspected from the air.

MRDC also briefed Dr. Frank Sheppard, Chief, Social Development Division, USOM and his staff in November.

Major General Singchai Menasuta, Commanding General, MRDC and Dr. Charles M. Herzfeld, Deputy Director, ARPA pose during a respite in the talks held during Dr. Herzfeld's visit to Thailand in November.

Left to Right: Major General Wienecke; Colonel Nuan; Commander, Mobile Development Unit - 2; Major General Singchai; Dr. Herzfeld; and Colonel Benjamin King, Deputy Director, OSD/ARPA R&D Field Unit-Thailand during a visit to MDU-2 field headquarters in Sakol Nakhorn Province, Northeast Thailand.

Mr. Thomas Brundage, Director, OSD/ARPA R&D Field Unit, Thailand; Major General Robert Wienecke, Executive Assistant to the Director, ARPA; and Mr. Stephen Dobrenchuk, U. S. Consul, Chiengmai during the Herzfeld-Wienecke party's visit to Chiengmai in North Thailand.

Mr. Brundage discusses operational problems with staff members of the Meterological Department's seismological station at Chiengmai. This station is part of the world-wide network of standardized seismic research stations established as part of ARPA's seismic research program called Project VELA-UNIFORM.

Left to Right: Major General Wienecke with Mr. Brundage; Major General Singchai; Mr. Choosck of the MDU-2 staff; Colonel Nuan; Colonel Lua, Deputy Director, MRDC-T; and Dr. Prasart of the Thai Meteorological Department at MDU-2 headquarters.

MAP


THAILAND
BURMA
LAOS
MAE NAM CHAO PHRAYA LOWLANDS
KHORAT PLATEAU
DANG REK
CAMBODIA
VIETNAM
MERGUI ARCHIPELAGO
MALAYA
INDONESIA
DEMARCATION LINE
International boundary
National capital
Principal port
Principal airfield
Selected main road
Selected secondary road
Railroad
Spot height (in feet)

27401 12-58

SUB-PROJECT I

TACTICAL UNIT WEAPONS SYSTEMS

SUB-PROJECT I

TACTICAL UNIT WEAPONS SYSTEMS

SUB-PROJECT OBJECTIVE:

To provide significant improvement in selected weapons and equipment employed by small tactical units engaged in conflict in remote areas. Under this task, research and engineering efforts to significantly improve the weapons, equipment and devices used by the individual soldier and by ground forces operating in tactical units up to the Company level of organization are undertaken.

All activity in this Sub-Project is presently conducted in CONUS and CDTC-V.

SUB-PROJECT II

AREA FIRE WEAPONS SYSTEMS

SUB-PROJECT OBJECTIVE:

To develop effective, or improve the effectiveness of, area fire weapons systems for both surface and tactical air employment which will provide maximum flexibility in application and superiority in fire power to the friendly local forces engaged in remote area conflicts.

Requirement: Aircraft and Air-Ground Armament and Munition Systems

Task: Counterinsurgency Aircraft

Sub-Task (Proposed) Environmental Effects on Aircraft Reliability

There was no change in the status of this Sub-Task from that reported in the Quarterly Report 1 July - 30 September 1963.

SUB-PROJECT III

REMOTE AREA MOBILITY AND LOGISTICS SYSTEMS

SUB-PROJECT III

REMOTE AREA MOBILITY AND LOGISTICS SYSTEMS

SUB-PROJECT OBJECTIVE

To improve all aspects of air, ground, and water mobility capabilities of friendly indigenous forces engaged in remote area conflict. Included are land vehicles, aircraft, and watercraft for transport of tactical units and for the delivery of supplies and equipment in support of military operations.

It should be understood that MRDC is not engaged in testing and evaluating vehicles for military application in the Mobility Sub-Project, at this time. The MRDC contribution to the purposes of this Sub-Project is to determine the validity of design concepts and principles from which superior vehicles may subsequently be derived and produced. Vehicles brought to Thailand for test may be experimental designs incorporating radically different design principles, or readily available vehicles posessing particular features needed to be analyzed in controlled test situations. In neither case are the MRDC investigations concerned with "proving" or disproving the suitability of the vehicle in question for immediate operational use. In fact, it may be necessary on occasion to test a vehicle already deemed operationally unsuitable in order to investigate a particular feature of interest which is incorporated in its design.

Requirement: Mobility Research

Task: Mobility Environmental Research (MERS)

1. On 5 October, Messrs. W. E. Grabau and E. E. Addor visited MRDC to discuss coordination of collection of environmental data for MERS and MRDC projects.

2. On 27 October, Mr. C. A. Blackmon arrived in Bangkok to establish offices and working space for the permanent party.

3. During November, Colonel J. M. Flesch visited the Director, Project MERS, at the U. S. Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, to coordinate MERS support requirements with other MRDC projects.

4. During November and December, soil samples and soil strength data were secured in the Nakorn Sawan area and in the Bang Pu area.

Requirement: Mobility Research

Task: Mobility Research and Testing (MORT)

Sub-Task: Trackmaster

1. During the previous quarter, the Trackmaster test program was completed, and the first draft of the final report was initiated. The vehicle was loaned to the Jansky and Bailey Company, working near Pakchong under the communications research program, to haul supplies to their test site. J&B personnel operating the Trackmaster will provide additional usage data on the vehicle's performance over trails during the wet season.

2. During the present quarter, the first draft of the report was completed, reviewed, and edited. The final draft is now being prepared; the report will be published and distributed upon approval.

3. J&B personnel reported difficulty with the Trackmaster's steering system, and that the vehicle threw tracks frequently on the severely rutted trail into the test site. Engineers and maintenance personnel from MRDC visited Pakchong to recondition the Trackmaster, install a new track, and evaluate the operating conditions. The trail was found to be so severely rutted as to be passable only with extreme difficulty and at considerable risk of damage to the vehicle. J&B was advised not to use the vehicle on that trail. They have retained the Trackmaster for reconnaissance of other unrutted trails in the area.

Requirement: Mobility Research

Task: Mobility Research and Testing (MORT)

Sub-Task: Canadian Jiger

1. The Canadian Jiger is one of the several vehicles being tested to develop design parameters and vehicle characteristics to improve ground mobility of the military forces.

2. The following modifications were required by ATAC:

a. Change the complete exhaust system.

b. Inclose the chains and sprockets. In one, Jiger styrofoam was used; in the remaining three, formed aluminum was used.

c. Installation of thermocouples and switches for the potentiometer.

d. Strengthen the stern panel with wooden members and fiberglas in order to install conventional mufflers and towing eye.

e. Install revolution counters.

f. Remove rear shelves to accommodate conventional muffler and replace strength with angle iron.

g. These modifications together with the inability to obtain the necessary items expeditiously in Thailand has delayed the program approximately four weeks.

3. The first environmental test was conducted at Lake Boraphet from 2 December through 7 December. The test included the following:

a. Fuel consumption for each vehicle.

(1) Normal running on water with wheels only propelling vehicle.

(2) Normal running on water with wheels and jets propelling vehicle.

b. Maximum speed in water.

(1) Wheels propelling vehicle over measured course.

(2) Wheels and jets propelling vehicle over measured course.

c. Bollard pull -- 100% slip, all vehicles.

d. Human engineering.

e. Measure freeboard of each vehicle in light and loaded condition.

f. Determine water worthiness of vehicle.

g. Ability to enter and exit over the shore.

h. Maximum angle of heel in water.

i. Determine no-go instances for vehicles and vehicle driver.

j. Detection of noise, smoke, odors and recorded distance of vehicle when first detected.

k. Engine temperatures for each engine.

l. Scale map of test area.

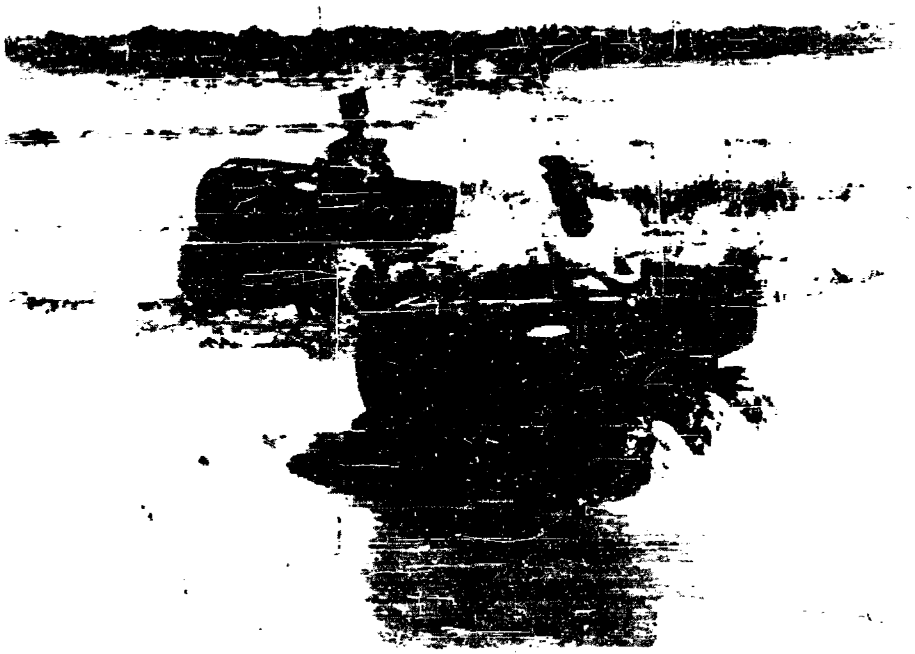
m. Soil samples of the area used were attained.

n. Cross-country driving in mud, water, high grasses, and hummocks.

o. Penetration of thick water, floating vegetation and tall grasses.

p. Recorded weather data throughout test.

4. Further testing will be conducted in the tidal flats in the vicinity of Bang Pu in accordance with the plan of test.



Jigers negotiating flooded rice paddy at Bang Pu during training program, 19 Nov 63.

Jiger tops dirt mound at Bang Pu during training exercise, 19 Nov 63.

Jigers exiting from flooded paddies, Bang Pu, 19 Nov 63.

Jiger exiting from water over dirt mound, Bang Pu, 19 Nov 63.

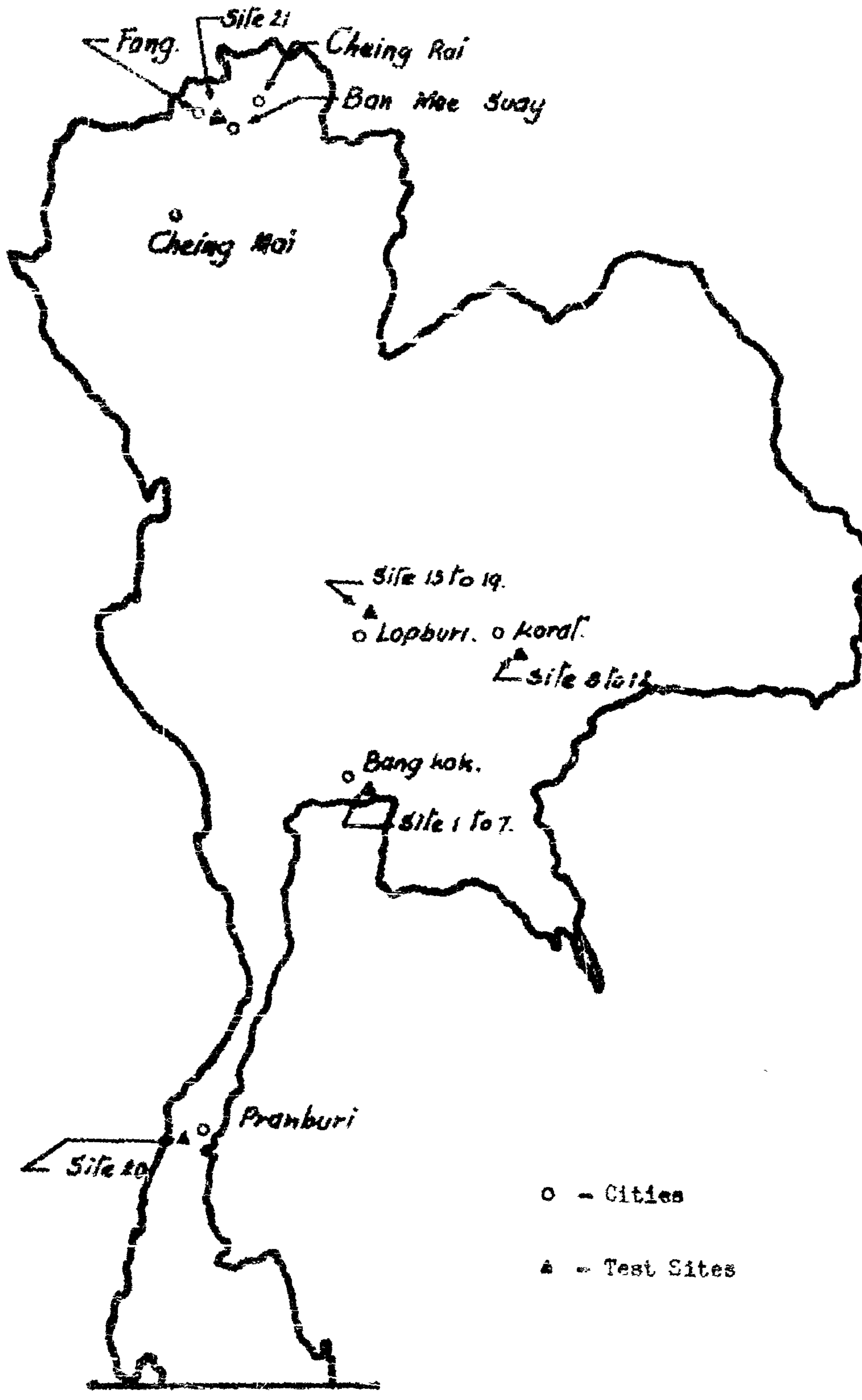
Requirement: Mobility Research

Task: Mobility Research and Testing (MORT)

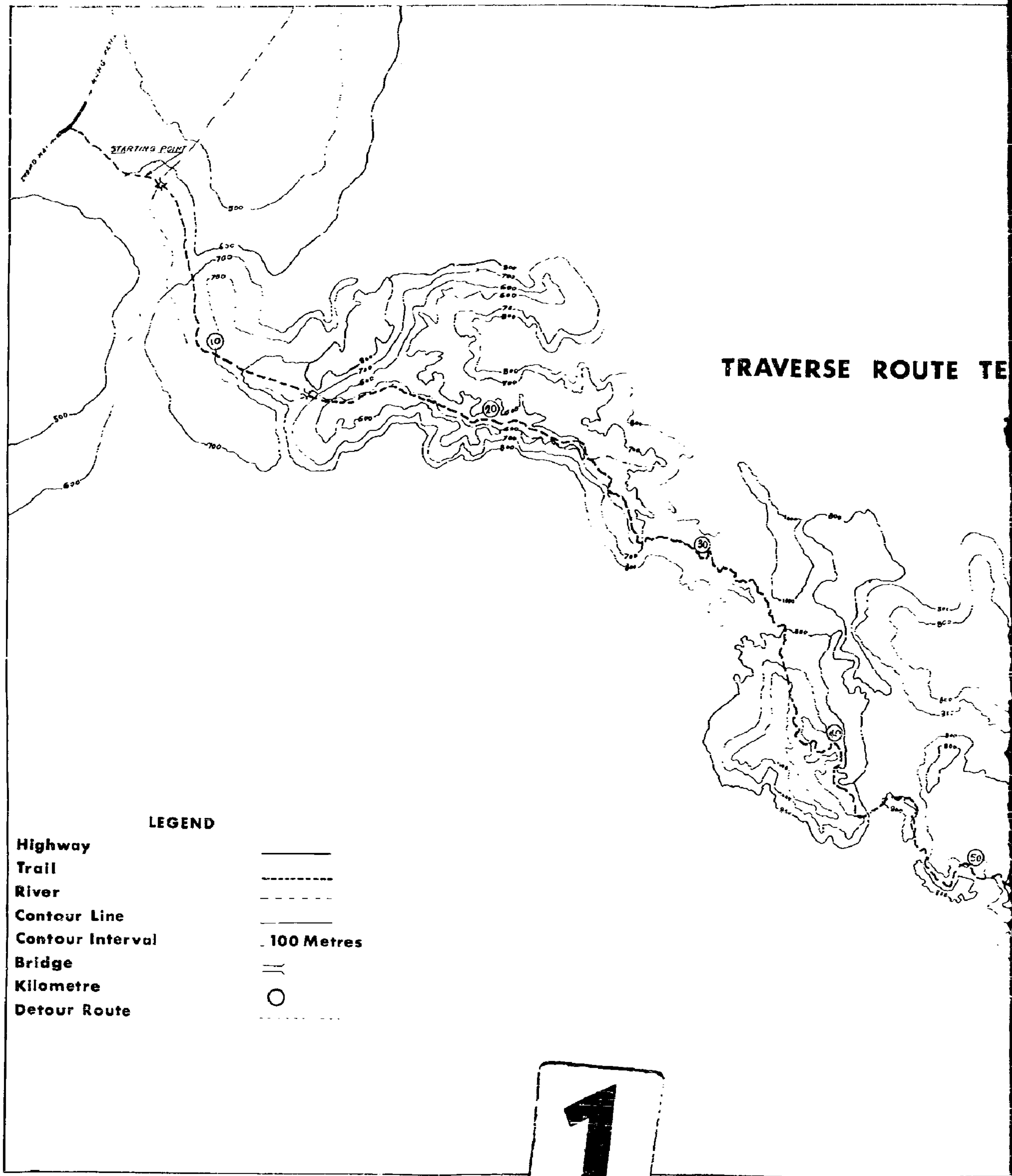
Sub-Task: Tote Gote

1. The Tote Gote test and environmental evaluation, begun in June, was completed in this quarter. The first draft of the final report has been initiated. Location of the twenty-one sites where the vehicle was tested is shown on the attached map.

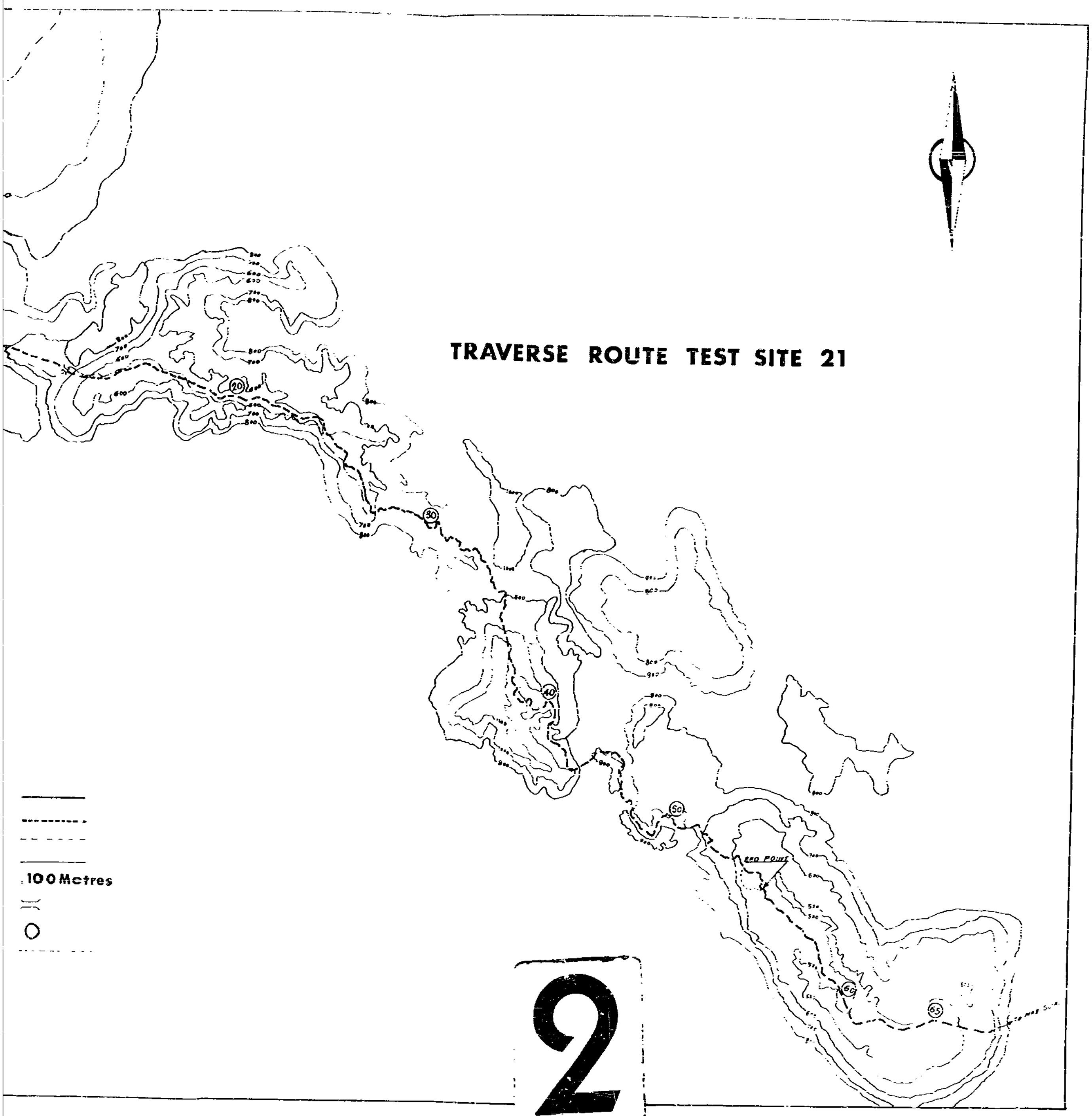
2. During the fourth quarter of CY 1963, a trail test was conducted at site 21, north of Chieng Mai. The test site was over a little-used mountainous trail, 73 kilometers in length, which linked together the villages of Fang and Ban Mae Suay (see figure. Test Site 21, Traverse Route). The purpose of the test was to obtain additional experience in operating the vehicle over remote trails and to provide data on vehicle performance during shallow stream crossings. Six vehicles were operated over the trail for a distance of 53.6 kilometers. This was the portion of the trail over which a four-wheeled vehicle cannot operate. The trail for the most part had been cut into the mountain slopes, channalizing all movement along the trail through steep vertical banks on both sides. The original trail width averaged about six meters, but because of years without maintenance, short portions of the trail had been reduced to one meter or less in width by washouts and slides. Equipment necessary to support the movement was transported on the Tote Gotes. Payloads varied from thirty to one hundred and sixty-three pounds (see accompanying photographs of vehicles with payloads). A summary of the three-day movement is given below:



Location of the 21 Test Sites Used During Tote Gote Evaluations


TRAVERSE ROUTE TE
STARTING POINT
LEGEND
Highway
Trail
River
Contour Line
Contour Interval
100 Metres
Bridge
Kilometre
Detour Route

1


TRAVERSE ROUTE TEST SITE 21
100 Metres
END POINT
20
30
40
50
60
65
2

Period of Travel	Distance Traveled (kms)	Elapsed Time (hours)	Average Speed (km/hr)
First day	26.4	8.6	3.1
Second day	22.3	8.6	2.6
Third day	4.9	1.9	2.6

3. Total elapsed travel time was 19.3 hours over a period of three days. Of this time, 7.7 hours were consumed in maintenance of vehicles, lifting vehicles over trees fallen across the trail, removing mud from the vehicles' running gear, fording streams, and for driver rest stops. The major mechanical problems were carburetor adjustment; accelerator control linkage adjustment; loosened muffler mounting bolts, carburetor mounting bolts and head bolts; broken starter re-wind spring; and failure in the electrical system during heavy rain. Two vehicles became immobilized while negotiating a small stream because soft soil packed in and around the rear wheel and jack shaft assemblies (see photograph). Frequent rest stops were required because of excessive driver fatigue. In a number of instances, some drivers were exhausted to the point where they lost control of their vehicle and overturned. Additional delay was experienced because in overturning, the engine became flooded and the vehicle had to be set upright to permit excess gas to drain from the carburetor prior to re-starting the engine.

4. The movement along the trail was seriously obstructed by vegetation. Obstacles consisted mostly of fallen trees and bamboo (see photograph). The fallen bamboo was particularly difficult to cross because of its smooth, wet surface. Driver fatigue coupled with especially slow and diffic[illegible] movement over this portion of the trail required freque[illegible]

Typical loads transported by Tote Gotes
during the linear traverse at
[illegible]

While fording a small stream during the first days travel, soft soil became packed around the rear wheel and in the chain drive assembly and immobilized the Tote Gote.

Test drivers had to lift all vehicles over a large tree which blocked the trail during the first day's travel.

Portions of the trail, narrowed because of slides and washouts, made operations hazardous and invariably slowed movement (see photograph). In one instance, the vehicle and driver skidded off the trail and fell approximately twenty meters down a vertical bank. At this point the trail was less than one meter wide. The other five drivers were too exhausted to lift the immobilized vehicle back onto the trail and they continued on foot to the nearest village for help in retrieving the vehicle (see photograph).

5. Whereas on a previous trail test in Southwest Thailand, the average rate of movement was three kilometers per hour, the progress over the mountainous trail at site 21 was somewhat slower, 2.7 kilometers per hour. The site 20 trail was shorter, the payloads carried smaller and the trail in somewhat better condition. On the site 20 trail the average traverse time was about four hours and the average payload was about fifty pounds. The mountainous trail at site 21 consisted of an extended march of three days and the average payload was seventy-nine pounds. In operations extending for short periods, such as those at site 20, driver fatigue is not so much of a factor as it is on extended marches. Tentatively, it is concluded that the two-wheel vehicle concept is impracticable for operation on soft soil and over very elementary and remote jungle trails such as those experienced in this test. Excessive effort was required to overcome trail obstacles. Operator fatigue becomes excessive and combat effectiveness would be materially affected.

During the second day's travel, the group was frequently slowed by trail widths as narrow as 1 meter or less.

Retrieving immobilized vehicle on the third day after operator and vehicle fell down an approximate 20 meter slope because of a driver error.

Requirement: Mobility Research

Task: Ground Mobility/Logistics Analysis

RACSEA-FS-5, "POL Distribution System in Thailand," issued during this reporting period in draft form for final comments by Thai and US officials, is one of a series of papers being produced by RAC that will deal with the specific task: Ground Mobility/Logistics Analysis. The objective of the POL paper is to contribute to the essential data from which an analysis can be produced bearing on the types and numbers of transportation, ordnance, and communications equipment and facilities that may be required by Royal Thai Government forces in counterinsurgency situations. A summary of the paper follows:

In present day military operations of whatever description POL normally constitutes at least 50 percent of the logistic load. This study is directed toward the possible military situation in which Thai military and paramilitary forces, with US and SEATO advisory and materiel support, combat Communist insurgents who receive only covert aid from outside the country. Knowledge of the existing and foreseeable capacities of the indigenous POL distribution system is essential for planning purposes.

It is assumed that the counterinsurgency (CI) situations logistic support for military operations must be provided with a minimum of disruption to the normal civilian economy. POL for CI operations and the means by which it is distributed must therefore be in addition to the ordinary commercial system.

The inland POL* market in 1962 was divided:

Shell	37.4%
Esso	30.5%
OFO	18.8%
Caltex	9.8%
US Summit	3.5%

OFO (Fuel Oil Organization) is operated by the Royal Thai Government (RTG) as part of the Defense Energy Department (DED) of the Ministry of Defense. By early 1964 a 5000-bbl/day refinery in the Port of Bangkok area, operated by the DED, should be in operation, its products to be handled by OFO. This will add jet fuel and Avgas to the OFO list of products and enhance OFO's capability to compete in the civilian market.

Figure 1 is a diagram of the POL distribution system; Figure 2 gives estimated daily movements in 1962 and estimated maximum capacities.

At present virtually all POL used in Thailand is imported in the form of refined products, almost all of it by sea and 90 percent of it through the Port of Bangkok where all the oil companies have terminals and tank farms.

The principal bottleneck in the whole distribution system is the constricted means of egress from the Port area: a single-track railline leading to the Ban Sue marshalling yard north of the city, a two-lane road leading into traffic-choked city streets, and the Chao Phraya river which in its upper reaches gives access to the maze of shallow canals in the Central Plain. (See Figure 3.)

*Unless otherwise specified, POL in this paper is used to designate petroleum products used for fuel.

For many years the State Railway of Thailand (SRT) has carried the bulk of the freight moving in and out of Bangkok. As highways are built or improved, truck haulage is becoming increasingly competitive within a radius of 200-250 kms from Bangkok, but rail transport remains the perferred means for long-haul. The recent provision under the US Military Assistance Program (MAP) of 100 tank cars and 10 diesel engines together with substantial additions out of RTG funds in the past few years in both categories has so relieved the shortage of such equipment that the oil companies can now concentrate on long-distance rail hauls.

Examination of the Port complex indicates, however that although dockage capacities are adequate to handle perhaps five times the POL imported in 1962, daily clearance of tank cars and freight cars from Port to Ban Sue could be increased to no more than double the present small normal pickup and only about 1.5 times the highest monthly average. The very limited capacity of the Port railway can be appreciated from the fact that even the estimated maximum pickup from the Port is less than one-third of the capacity of the 9 freight trains now scheduled, which often run with less than the full complement of cars. The capacities of the Ban Sue yard are somewhat less limited. According to SRT officials, the yard could handle daily a total of 12 freight trains made up of 40 cars four-wheeler size or the equivalent in mixed four and eight wheelers.

Present tank-truck loads of POL from the Port terminals are estimated to average 200-250/day. Although the terminals have the capacity to fill some 700/10-hour day, it is impossible to forecast how much of an increase would be feasible as long as Bangkok streets are in their present torn-up condition. Esso at least is enlarging its company-owned Bangkok-based fleet by 90 percent in 1963. An increase to 300-350 tank truck loads/day may be a feasible maximum under present conditions.

Use of inland waterways to transport POL for military purposes appears to offer few advantages. A Bangkok ordnance permits barge transport through the city only of products with a flashpoint above 73°F., i.e. kerosene, diesel, and fuel oil - for which military requirements are minimal. If this regulation were waived (although the prevalence of open fires on stream banks and open boats seems to justify the requirement), some of the oil-company-owned or controlled barges could be cleaned to permit their carrying white oils, and country boats (rice barges, average capacity, 30 tons) could be fitted with tanks or padded to permit carrying drums. But most likely areas for CI operations are the Northeast and North borders of Thailand, and POL, moving by boat out of Bnagkok, to reach these would have to be transferred to rail or truck at Ayutthaya, Sara Buri, or Nakhon Sawan, depending on the seasonal depth of water. Landings and storage at transfer points would have to be built. Furthermore, barge transport takes 4-5 times longer than train or truck.

POL commercial storage facilities in Thailand are minimal and serve mainly as equalizing factors. Turnover is rapid throughout the distribution system. The peak comes in May and early June when dealers are stocking up before the rains cut down transport by road. In 1962 and 1963, the extraordinary demands of US and SEATO exercises have coincided with this commercial peak. In 1963, when the greater part of Joint Task Force 116 including airplanes and helicopters was in the country for several weeks, the civilian distribution system, even though the relatively large storage facilities at military airfields were used by the military, was severely strained.

Substantial changes in the POL distribution system in Thailand may be expected in the next few years. There is general expectation that in ten years or so, when a large enough group of trained Thai technicians has been built up, the RTG will dominate the POL market in Thailand. In addition to the DED refinery, the Thai Oil Refinery Corporation (TORC) is building a 36,000 bbl/day oil refinery south of Si Racha on the east coast of the Gulf of Thailand. TORC is a quasi-governmental organization, backed by Shell which will supply the crude oil. After this refinery comes on stream, perhaps in 1965, the foreign oil companies are expected to buy from it rather than to continue to import refined products. Some years hence, when the developing road network and perhaps a branch rail line permit, TORC products can be distributed within the country without passing through the Bangkok bottleneck.

Indications are that growth of the POL market in the immediate Bangkok area is levelling off but that the hinterland markets are as yet limited only by lack of passable roads by which to reach them. The foreign oil companies are primarily seeking to expand the markets in southern Thailand, an area far more easily reached from the Shell-Esso terminal on Phuket Island or by overland routes from Malaysia than from Bangkok or Si Racha. OFO, although interested in developing a market in the Peninsula, is apparently concentrating on enlarging its share of the retail business in the Northeast and North. Its expansion has been aided by allotment of 40 of the 100 US MAP tank cars.

For CI operations, the present POL distribution system seems likely to be adequate out to distribution points along the rail lines. The crucial gap is transport between these centers and small units operating in areas remote from rail lines and main roads. Commercial filling stations are located along all-weather roads, stores even in remote villages

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For CI operations, the present POL distribution system seems likely to be adequate out to distribution points along the rail lines. The crucial gap is transport between these centers and small units operating in areas remote from rail lines and main roads. Commercial filling stations are located along all-weather roads, stores even in remote villages carry a few drums of gasoline and kerosene; but these stocks are inadequate to support continued operations. The Royal Thai Army (RTA) is amply equipped with US MAP-provided 5-gallon tins, but these give a reserve for short trips only; the RTA has no capabilities for bulk transport. Their trucks could carry 55-gallon drums but their truck allowances are austere. Oil companies, including OFO, control about 40 tank trucks in the Northeast and about 55 in the North and Central Plain north of Bangkok but these are required in their ordinary commercial business. RTA arrangements with local truckers for drum transport might be made on an individual basis if funds were allotted for the purpose. Recent moves by the RTG to increase its control over trucks in the provinces suggest a possible solution. Air delivery of drums is another possible means of resupply, at least as supplementary to truck delivery.

The conclusions of the report are as follows:

1. About 90 percent of the POL products distributed within Thailand enter the country through the oil company terminals in the Port of Bangkok.

2. The major bottleneck which severely limits the amount of POL that can be brought in through the Port is the constricted means of egress from the Port area; one single-track rail line, one road, and the Chao Phraya River on which passage through the city is prohibited to vessels carrying aviation or motor gasoline.

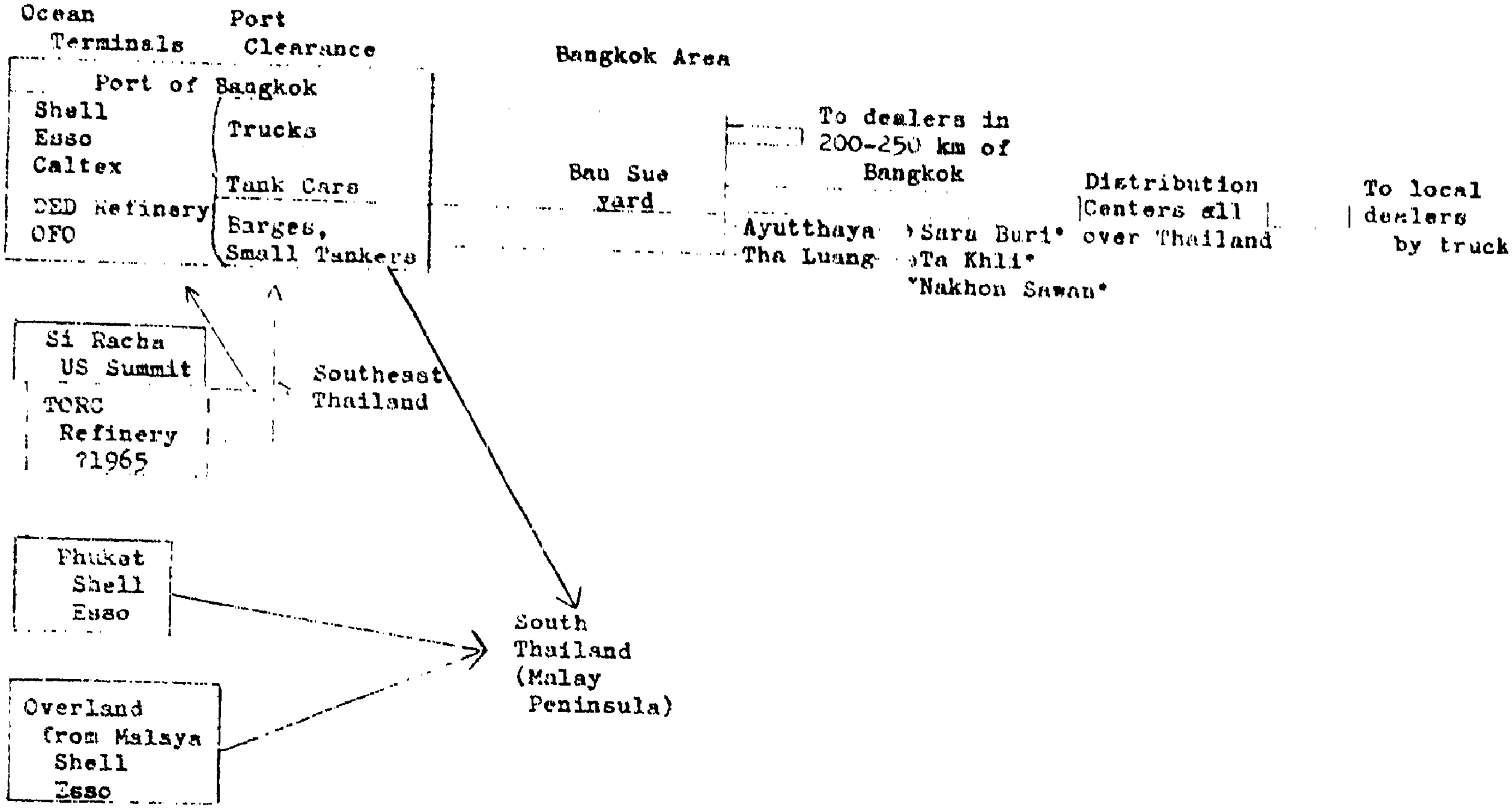
3. Some years hence, as the road and rail network develop, products of the 36,000 bbl/day TORC refinery (now being built on the east coast of the Gulf of Thailand) could be distributed without passing through the Bangkok bottleneck.

4. Under the present distribution system, it is believed that sufficient POL to support counter insurgency operations can be delivered as far as upcountry distribution points. The crucial gap is between distribution points and small units in remote and inaccessible parts of the country. Delivery would have to be made in 55-gallon drums or some equivalent containers. The mode of delivery, land or air, to CI forces in remote areas requires analysis. Major reliance on air may be necessary.

5. This paper is part of a study based on CI operations, but the data on the POL distribution in Thailand can be used to compare present capacities against the requirements of larger and more complex force structures.

Figure 1

CHART OF POL DISTRIBUTION SYSTEM IN THAILAND



*Wet season only.

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Figure 2

DAILY MOVEMENTS OF POL IN 1962 AND MAXIMUM CAPACITIES

IMPORTS

Port of Bangkok

1962	Estimated Maximum Capacity
1,260,000 gals/day	6,300,000 gals/day

Si Racha
Phuket
Overland from Malaya

1962	Estimated Maximum Capacity
144,000 gals/day	1,300,000 gals/day including TORC Refinery

CLEARANCE FROM PORT OF BANGKOK

Tank Trucks

1962	Estimated Maximum Capacity
142 company-controlled 200-250 loads/day (500,000 - 550,000 gals/day)	700 loads/day - full capacity 300-350 loads/day - max. feasible (depends on Bangkok traffic)

Barges, Small Tankers

1962	Estimated Maximum Capacity
420,000 gals/day	No estimate; probably could be considerably greater

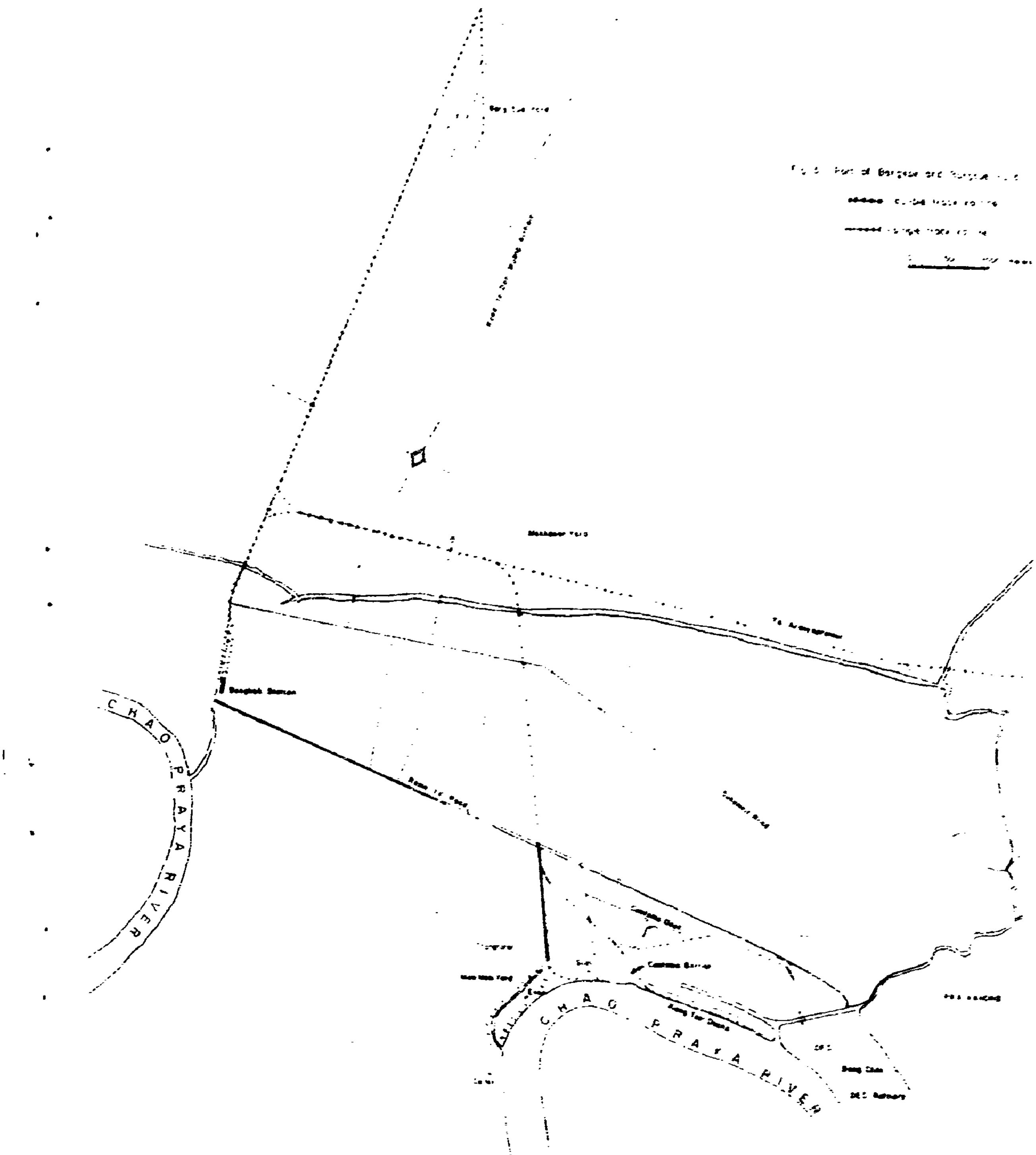
Tank Cars

1962	Estimated Maximum Capacity
Normal - 52/day (273,000 gals) Peak - 62/day (354,000 gals)	85-95/day (493,000 - 549,000 gals)

FREIGHT TRAINS FROM BAN SUE YARD

1962	Estimated Maximum Capacity
9/day (40 - 4-wheeler equivalents/train)	12/day (40 4-wheeler equivalents/train)

CONFIDENTIAL


Bangkok Station
C H A O P R A Y A R I V E R
C H A O P R A Y A R I V E R

Requirement: Mobility Research

Task: Route Capacity Formula

Road tests were conducted in November of last year in relatively dry weather conditions under the direction of Mr. Holliday of The RAND Corporation. The data was used as a basis for a new method of calculating road capacity and truck requirements suitable for use in Southeast Asia. In October 1963, Mr. Holliday conducted further tests, this time under wet conditions, and again by means of RTA trucks and personnel, to get information to verify the application of the new method to rainy season conditions. The field report on the wet season truck tests is included as an appendix to this Quarterly Report. The work of the entire task, including a review of present road capacity methods, a description of the field test results, details of the new method, and road capacity tables calculated with the new method, has now been published in the report:

Holliday, L. P., A Method of Estimating Road Capacity and Truck Requirements, The RAND Corporation, Memorandum RM-3331-ARPA, November 1963 (U).

Requirement:	Mobility, Ground and Water
Task:	Delta Mobility - Small Craft

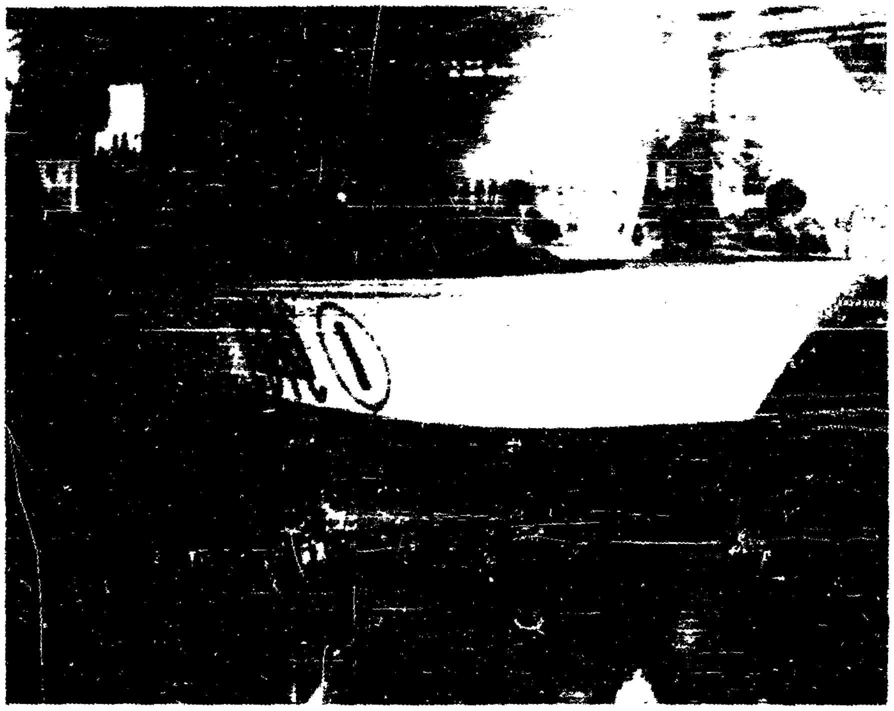
The construction of a 6 1/2 meter long hull Thai klong boat to meet military requirements for a light weight, high speed, shallow draft boat is in progress. This craft has one-foot frame spacing with Mai Ta Kien (a hardwood similar to oak) for the frames and bottom planking and teak for the sides. It can accept either a conventional outboard motor or a long shaft motor.

The following performance is expected:

	45 hpr outboard Mercury	13 1/2 hpr JLO
Speed light	50 km	20 km
Speed 1200 lbs.	40 km	15 km
Fuel consumption	16.75 liters per hr.	6 liters per hr.
Capacity	8 armed men	

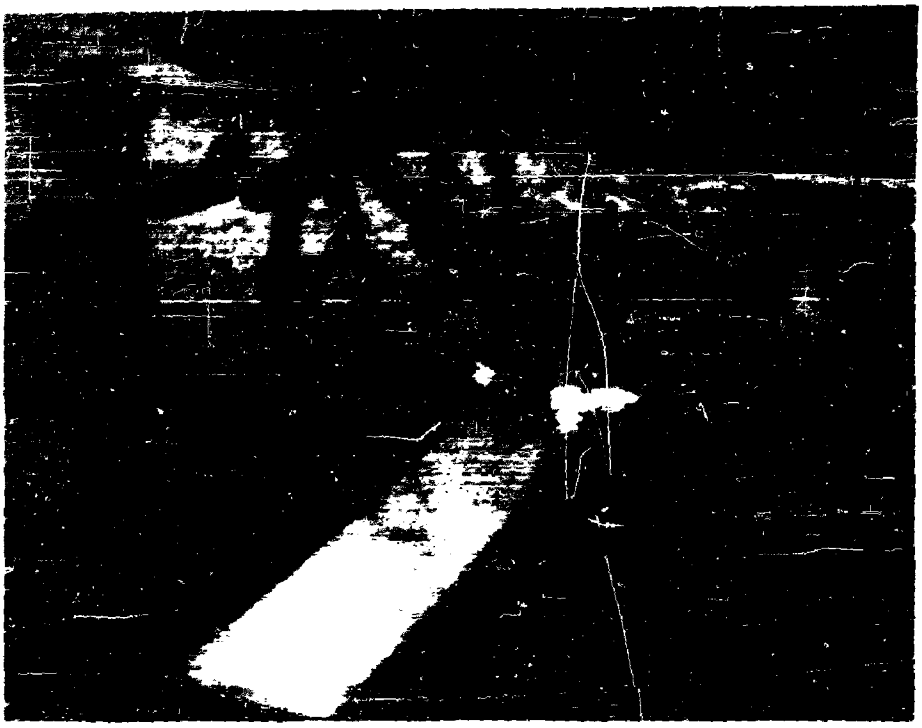
Employment of this boat will fulfill the military need for a quick response capability with speeds equal to or greater than that afforded by the Dong Nai boat in Vietnam and at approximately 1/5 the cost. For paramilitary forces it will provide light freight and passenger capability in remote areas such as the upper reaches of Thai rivers for medical, police, census, and mobile development work.

The total cost of construction is 4000 Baht per boat or less than $195.00 at the present rate of exchange. At present, construction time from purchase of the log to the completion of the boat is about 21 days.



Completed hull.

Boat, powered by long shaft engine, is tested by
CDR L. O. Nasset, MRDC Project Officer.

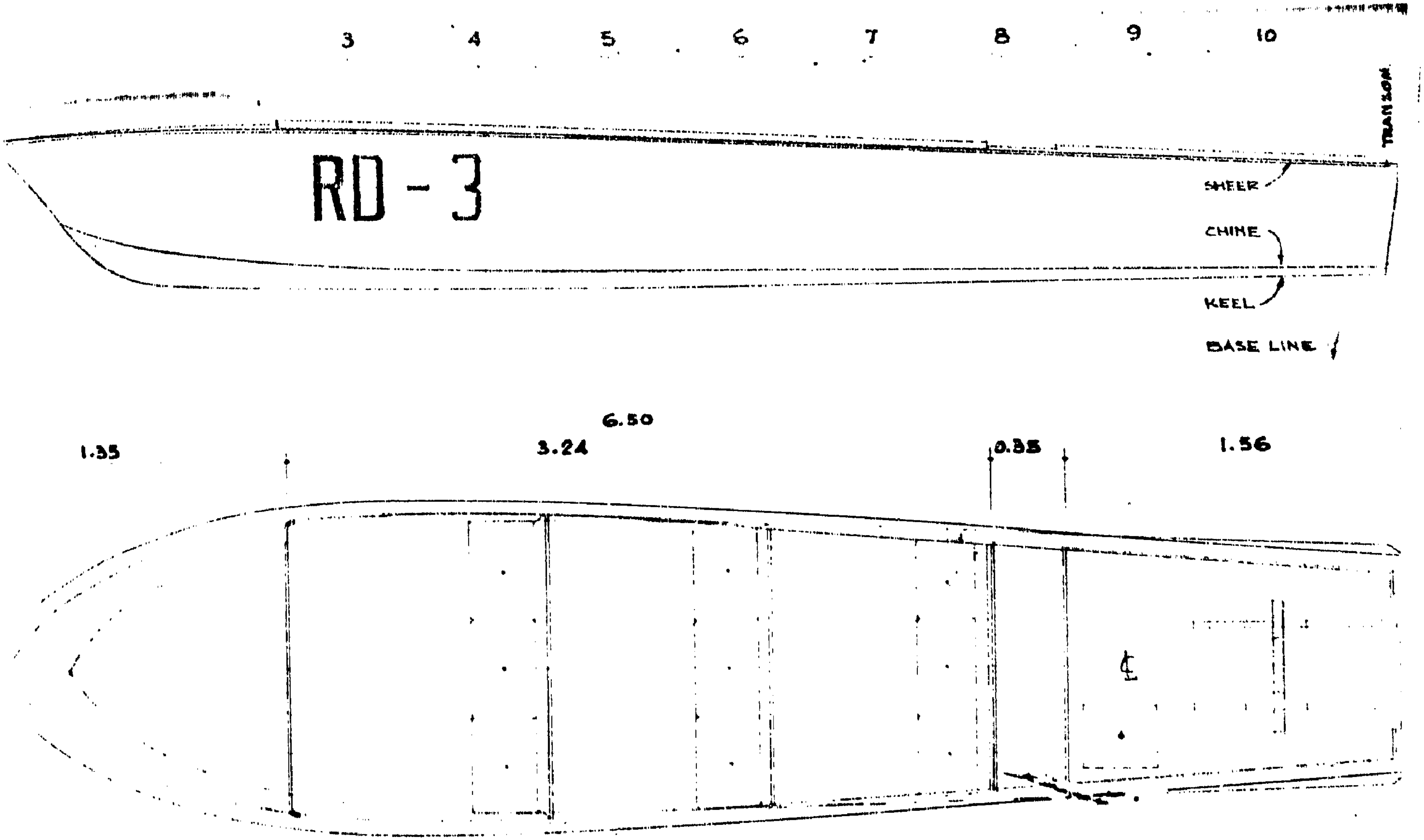


Shaping the wood using dry heat.

Unfinished hull.

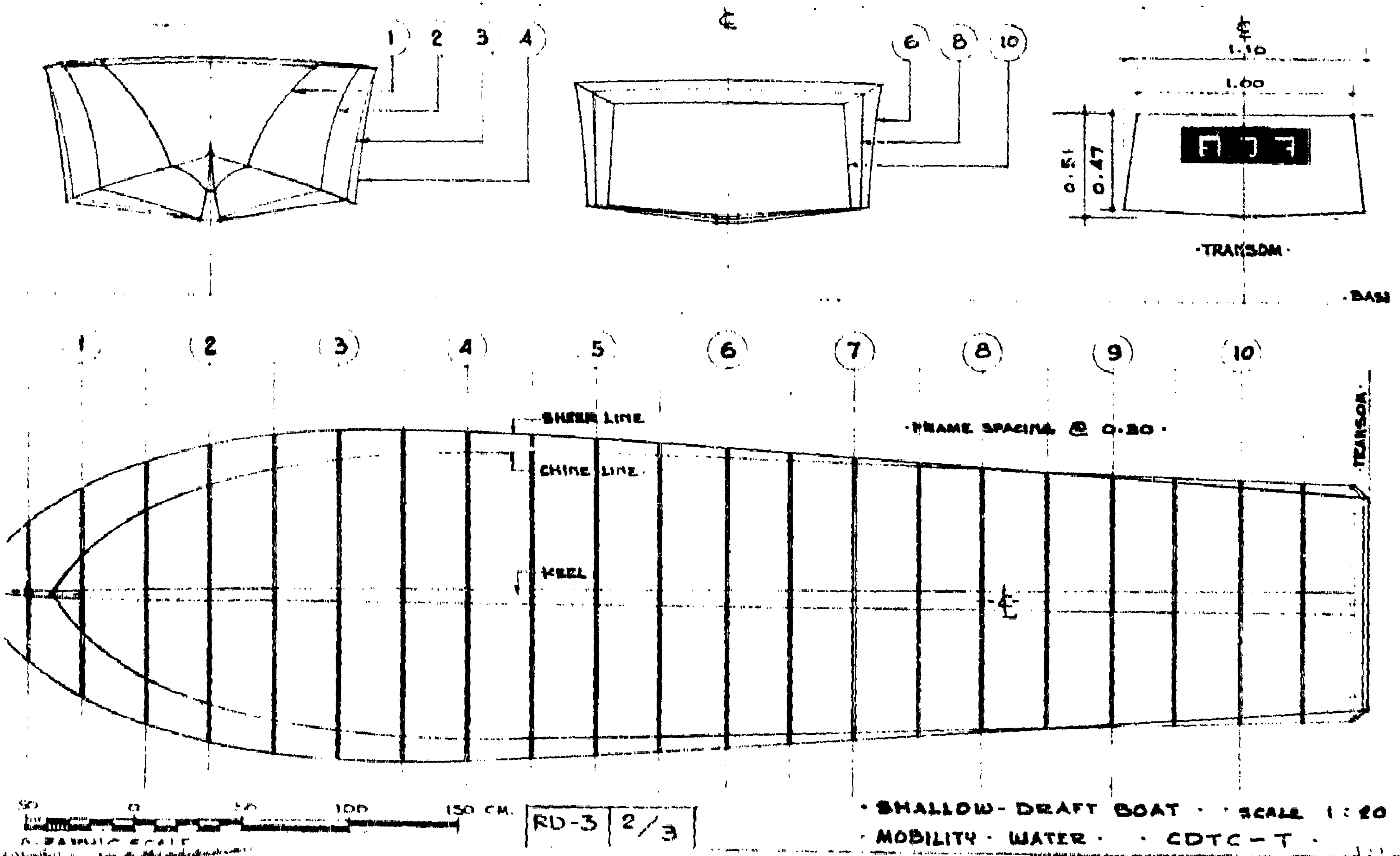
Ripping the log for the shallow draught boat. The wood is Maitakien.

Boat frame.



RD-3 | 1/3

· SHALLOW - DRAFT BOAT ·   · SCALE 1:2



1
2
3
4
6
8
10
1.10
1.00
0.51
0.47
·TRANSOM·
·BASE
SHEER LINE
CHINE LINE
KEEL
·FRAME SPACING @ 0.80·
TRANSOM
50
0
50
100
150 CM.
RD-3
2/3
·SHALLOW-DRAFT BOAT· ·SCALE 1:20
·MOBILITY· WATER· ·CDTC-T·

L. O. A.	6.50	METERS.	ENGINE	2-CYCLE	
L. W. L.	5.90	"		AIR COOLED.	
BEAM	1.54	"	HP	13.5	
DRAFT	(0.075)	"	STEERING	TILLER.	
SEATING CAPACITY	4 – 5		TRANSMISSION	NONE.	
SLEEPING CAPACITY	2		TROTTLE CONTROL	HAND LEVER	
CARGO SPACE	1.20	M^3	LONG SHAFT DIRECT DRIVE		
PAYLOAD	545.0	KG.			
WEIGHT EMTY	120.0	KG.	FINISH	MARINE PAINT.	

BOTTOM PLANKING.	3/8" TAKIEN.	ANTI-FOULING.
FRAMES	3/4" × 1½" "	BOTTOM PAINT.
HULL SIDES	3/8" TEAK.	NON-SKID PAINT
KEEL	1"×4" TAPER TO 2" TAKIEN.	FOR FLOOR &
FORWARD, SIDE & AFT DECK.	3/8" TEAK.	DECK.
FLOOR	3/8"×2" " & PLYWOOD.	
SEATS & BACK REST.	½ "	

· TABLE OF OFFSETS FOR HULL SHAPE ·

· ALL DIMENSIONS GIVEN IN CENTIMETERS TO OUTSIDE OF 3/8" PLANKING · DISTANCE BETWEEN STATIONS 60.0 CM

STATIONS	1	2	3	4	5	6	7	8	9	10	TRANSOM
BASE TO KEEL	49.00	37.00	35.50	35.00	35.00	36.00	37.00	37.50	38.00	39.00	40.00
BASE TO CHINE	51.00	50.00	45.50	44.00	44.00	44.00	44.00	44.00	44.00	44.00	44.00
BASE TO SHEER	106.00	107.00	108.00	106.00	105.00	103.50	101.00	98.00	95.50	93.00	91.00
℄ TO CHINE	17.00	51.00	64.50	67.00	65.50	64.00	63.00	60.00	58.00	56.50	50.00
℄ TO SHEER	48.50	69.00	77.00	77.00	73.50	69.50	66.00	61.50	57.00	55.50	55.00

· SHALLOW-DRAFT BOAT ·

KD-3 | 2 3

Requirement: Mobility, Air

Task: Remote Area Airstrip

Sub-Task: Survey, Classification and Data Analysis of Airfields in Thailand

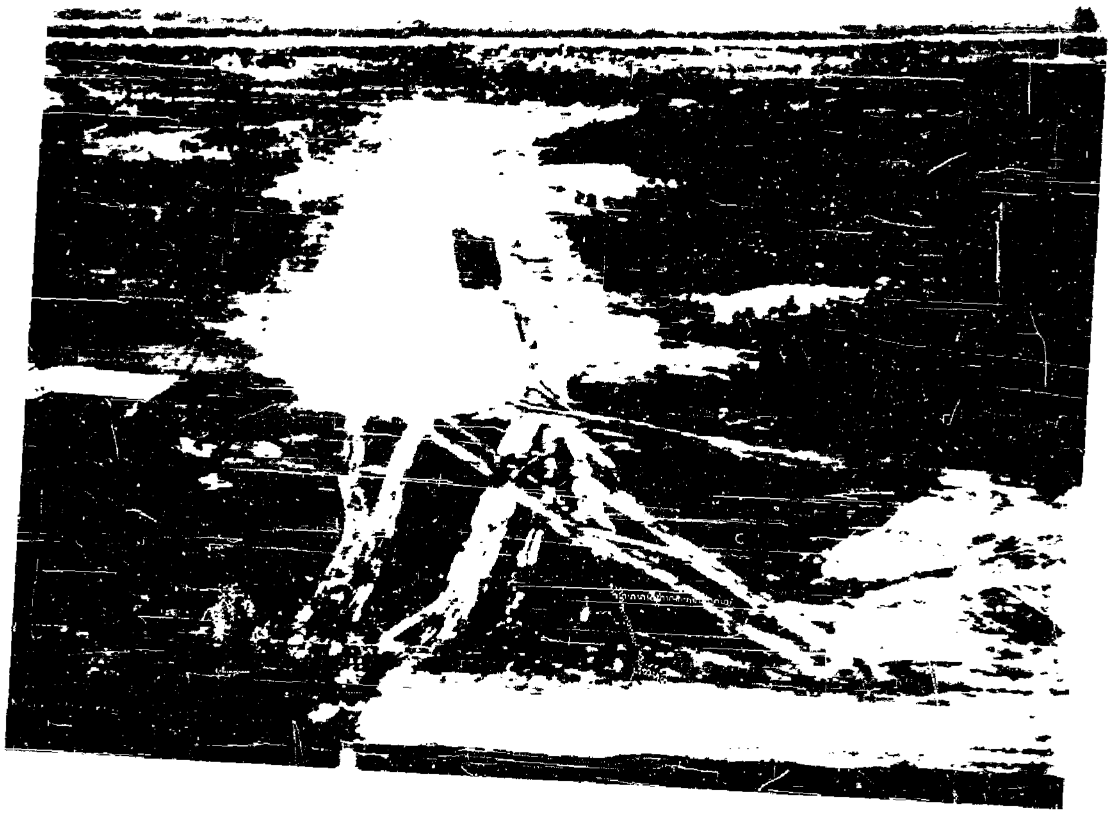
This project was described generally in the CDTC-T Quarterly Report for 1 July - 30 September 1963, pages 19 and 20. It is being conducted in close coordination with JUSMAG, Thailand. Whenever possible, existing data are utilized. For some technical problems, for example, soil characteristics, available standardized airfield information is inadequate and a limited amount of field sampling and data acquisition is necessary.

Work has progressed to the point where a preliminary report of some findings has been prepared. It is found in Appendix B.

Sample photographs of various Thai airfields are attached for illustrative purpose.

Chiang Khong near the Lao border in northern Thailand.

Pranburi, southwest of Bangkok near the Burma border.



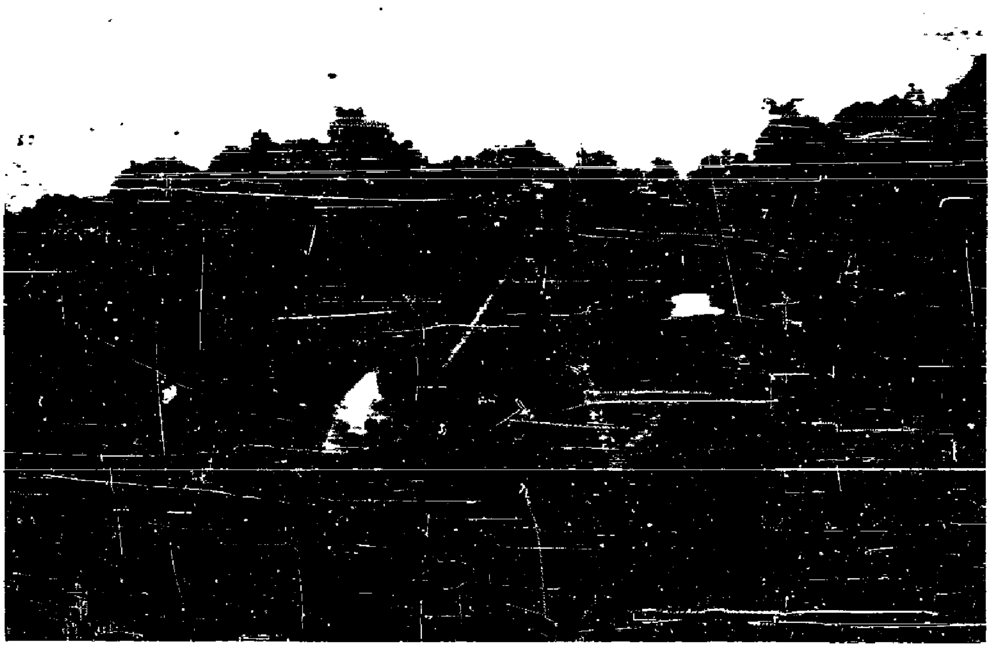
Tak, on the Ping River in western Thailand.

Chiang Rai in northern Thailand.

Dong, an overgrown and abandoned airstrip.

Chiang Khong near the Lao border in Northern Thailand

MRDC Thai engineers taking soil samples at a remote area airstrip.



MRDC Thai engineers surveying a remote area airstrip.

Nakhon Phanom - New Air Field in Northeastern Thailand

Sat Yai an ATOL field in Southwest Thailand, near the Burma border.

SUB-PROJECT IV

COMMUNICATIONS SYSTEMS

SUB-PROJECT IV

COMMUNICATIONS SYSTEMS

SUB-PROJECT OBJECTIVE:

To develop communications equipment, techniques and systems which will provide friendly local forces in remote area conflict situations an effective capability for:

a. Tactical communications within and among units and for control of support aircraft.

b. Communications of alarm signals from villages, strategic hamlets, convoys, and outposts in the event of attack.

c. Communications for control and operation of naval units primarily composed of river and coastal craft.

In Thailand, communications research tasks are often referred to collectively at SEA CORE (South East Asia Communications REsearch Program).

Requirement: Remote Area Conflict Communications Research

Task: Operations Analysis (1A)

Sub-Task: Small Unit and Patrol Communications

One of the major objectives of the Communications Systems Project is to determine the desirable characteristics of military communications systems and equipments for Thai forces. Not only must the characteristics be feasible both technically and economically, they must also satisfy operational requirements. Accordingly, there is a need to study and analyze present and future systems and equipments, in order to obtain information on which to base a determination of necessary characteristics.

The purpose of this sub-task is to determine the adequacy of existing communications equipment and practices of small Thai police and associated military units employed in border security missions. Emphasis is placed on forward communications and on units of patrol, squad, platoon, and company size. Seven Border Patrol Police platoons and two RTA platoons were visited in the course of a field trip to Northeast Thailand in October 1963. The MRDC team included Thai, U.S., and British personnel; team members were competent in both technical and operational analysis matters. A field trip to North Thailand began on 12 December.

Other operations analysis sub-tasks are being formulated. The SRI operations analysis group now numbers four Americans, one of whom is simultaneously the Senior SRI Representative in Thailand.

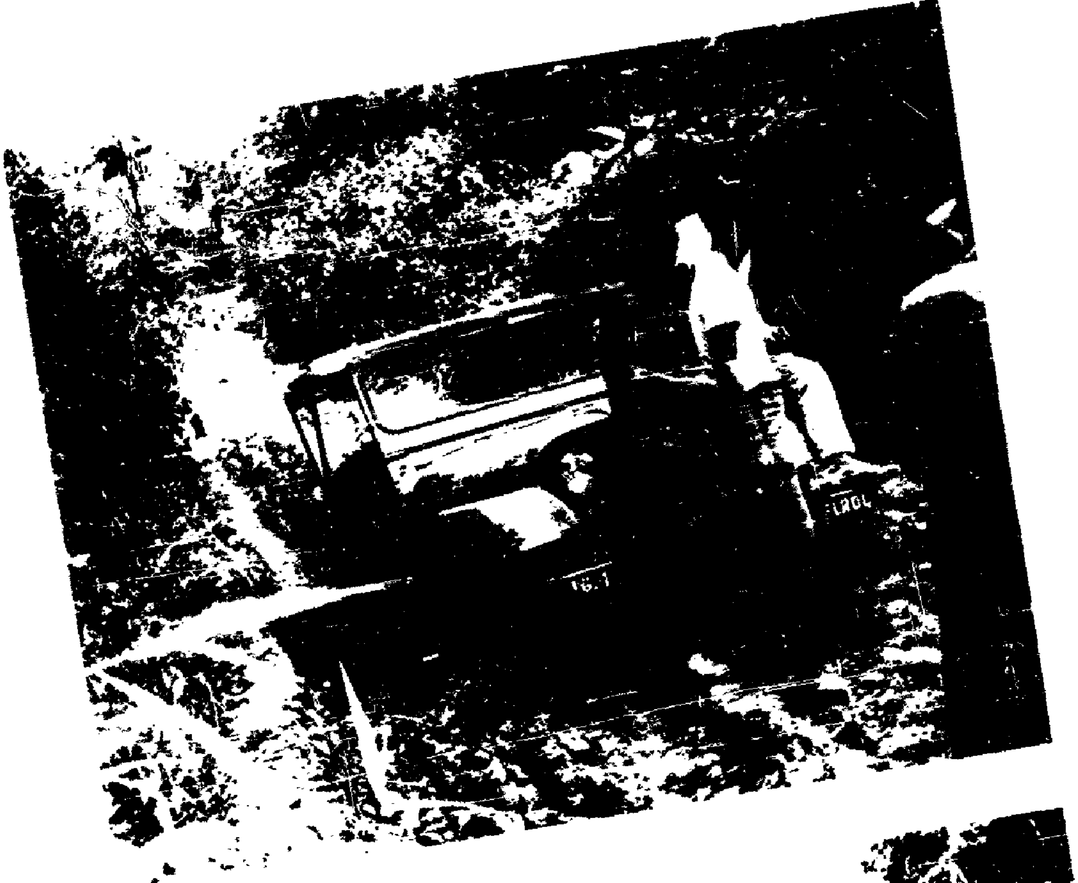
Requirement:	Remote Area Conflict Communications Research
Task:	Phenomenological Research (1B)
Sub-Task:	Radio Propagation in Tropical Vegetation

A second major objective of SEA CORE is to obtain a systematic and comprehensive body of data on those factors of terrain, vegetation, and ionospheric behavior which affect electromagnetic wave propagation in Thailand. Such data are significant because they affect the utilization of avilable radio equipment and the design and development of new equipment.

It is the objective of this sub-task to measure and analyze the factors which influence the propagation of radio waves in areas of dense tropical vegetation. The SEA CORE contract with Jansky and Bailey places especial emphasis on the influence of terrain and vegetation, at ranges up to 30 miles and at frequencies between 100 KC and 425 MC. In these frequency and distance ranges, the path loss will be measured over various types of terrain for all practical modes of propagation, including a measurement of short term variations, diurnal variations, seasonal variations, and atmospheric noise levels. The effects of polarization and the effects of changing the transmitter and receiver antenna elevations will be determined by measuring the path loss for the various modes.

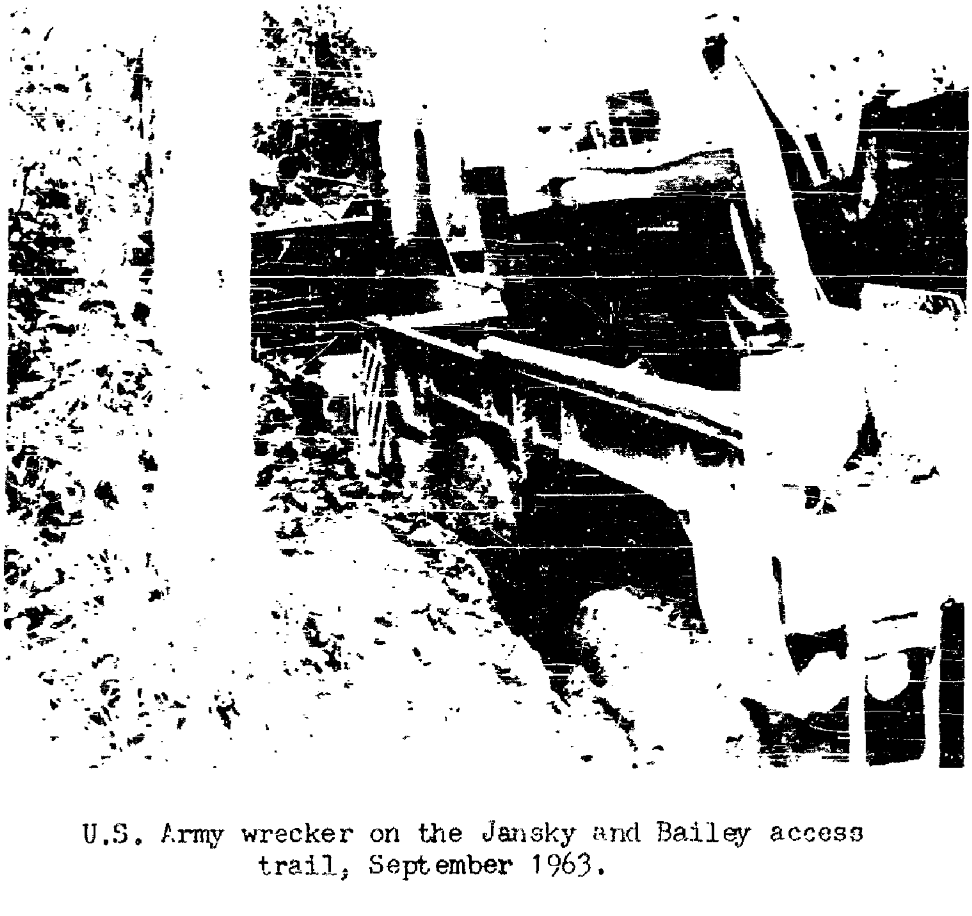
Construction of the Jansky and Bailey transmitter site, some 80 miles NE of Bangkok, was substantially accomplished by the end of November. Drilling and preparation of a well to provide an adequate water supply is still in progress. Road movement over the trail from Friendship Highway to the transmitter site was extremely difficult during September and almost impossible during the first half of October; during the latter period, it was necessary to use elephants as a mode of transportation. Weekly helicopter flights between Bangkok and the site began on 6 November. Two Thai employees were evacuated by helicopter from the transmitter site to Bangkok on 20 November for emergency medical reasons. The site is now under continuous Thai police protection and a Thai military medical aid man is in residence.

The Jansky and Bailey permanent party of eleven is now complete. The measurement program is expected to begin in December.



Access trail to Jansky and Bailey transmitter site,
September 1963

Capt Prapat Chandaket, RTN, Electronics Laboratory Coordinator, examines the terrain, September 1963



U.S. Army wrecker on the Jansky and Bailey access trail, September 1963.

In early October 1963, elephants provided faster transportation then any available motor vehicles for movement along the trail from Friendship Highway to the Jansky & Bailey transmitter site.

Two trails in the same part of the Jansky & Bailey test area, October 1963. Right photograph shows the results of heavy traffic.

Requirement: Remote Area Conflict Communications Research

Task: Phenomenological Research (1B)

Sub-Task: Vertical Incidence Ionospheric Sounding

It is the purpose of this sub-task to collect vertical incidence ionospheric sounding data for Thailand, as a contribution to the world-wide ionospheric data system, with the long-term objective of improving the accuracy of frequency predictions for Southeast Asia.

The C-2 Vertical Sounder is in operation and data are being forwarded to the National Bureau of Standards through the U. S. Army Signal Radio Propagation Agency (USASRPA). Data are also being exchanged with stations in Manila and Singapore. Two enlisted men of USASRPA are now operating the Sounder 24 hours a day, 7 days a week. The rate of successful operation was 94% in October and 90% in November.

Requirement: Remote Area Conflict Communications Research

Task: Development of Host Nation Electronic Research Capabilities (1C)

As a natural result of SEA CORE activities, the Thai military personnel associated with the Electronics Laboratory are gaining valuable experience which increases their abilities to contribute to the development of Thailand. The number of such Thai military personnel now totals 7 commissioned officers, and 4 warrant-officers and non-commissioned technicians. All of the commissioned officers are educated to at least the bachelor degree level, and 3 of them are Ph. D. 's. The Communications Systems Sub-Project is operated as an integrated, combined Thai-U.S. effort.

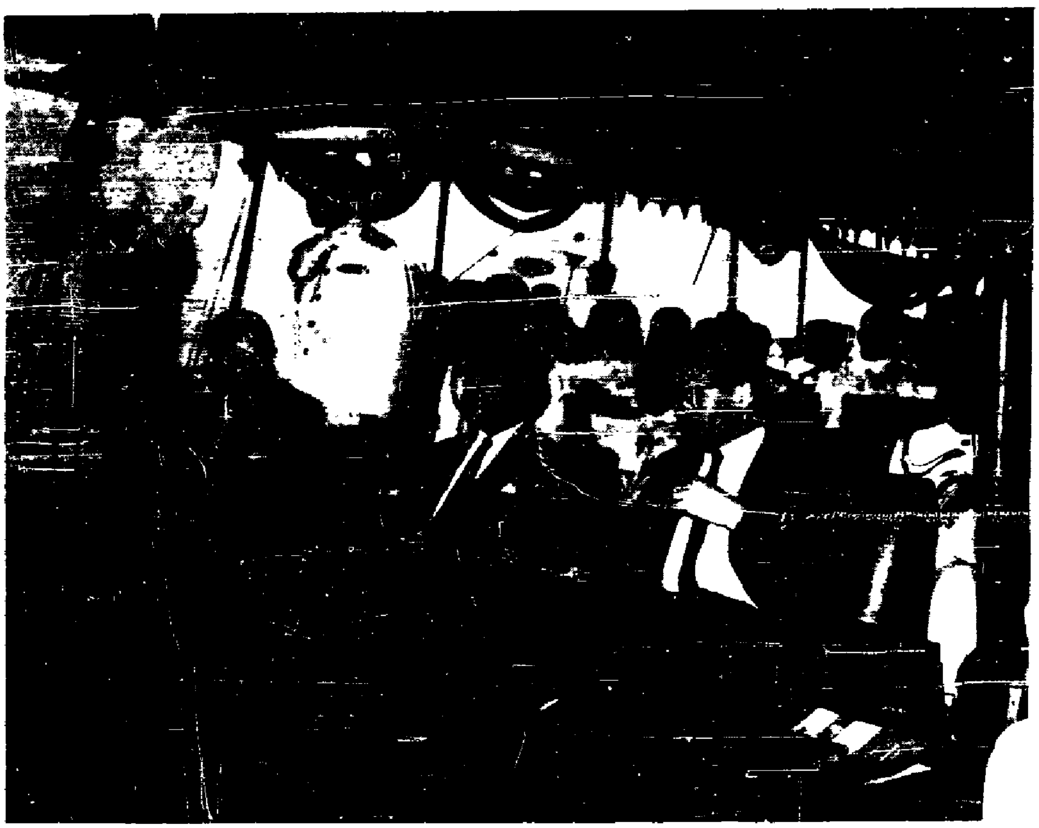
Currently, Thai participation is mainly concentrated in Task 1D.

On 23-24 September, Dr. Edward T. Pierce of Stanford Research Institute conducted two seminars on lighting, atmospherics, radio noise, and very low frequency propagation. The seminars were attended by approximately fifty Thai personnel from the Armed Forces and other government organizations.

The Electronics Laboratory was inspected by Major General Subachai Surawantana, Chief Signal Officer, Royal Thai Army, and some of his staff on 27 September; a group of Royal Thai Navy officers visited the Laboratory on 28 October.

A formal opening ceremony for the Electronics Laboratory was held on 4 October 1963. The event was covered by television and by the U. S. Information Service. News stories appeared in two English-language, two Chinese-language, and five Thai-language Bangkok newspapers. Following is a partial listing of the guests at the ceremony:

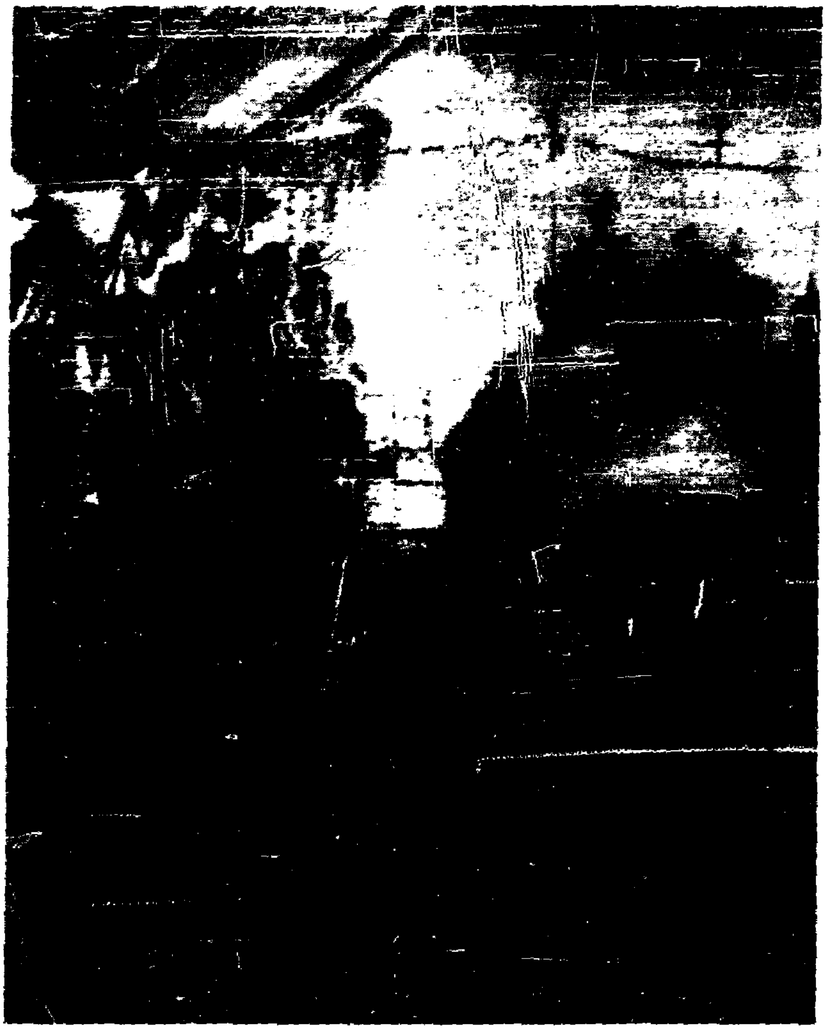
His Excellency, Pote Sarasin, Secretary General of SEATO
His Excellency, Allen Loomes, Australian Ambassador
The Honorable Alfred Puhan, USA Chargé d'Affaires
Air Chief Marshal Dawee Chullasapya, Chief of Staff Supreme Command, guest speaker of honor
Lieutenant General Boriboon Chulajararitta, Deputy Chief of Staff, Supreme Command
Lieutenant General Viroj Invasa, Director of Operations, Supreme Command
Lieutenant General Wek Chiewej, Adjutant General, Supreme Command
Vice Admiral Thavil Rayananon, Chief of Staff, Royal Thai Navy
Vice Admiral Phuan Sripet, Director Royal Thai Navy Dockyard Department
Major General Ernest Easterbrook, Chief, JUSMAG, Thailand
Major General Chalerm Mahatananond, Director of Education and Research, Supreme Command
Major General Singchai Menasuta, Director, Military Research and Development Center, Supreme Command
Major General Subachai Surawatana, Chief Signal Officer, Royal Thai Army
Air Vice Marshal Pipatana Banaruka, Technical Advisor to Communications Department, RTAF
Major General Robert York, Joint Operations Evaluation Group, Vietnam
Brigadier General Dorr Newton, SEATO Military Planning Office
Mr. Tracy S. Park, Jr., Deputy Director, USAID
Dean Milton E. Bender, Jr., SEATO Graduate School of Engineering
Mr. Fred Dickson, Chief Scientist, U. S. Army Signal Radio Propagation Agency, Representing the Chief Signal Officer, U. S. Army
Nai Smarn Punyaratabandhu, Chief, Investigation and Research Division, General Post Office



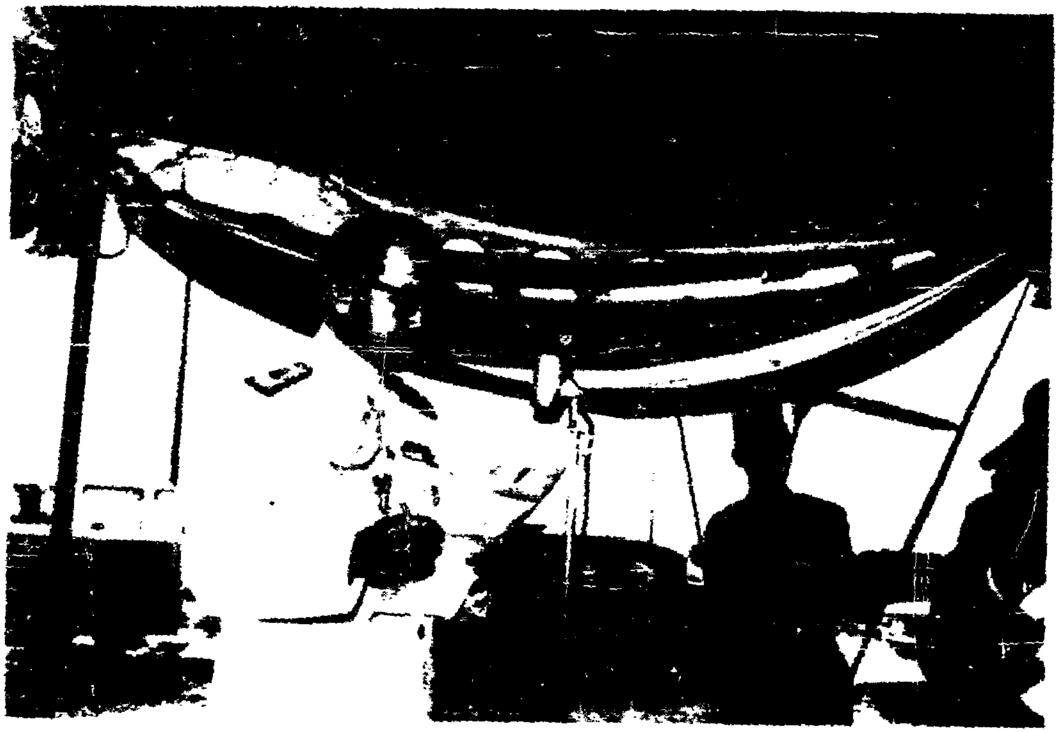
Guests of Honor at the Opening Ceremony of the Electronics Laboratory included - left to right - Mr. Alfred Puhan, U.S. Chargé d'Affaires ; Mr. Pote Sarasin, Secretary General of SEATO; and Mr. Allen Loomes, Australian Ambassador

Major General Singchai Menasuta poses with Mr. Fred Dickson, Chief Scientist, U. S. Army Radio Propagation Agency, representing the Chief Signal Officer, U. S. Army

Mr. Brundage talks with Lt. General Boriboon Chulajaritta, Deputy Chief of Staff, Supreme Command

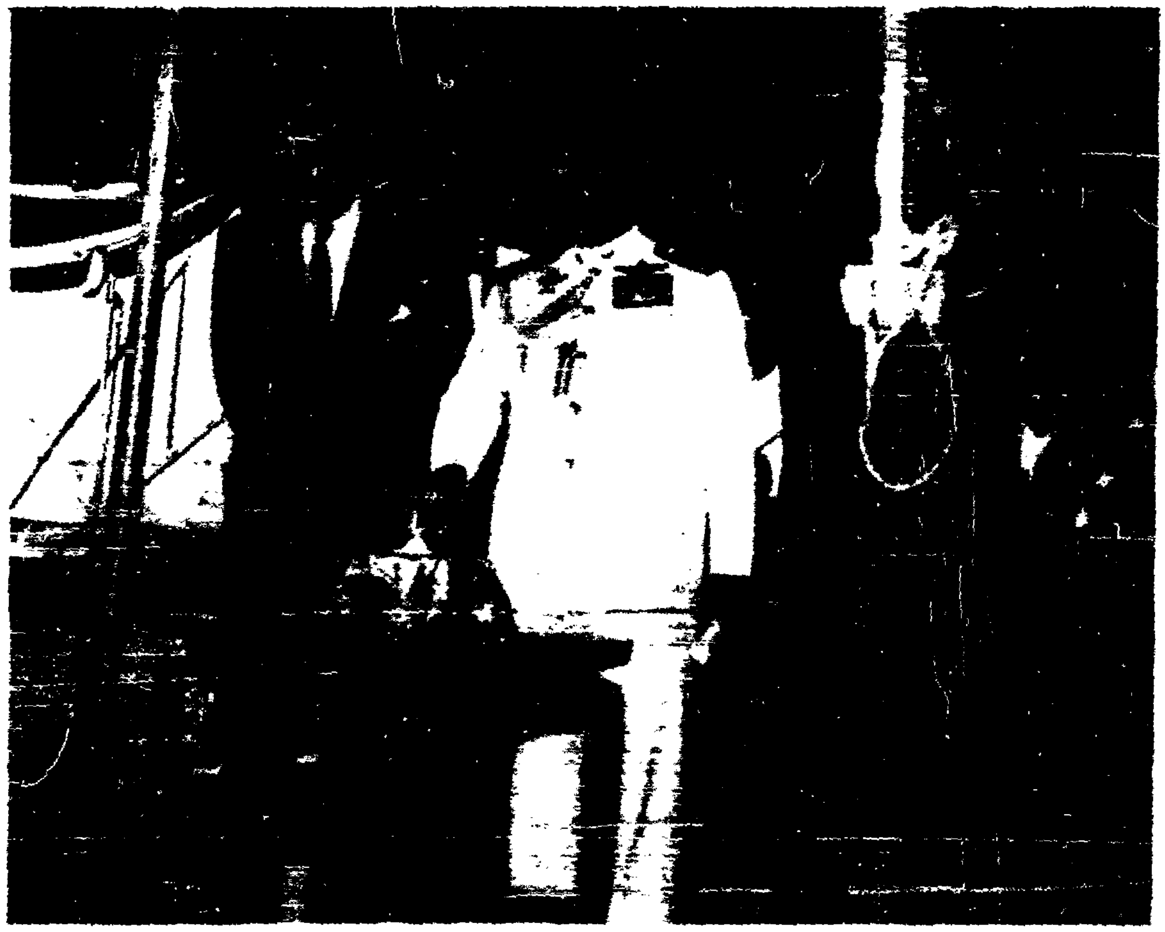


Buddhist Priests participated in the ceremony

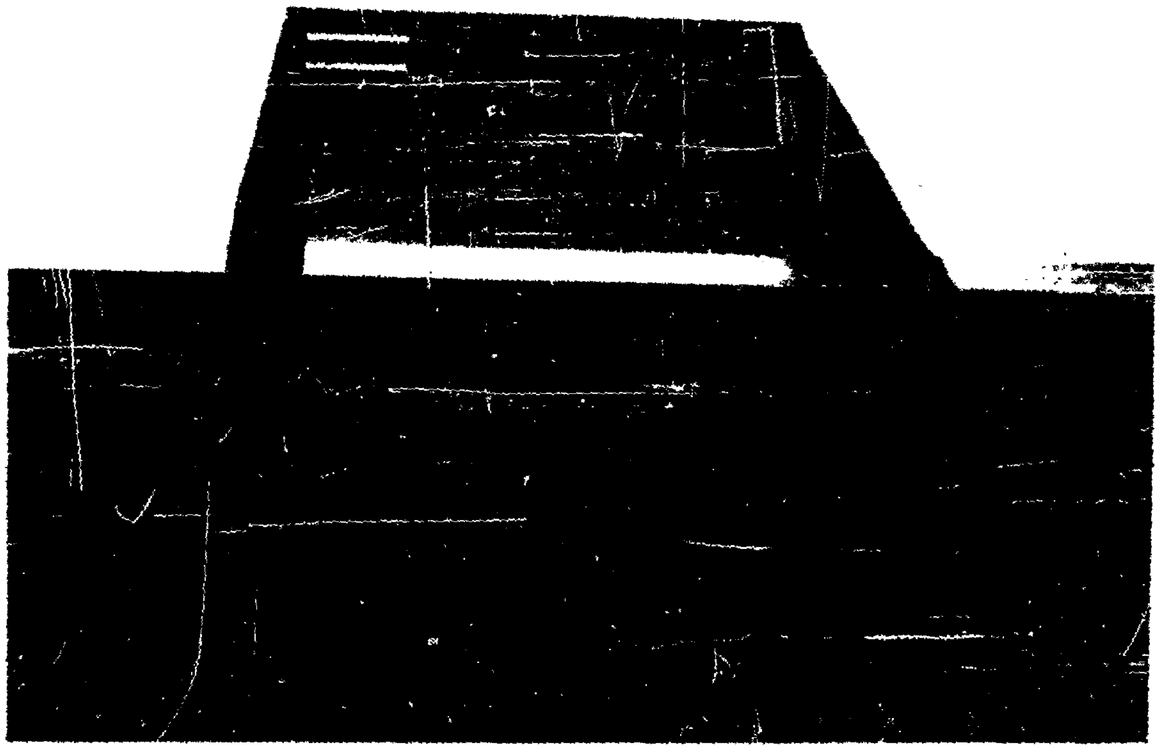


Major General Singchai explains the objectives
of the Laboratory

Air Chief Marshal Dawee Chullasapya, Chief of Staff, Supreme Command, thanks the United States for establishing the Laboratory.



Mr. Puhan and Mr. Pote Sarasin watch as ACM Dawee presses the button for the unveiling of the entrance sign



Unveiled entrance sign of the Laboratory

Captain Termpoon Kovattana, RTAF, (back to camera), briefs ACM Dawee and other distinguished guests

Lt. Paibul Nacaskul, RTN, explains the microwave demonstration to Nai Smarn Punyaratabandhu, Chief, Investigation and Research Division, General Post Office

ACM Dawee and Mr. Pote Sarasin are escorted by Captain Prapat Chandaket, RTN, Electronics Laboratory Coordinator

Air Vice Marshal Pipatana Banaruka, Technical Advisor to Communications Department, RTAF, leaves the Laboratory followed by Major General Easterbrook, Chief, JUSMAG - Thailand

Requirement: Remote Area Conflict Communications Research

Task: Investigation of Communications Techniques and Devices (1D)

The major effort of the Electronics Laboratory in Thailand is currently focussed on the investigation of communications techniques. The purpose is to determine the utility of promising techniques in the geophysical environment of Thailand and Southeast Asia, with the objective of enhancing the communications capabilities of Thai forces. Initial emphasis of this effort is on radio, but all operationally useful means of communication are within its scope.

Certain of the sub-tasks listed in the pages which follow have a close relationship to other tasks, particularly 1B, of the Communications Systems Sub-Project. For contractual purposes, these primarily technical sub-tasks have been numbered consecutively in a single series. They are grouped under Task 1D in an effort to achieve simplicity of presentation.

It should be recognized that the scientific efforts listed below are in their early stages. It is not unlikely that some will be dropped and some redirected; others will be added as the work progresses.

Requirement:	Remote Area Conflict Communications Research
Task:	Investigation of Communications Techniques and Devices (1D)
Sub-Task:	Test and Evaluation of Tactical Communications Devices

See Task 2A and Task 2B.

Requirement:	Remote Area Conflict Communications Research
Task:	Investigation of Communications Techniques and Devices (1D)
Sub-Task:	Noise Measurements

It is the objective of this sub-task to determine mean atmospheric noise levels and their periodic variations in Thailand. Noise-recording equipment currently on hand in Thailand is designed to measure noise at frequenices below 300KC, which does not appear to be the range of greatest interest to AGILE. The possibility of acquiring more suitable equipment from the National Bureau of Standards is being explored, and efforts are underway to locate a satisfactory site for the making of noise measurements. Laboratory personnel are familiarizing themselves with noise measurement techniques and problems.

Requirement: Remote Area Conflict Communications Research

Task: Investigation of Communications Techniques and Devices (1D)

Sub-Task: Antenna Orientation Effects

In this sub-task it is intended to evaluate the advantages of NORTH-SOUTH alignment of dipole antennas for short-range sky-wave communications in an area near the magnetic equator. Theoretical work suggests that there is an optimum orientation for linearly polarized antennas used on short ionospheric paths near the geomagnetic equator, and that this optimum orientation is not necessarily broadside to a straight line from the transmitting station to the receiving station. Consideration of the magneto-ionic theory and its application to antenna-to-medium coupling problems indicate that aligning such antennas parallel to the earth's magnetic field will maximize signal strength and minimize polarization fading.

A five day continuous-wave test was conducted in November on 1.7, 3, 6, and 12 megacycles, with results which tend to confirm the theory. A larger and more elaborate program of field tests has begun.

Requirement: Remote Area Conflict Communications Research

Task: Investigation of Communications Techniques and Devices (1D)

Sub-Task: Ground Constants

This sub-task seeks to determine the magnitudes of ground conductivity and dielectric constant at selected locations in Thailand. A study is being made of the known techniques for measuring ground constants. It is planned to explore the feasibility of correlating soil and geological types of Thailand with soil and geological types of areas (primarily the United States) for which the values of the ground constants are known.

Requirement: Remote Area Conflict Communications Research

Task: Investigation of Communications Techniques and Devices (1D)

Sub-Task: Earth Potential Measurements

MRDC has considered exploring earth potential measurements to obtain indications of ionospheric and magnetic storms. At present, however, this sub-task is inactive and is being reconsidered to determine if the objective can be achieved as a by-product of another sub-task(s).

Requirement: Remote Area Conflict Communications Research

Task: Investigation of Communications Techniques and Devices (1D)

Sub-Task: Frequency Prediction

This sub-task is concerned with improving frequency prediction capabilities in Thailand. The flow of data from the C-2 sounder into the world-wide ionospheric data system is expected, in the long term, to result in improved frequency predictions for Southeast Asia. It appears possible, however, to improve the frequency-prediction situation in the short term.

Accordingly, data from the Bangkok Sounder (see Task 1B, Sub-Task: Vertical Incidence Ionospheric Sounding) are being studies and analyzed locally. These data are considered in conjunction with the frequency predictions made by the Central Radio Propagation Laboratory and the U. S. Army Signal Radio Propagation Agency. Frequency recommendations have been prepared and furnished to JUSMAG for a Counter-Insurgency Field Training Exercise to be conducted by Thai forces early in 1964.

Requirement: Remote Area Conflict Communications Research

Task: Investigation of Communications Techniques and Devices (1D)

Sub-Task: Antenna Terrain Effects

This sub-task is designed to investigate the effects of terrain in the immediate vicinity of field antennas and the performance of those antennas. It is not yet active.

Requirement:	Remote Area Conflict Communications Research
Task:	Investigation of Communications Techniques and Devices (1D)
Sub-Task:	Flutter Fading

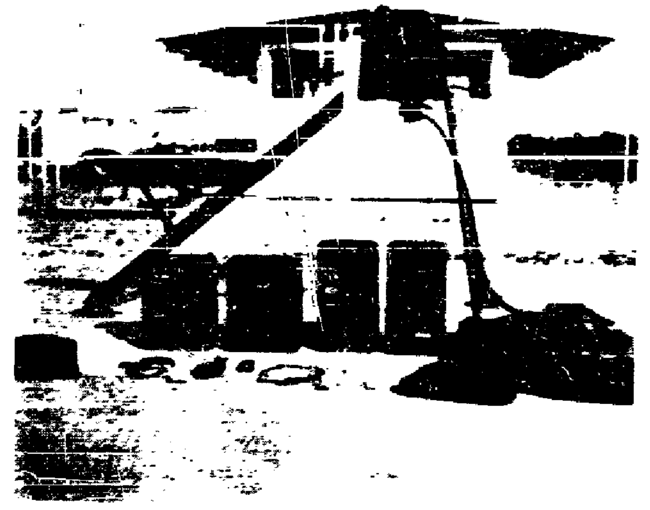
This sub-task is concerned with the determination of the effect of equatorial flutter fading on field communications. It is not yet active.

Requirement:	Remote Area Conflict Communications Research
Task:	Investigation of Communications Techniques and Devices (1D)
Sub-Task:	Vertical Incidence Ionospheric Measurements

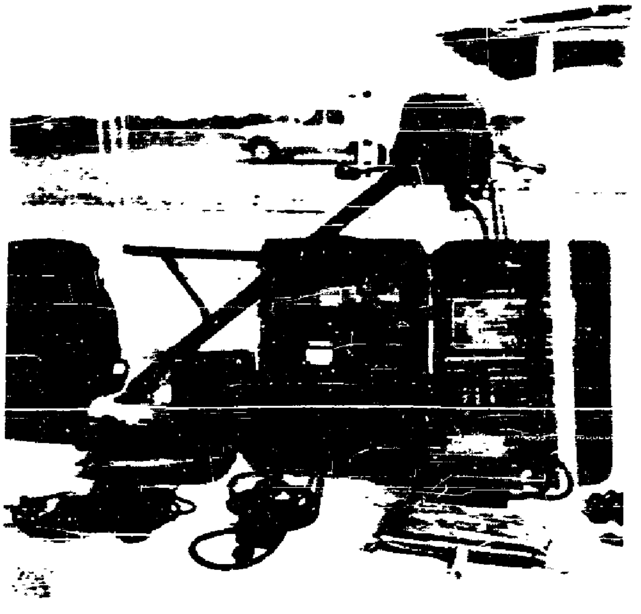
See Task 1B and Sub-Task: Vertical Incidence Ionospheric Sounding.

Requirement:	Remote Area Conflict Communications Research
Task:	Investigation of Communications Techniques and Devices (ID)
Sub-Task:	Oblique Incidence Ionospheric Measurements

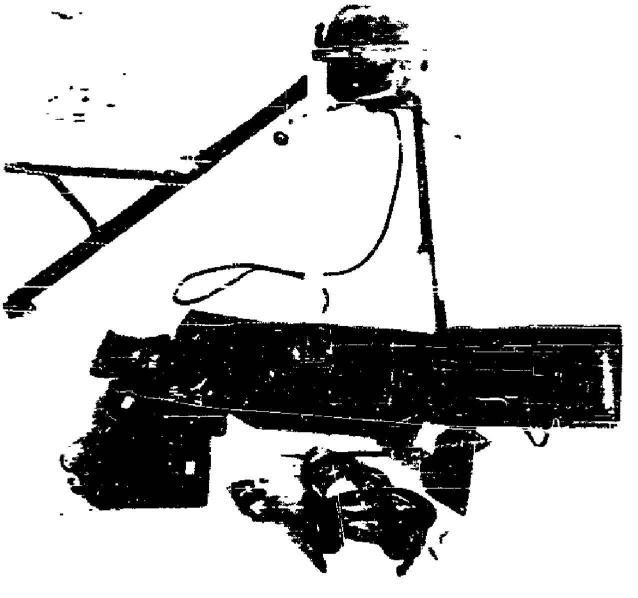
Utilizing an oblique incidence sounder it is planned to examine typical field communication paths and determine the nature and characteristics of the propagation modes and antennas effects, and the consequences for tropical field communications. Technical planning is underway, and a decision on procurement of an oblique sounder is anticipated in the next quarter.



RS-6A



AN/GRC-87



Composite Set
RS-6A/GRC-87

The MRDC has distributed antenna reports, prepared by the Combat Development and Test Center in Vietnam, to both Thai and U. S. authorities in Thailand. The bamboo frame Yagi VHF antenna, described in one of these reports, was demonstrated with the AN/PRC-10 at the October JUSMAG-Thailand Army Section Advisors Conference, through the efforts of the Army Section Single Branch and the Thai Army Signal Department. As a JUSMAG follow-up to this demonstration, all officers of the 4th Thai RCT received instruction in the antenna on 13 November; a range of 24 kilometers was achieved on that day over an AN/PRC-10 link utilizing the Yagi antenna.

Requirement: Investigation, Development, and Evaluation of Communications Techniques and Devices

Task: Tropical Intra-Patrol Radio Communications (2A)

The test and evaluation of specific items of communications equipment, to determine the utility in Southeast Asia of these equipments or of some of their specific characteristics, is also within the scope of the SRI contract.

The assignment of a higher priority to Sub-Task: Antenna Orientation Effects of Task 1D has deferred until the next quarter tests of the following items:

1. Motorola H-21-DCN (VHF-FM) This set is one of a number of commercially available, hand-held, voice only transceivers using entirely transistorized circuitry. It weighs 33 ounces complete and radiates 1.4 watts at frequencies between 24 and 54 MC.

2. PRC-35, Experimental (VHF-FM) This set was developed by RCA on contract to USAELRDL as a replacement for the AN/PRC-6, but it has not been standardized. It is transistorized and has a voice capability between 30 and 70 MC at a radiated power of about 1/3 watt.

3. AN/PRC-25 (VHF-FM) Covering a frequency range of 30-76 megacycles and weighing approximately 20 pounds, this set is beginning to replace the AN/PRC-8, -9, and -10 in the U. S. Army. It radiates 1.5 watts. Also on hand are experimental power amplifiers which can boost the power output of the AN/PRC-25 to 15 and 30 watts.

Requirement:	Investigation, Development, and Evaluation of Communications Techniques and Devices
Task:	Tropical Man-Pack Radio Communications (2B)

Partial distribution has been made of SRI Research Memorandum 3, "Field Tests on Man-Pack Radios in a Tropical Environment." Distribution will be completed when additional copies are received from SRI.

SUB-PROJECT V

COMBAT SURVEILLANCE AND TARGET ACQUISITION SYSTEMS

SUB-PROJECT V

COMBAT SURVEILLANCE AND TARGET ACQUISITION SYSTEMS

SUB-PROJECT OBJECTIVES:

To develop combat surveillance and target acquisition techniques, systems, and devices which will enable friendly local forces in remote area conflict sutuations to:

a. Detect, locate and maintain surveillance of hostile units, bases, stores and supply routes.

b. Detect infiltration of borders and incipient ambushes or attacks on outposts and communities.

c. Effect rendezvous of friendly elements with each other and with supply drops or caches, and guide friendly units to the location of hostile elements.

d. Improve the degree of mobility and the effectiveness of logistic support though better navigation and point-location in remote areas.

e. Exploit the knowledge of communications techniques and equipment to locate, neutralize or destroy hostile bases and headquarters.

Requirement: Remote Area Conflict Surveillance Research

Task: Phenomenological Research (1B)

Sub-Task: Forest Canopy Obscuration

I. PURPOSE

The purpose of performing this sub-task is to:

a. Develop a method or methods of measuring the obscuration to viewing caused by a forest canopy.

b. Determine the existence and value, if any, of characteristic trends of obscuration of forests in Southeast Asia.

This interim report discusses the first objective and concludes that one satisfactory method of measurement has been developed. In addition, an indicative trend of one characteristics of obscuration is presented.

II. BACKGROUND

A major problem in the conduct of counterinsurgency warfare is the detection of personnel who reside, train and deploy under a forest canopy. This is an especially difficult problem if ground access is prohibited and only aerial surveillance is possible. Solutions to this problem are the subject of a number of research and development efforts. All of these efforts pre-suppose that the canopy is not totally opaque but rather has openings of certain sizes and distribution. That is this, in fact, true in readily observable by anyone standing on the floor of a forest. During daylight hours there is appreciable light on the floor of even the densest forest.

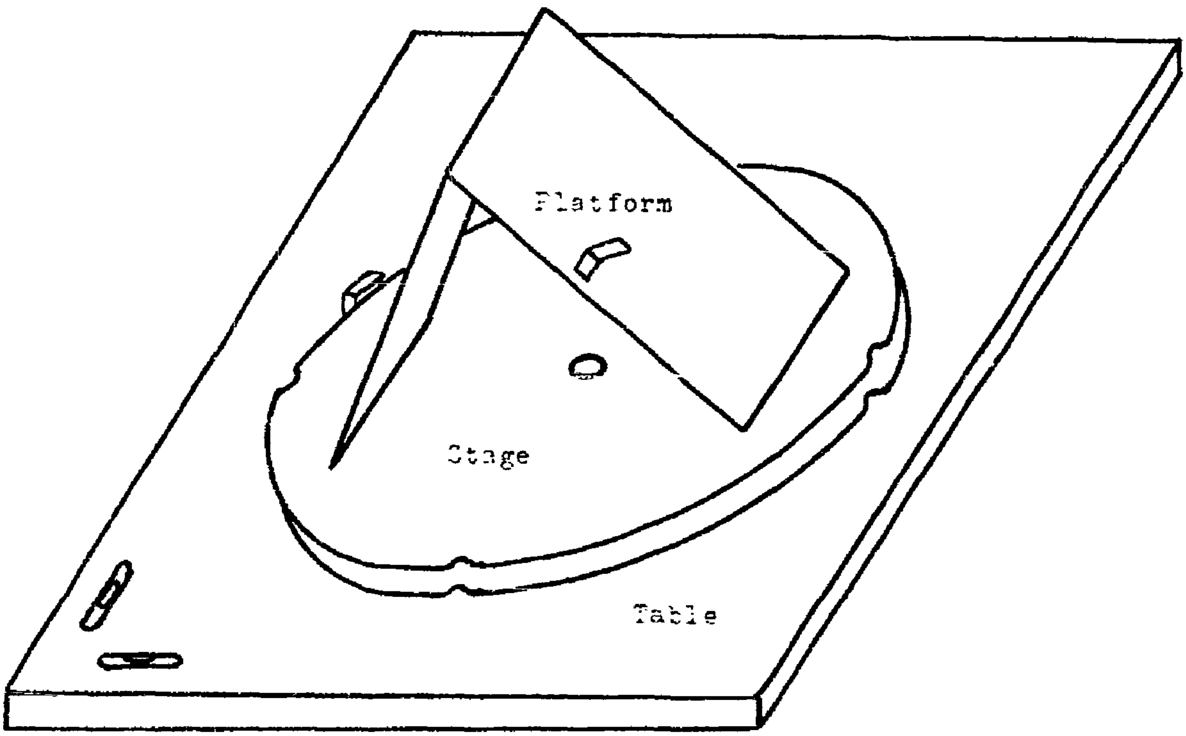
Some experimeters have assumed that the obscuration of the ground from the air caused by the forest canopy is independant of nadir (zenith) angle or at least not strongly dependent upon it. They have assumed that the degree or amount of obscuration is principally dependent only upon the species and age of the trees constituting the forest. Other experimenters have observed that canopy obscuration is a function in some way of nadir angle. The Forest Fire Laboratory of the United States Department of Interior and the Forestry Department of the province of Ontario, Canada have reported results that indicate such a dependence. Attempts to detect simulated smoldering fires in the coniferous forests of North America using aircraft-carried infrared receivers disclosed that the highest probability of detection occurred when the detector was directly over the fire. The probability of detection decreased rapidly as the viewing angle changed from vertically downward to oblique. MRDC personnel have previously observed while flying over forested areas of Thailand that the "best" view of the ground surface through the trees was obtained when looking obliquely at some angle between the nadir and 45°. Discussions with other aerial observers disclosed that a comparable impression had been gained by them when flying over tropical forests in Southeast Asia and other parts of the world. The existence of a viewing angle at which the obscuration caused by a forest canopy is a minimum can have a significant effect upon the utility of aerial surveillance devices. This is partciularly true if the angle of minimum obscuration is generally constant and if the variation in obscuration is significant.

It was concluded that an experiment intended to measure forest canopy obscuration of the ground from the air would be difficult and expensive to conduct. An experiment intended to measure the forest canopy obscuration of the sky could be economically and easily conducted, however. For the purpose of this experiment it is assumed that measured values have reciprocal validity, that is, that the absolute value of obscuration is independent of direction of line-of-sight. It is further assumed that a photograph of the sky as viewed through the tree canopy can serve as a valid source of raw data. A last assumption is that a particular forest type, as defined by botanical methods, has a value of canopy obscuration which can be analysed and described using standard statistical mathematical methods.

III. PRODEDURE

The camera selected for use in data acquisition was the Eastman Kodak Retina Reflex III with the Retina Curtagon 28 mm wide angle lens. By taking a photograph of a rectangular grid surface (a wall covered with acoustic panels) from a measured distance it was possible to accurately determine the angular characteristics of the camera field of view. The field of view was found to be 45.8° by 63.6° and approximately 75° on the diagonal of the format. Five photographs taken with this camera are then able to record the significant portion of the upper hemisphere. One photograph must have the center line-of-sight exactly vertical; the remaining four photographs must have their center line-of-sight depressed 52° from the vertical and will be separated exactly 90° in azimuth. For later convience in data reading these four photographs should be oriented with the vertical photograph in such a way that the format edges are parallel or perpendicular. With this orientation of pictures, solid coverage is obtained of that portion of the hemisphere from vertically upwards to a zenith angle of 30°. Coverage is obtained down to a zenith angle of 85° or 5° above the horizon. At this lower angle, approximately 180° (4 x 45.8°) of azimuthal coverage is obtained. Consequently, with five photographs properly oriented, the upper hemisphere can be photographed in such a manner that only four pie-shaped areas of non-coverage exist. These areas of non-coverage will have no effect on the final results in care is taken not to introduce any azimuthal bias when the photographs are obtained.

In order to insure that the photographs are taken with the desired orientation, a camera mount was designed and constructed as illustrated.



Camera Mount for Obscuration Photography

The table was mounted on tripod legs. In practise the table is levelled by adjustment of the tripod and no attention is paid to azimuthal orientation. The camera is held to the platform by inserting the bracket into the camera accessory shoe. The hinged platform is folded to the horizontal position, the stage is rotated to one of the deteted positions and a vertical picture is taken. The the hinged arm of the platform is opened aligning the camera to the desired depression angle of 52°. The stage is rotated through each of the detented 90° azimuthal points and a picture is taken at each position. The film is developed and the pictures are enlarged with the magnification used for a standard 5 x 7 inch print from 35mm film. The prints are not border-cropped, however, and the sprocket holes are printed. This insures that the negative is not over-enlarged and then cropped to the requested size.

For the initially determined angular field of view of the camera, it is a straightforward process to determine the projection of the epherical coordinates into the plane of the film. This projection is necessary in order to measure the angular value of any point in the acquired photographs. Transparent grid overlays are constructed of this projection to the scale as the enlarged prints. The grid overlays for use with the vertical and depressed photographs are as shown.

The process of determining obscuration consists of placing the appropriate grid overlay on the selected picture. The obscuration of each segment in each of the angular bands is estimated and the values for all of the segments of one angular band are averaged. In this way values of obscuration as a function of zenith angle for 5°-wide bands can be obtained.

IV TEST

A site was selected for the testing of this procedure. This site is part of the national forest of Thailand and is described botanically as a semi-deciduous tropical evergreen forest. This test site is atypical of forested areas of Southeast Asia and is located on the Kra Peninsula of Thailand between the towns of Prachuab Khirikhan and Chumporn.

Photographs were taken at seventeen locations in the forest. Each of these locations was on a foot or animal trail. The ground growth off the trails was such as to make human passage very difficult and erection and use of the camera mount generally impossible without the cutting of vegetation. The photographic film was given normal development and the pictures were printed on average contrast paper.

The set of pictures from the seventeen locations were independently read by five different individuals, four of whom were Thai. Each reader had an engineering background and was familiar with the purpose of the experiment. An average value of obscuration for each 5°-wide angular band for the seventeen locations was determined. It was assumed that the distribution of values was Gaussian and that the root-mean-square value of the deviations from the mean was proportional to the standard deviation, s. The standard deviation was calculated from the formula

$$s = n^{1/2} (n-1)^{-1/2} (\overline{x^2} - \bar{x}^{2})^{1/2}$$

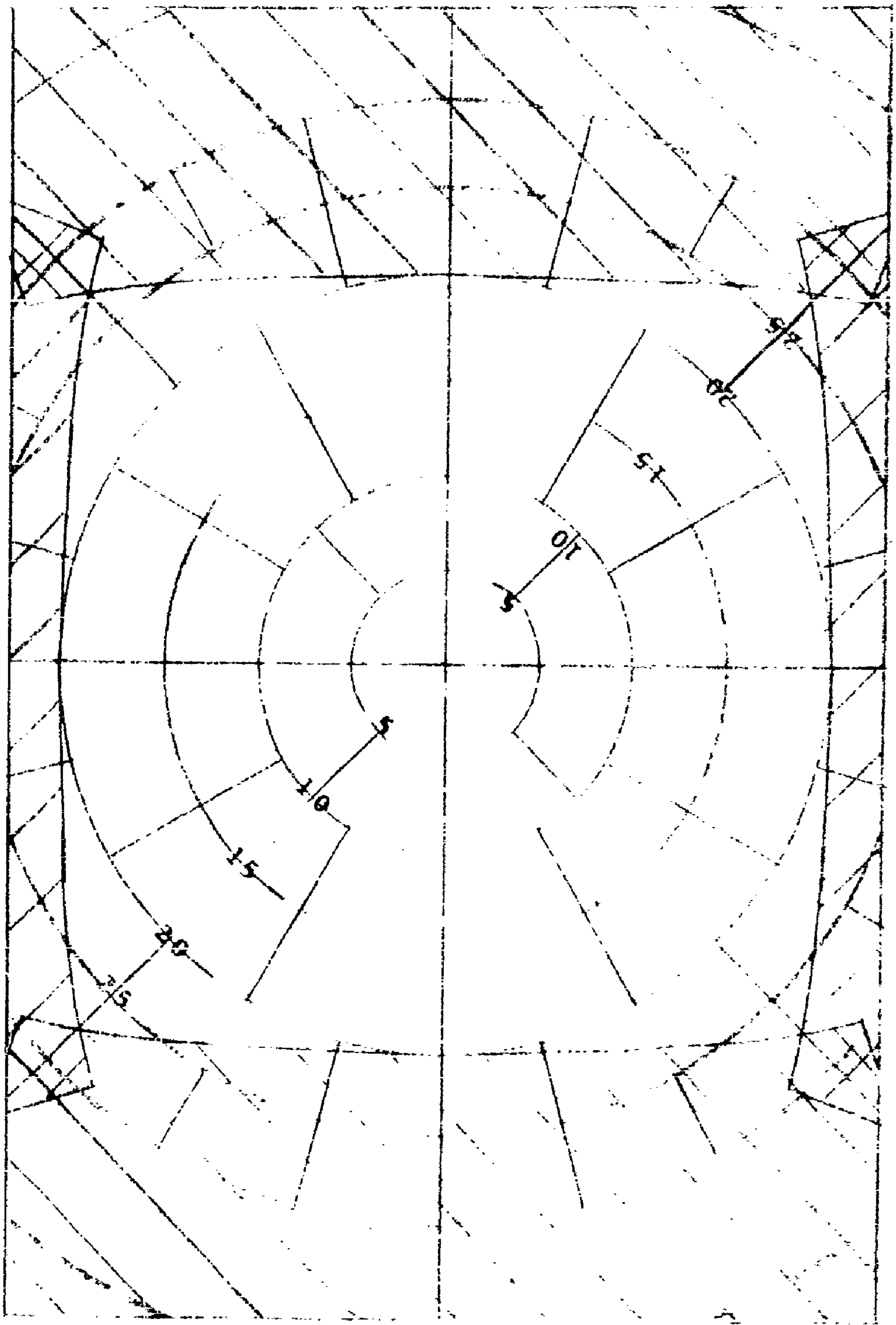
where n = Sample size (17)

$\overline{x^2}$ = mean squared value

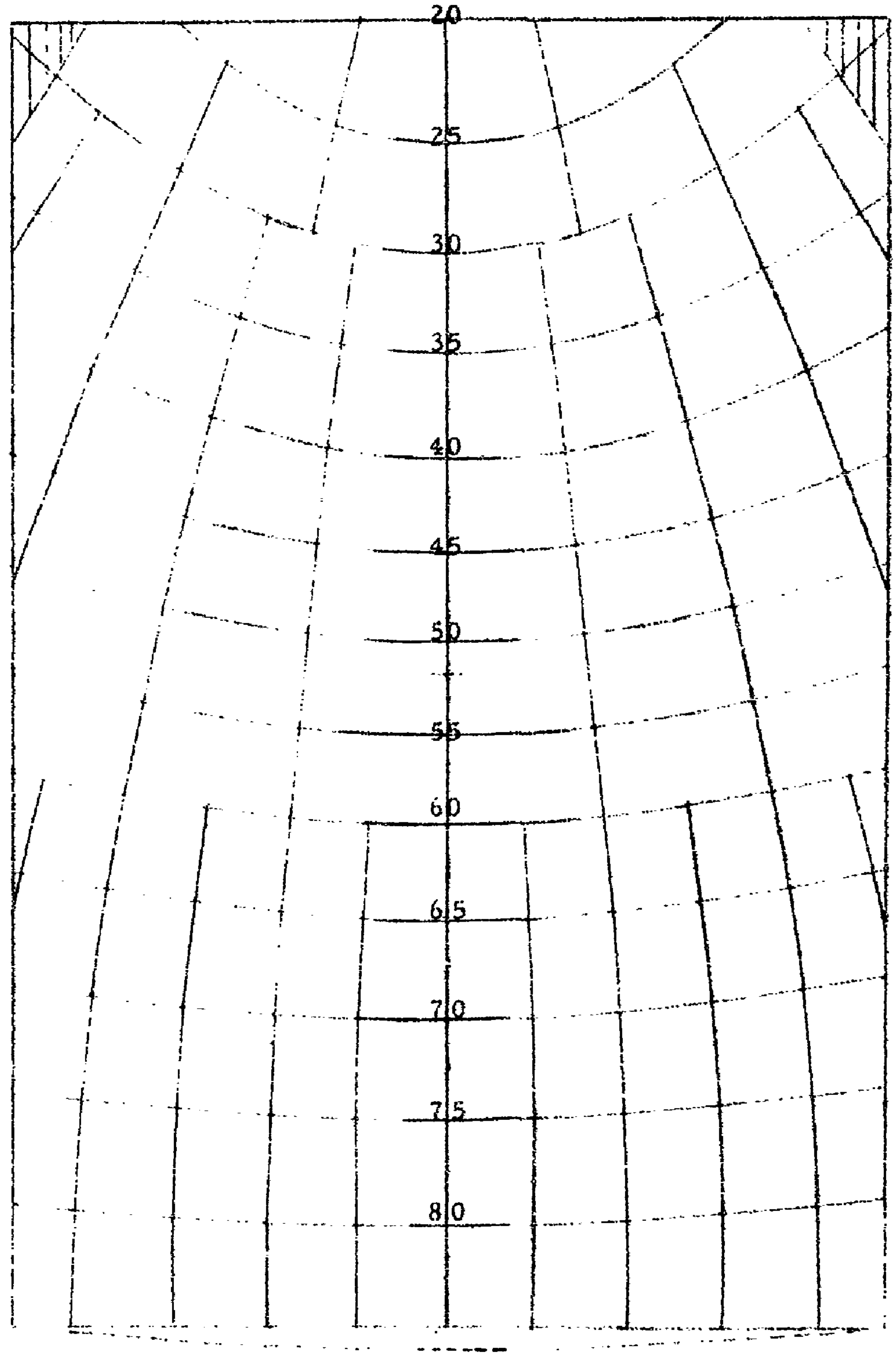
$\bar{x}^2$ = squared mean value

A value, r_x, the probable error of the mean was calculated from the formula $r_x = 0.6745\, s\, n^{-1/2}$

The mean value, $\bar{x}$, and the probable error value, r_x, were used to compare the results obtained by each reader and are

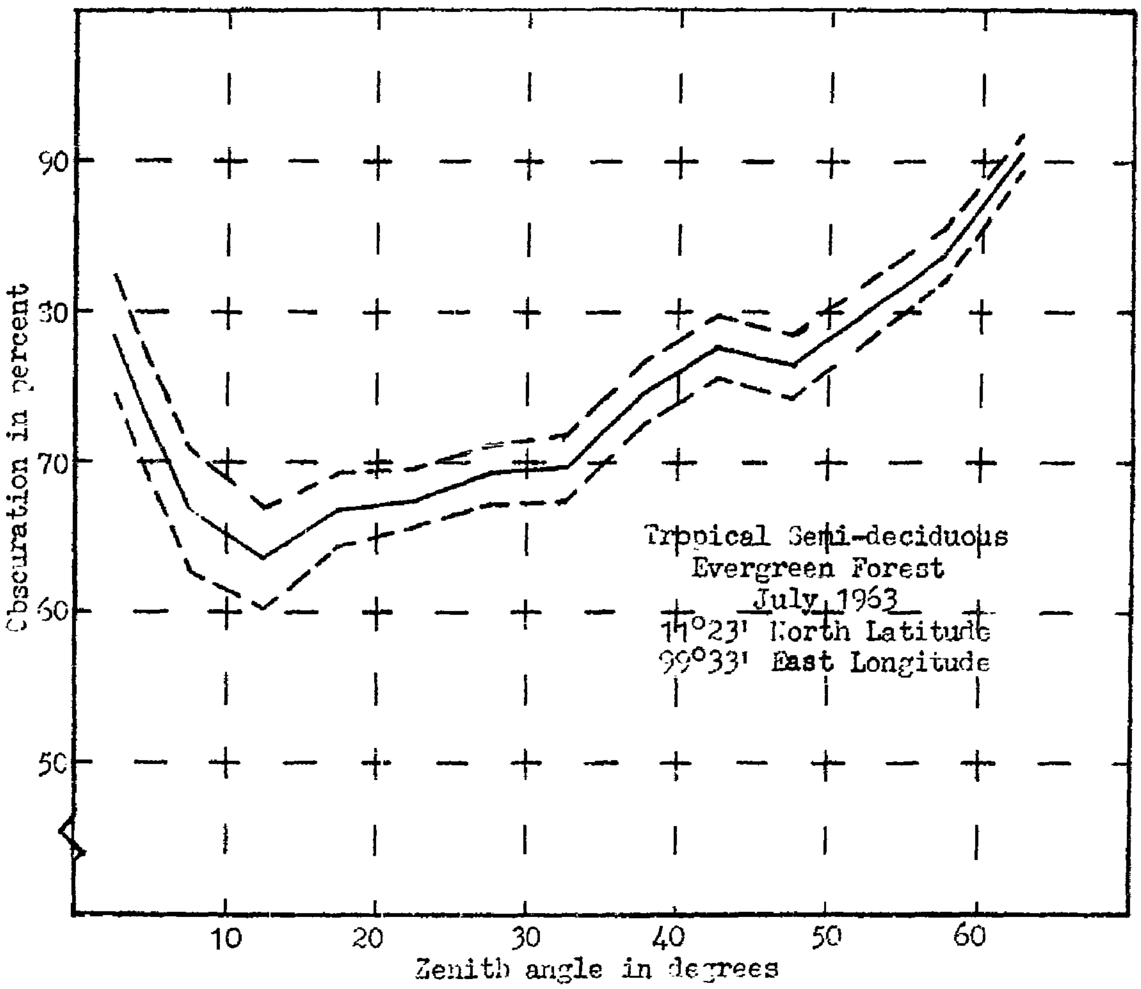


Field of View
E-K Retina Reflex III
with
28mm Retina Curtagon
$(45.8^{\circ} \times 63.6^{\circ})$
Line-of-Sight — Vertical



Field of View
E-K Retina Reflex III
with
28mm Retina Curtagon
(45.8° x 63.6°)
Line-of-Sight — Depressed 52°

the values used in the plot of obscuration versus zenith angle. The values for each 5° -wide angular band are plotted at the mid-angle point of that band.



The mean values of obscuration for each angular band as determined by four of the five readers showed a maximum difference of 4.5% (at 10° to 15°) and were within a span of 2% at the angle of closest agreement (55° to 60°). The mean values as determined by the fifth reader were consistently lower than those of the other four by an amount of 5 to 10%. The values of r_x for all five of the readers for all of the angular bands were within 0.5% with the exception of one band (25° to 30°) where the span of r_x deviation was 0.8%. The plotted value of obscuration versus zenith angle for the test site was obtained from an average of the mean values and r_x values determined by the four mentioned readers.

V. CONCLUSIONS

It is concluded that a satisfactory, acceptable and useful method has been devised to measure the obscuration to viewing caused by a forest canopy. It is tentatively concluded, pending measurements by other methods, that the subjective evaluations by humans will result in objective evaluations of a natural phenomenon. It is further concluded that there is, for one type of tropical forest, a characteristic trend of obscuration. This trend is a significant decrease in obscuration when the zenith or nadir angle changes from zero (vertical) to ten degrees, remains at a low value until an angle of thirty degrees and then increases reaching a maximum value at or near ninety degrees (horizontal).

VI. RECOMMENDATIONS

It is recommended that additional data be acquired and analyzed to determine the variation in trend of obscuration to viewing caused by forest canopies of Southeast Asia. It is also recommended that the probable variations in obscuration as a function of zenith angle be considered by the designers of that airborne equipment which is intended to perform a surveillance function over forested areas.

Requirement: Investigation, Development and Evaluation of Techniques and Devices

Task: Airborne Infra-Red Systems (2A1)

Sub-Task: Reconnaissance Program

A second site to be used in the proposed feasibility test of detecting cooking fires imbedded in tropical forests has been selected. This site is a rubber plantation located at 12° 33' North Latitude, 102° 09' East Longitude on the east coast of the Gulf of Thailand near the town of Chantaburi. A survey of the site has been performed and the prospective location of the test fires has been determined. Photographs of the canopy have been taken at each test-fire location and the obscuration is in the process of being obtained.

As part of the Vegetation Study (1A2) of Sub-Project VII, Technical Planning and Programming, canopy photography is being obtained. The Thai Department of Forestry survey team has been requested to obtain canopy photographs from at least fifteen random locations in each type of forest for which a profile is obtained. These canopy photographs will be used to determine obscuration as a function of zenith angle for the particular forest involved.

Requirement: Investigation, Development and Evaluation of Techniques and Devices

Task: Visual Surveillance and Low-Light-Level Amplification (2A4)

Sub-Task: Airborne Visual Surveillance

The RAND Corporation staff completed a visual search test in April 1963, using RTAF resources. The work was published as a CDTC report. * It was recommended in that report that the exploratory April test be followed by further tests which should be conducted at an altitude determined by the April test and would be an attempt to determine the quantitative relationship between search strip width, aircraft velocity, and slant range at identification. This is the primary purpose for tests now proposed. The April test was made simple enough so that basic information on the capabilities of observers to detect individual men on the ground in various contrast situations typical of SEA could be derived. Quantitative measures of observer capability such as the maximum slant ranges at identification for narrow search strips were derived. It was shown that slant ranges of identification could be great enough that surprise is possible with aircraft modified for quietness. The large number of variables was decreased, and test and analysis procedures were substantiated.

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* Blakeslee, D. J., Visual Search From the Air for Individual Men: An Exploratory Field Test in Southeast Asia, July, 1963 (U).

The follow-on test that is now proposed would be conducted in the same way as the previous test, with the same equipment, test course, and basic method of analysis. Therefore this will provide a good opportunity to train Thai military personnel in a practical and uncomplicated test and analysis.

The proposal is to teach three Thai officers in the procedures of test and analysis used in the April test and to guide them through all parts of the follow-on program now proposed. It is planned that the Thai officers will themselves, under guidance, do the testing, data transcription and analysis, derive the final results, and prepare such of the final report. This will further the informing of the Thai military about R&D task direction, scientific testing, data-taking, and operations analysis. At the same time, important work toward establishing possible limitations on search aircraft speed as a function of search strip width and slant range at identification will be accomplished.

The proposal with a work schedule covering the period from 12 February to 15 May has been submitted to the Director of MRDC with copies to JUSMAG, Thailand and CINCPAC, and transmitted to the RTAF for their approval.

Requirement: Investigation, Development and Evaluation of Techniques and Devices

Task: Surface Systems (2B)

The reports of tests involving the breakwire detectors, the seismic detector and the paraffin test have been distributed. Discussions were held with members of the staff of Headquarters, Thai Border Patrol Police concerning the nature of the surveillance problem on the national border. The breakwire and the seismic detectors were demonstrated as illustrative examples of the results of research and development in the field of surveillance. The Headquarters staff members requested that the Border Patrol Police be loaned some of these devices for test and evaluation and that the Headquarters be kept informed of any developments that might have value for them. The Border Patrol Police offered to assist the MRDC staff members in the development of cogent and pertinent requirements for the development of surveillance techniques and/or devices. Further discussions, including field visits, are expected during the next quarter.

SUB-PROJECT VI

INDIVIDUAL AND SPECIAL PROJECTS

SUB-PROJECT OBJECTIVE

This sub-project provides for centralized management and control of those AGILE efforts which because of sensitivity, diversity, or uniquenese of application are not included in other segments of the AGILE program. As a consequence, this sub-project covers a range of requirement areas and involves varying applications of research and engineering resources, from field investigations and analyses of insurgency problems to the design and development in the U. S. of hardware and other items designed to fill specific indigenous needs.

While the requirements and tasks currently being pursued under this sub-project are shown on the immediately following pages, it should be emphasized that its composition is, by design, flexible and subject to change.

Requirement: Military Chemistry

Task: Defolitation (1A)

Sub-Task: Thailand Defoliation Test Program

During the reporting period contractual arrangements were completed for the provision of a spray aircraft. It should be ready for use in January 1964. Necessary chemicals and equipment have been stored at the principal test site on Pranburi Military Reservation.

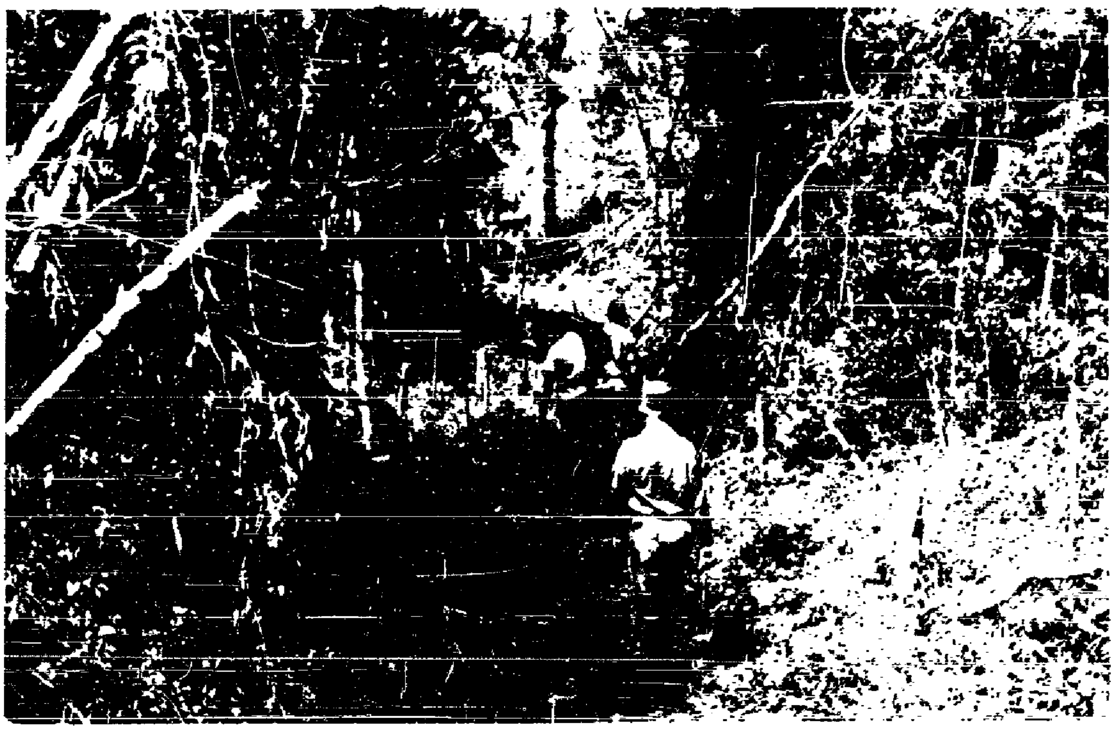
An area at the site was cut into blocks or sections for further botanical study, defoliation treatments, and follow-up evaluation activity. Figure 1 represents a schematic diagram of this area. The site probably comes under the broad botanical description of a dry evergreen forest with a transition zone of a few deciduous species. A more exact study of the plant species and the environmental factors involved will be conducted by specialists at the test site as the defoliation project progresses.

A general view of the forest can be seen in the accompanying photographs. The average height of the trees is 30 to 40 feet with a few trees growing to 125 feet. Photographs show paths or lanes cut through the jungle. Some of the lanes are 10 to 12 feet in width and are easily distinguishable from the air. On other lanes the canopy was not opened, but it allows easy access into the furthest reaches of the test site. The lanes are cut 500 yards wide, parallel to each other, and are from 2100 to 2400 yards in length. The lanes total approximately 160,000 yards and required the labor of 8 to 12 local Pranburi men for about six weeks. Photograph shows some of the local Thai workers cutting a lane. The total acreage encompassed within the test area is approximately 1,400 acres. This acreage will allow approximately 90 plots of 15 acres each or approximately 140 plots 10 acres in size.

A large area, estimated at 6,000 acres, was found not to be entirely safe for ground work. Part of the area is an artillery range hence the likelihood of numerous duds. Nevertheless, it is felt that a satisfactory method of marking areas from the air can be devised.

Several plants specimens were collected, dired, and shipped to the United States for identification. The plant drier has been relocated near the test site for more effecient usage in plant collection activities.

Workers cutting a trail.



A trail cut through the forest.

The undisturbed test site at Pranburi.

A trail cut through the test site.

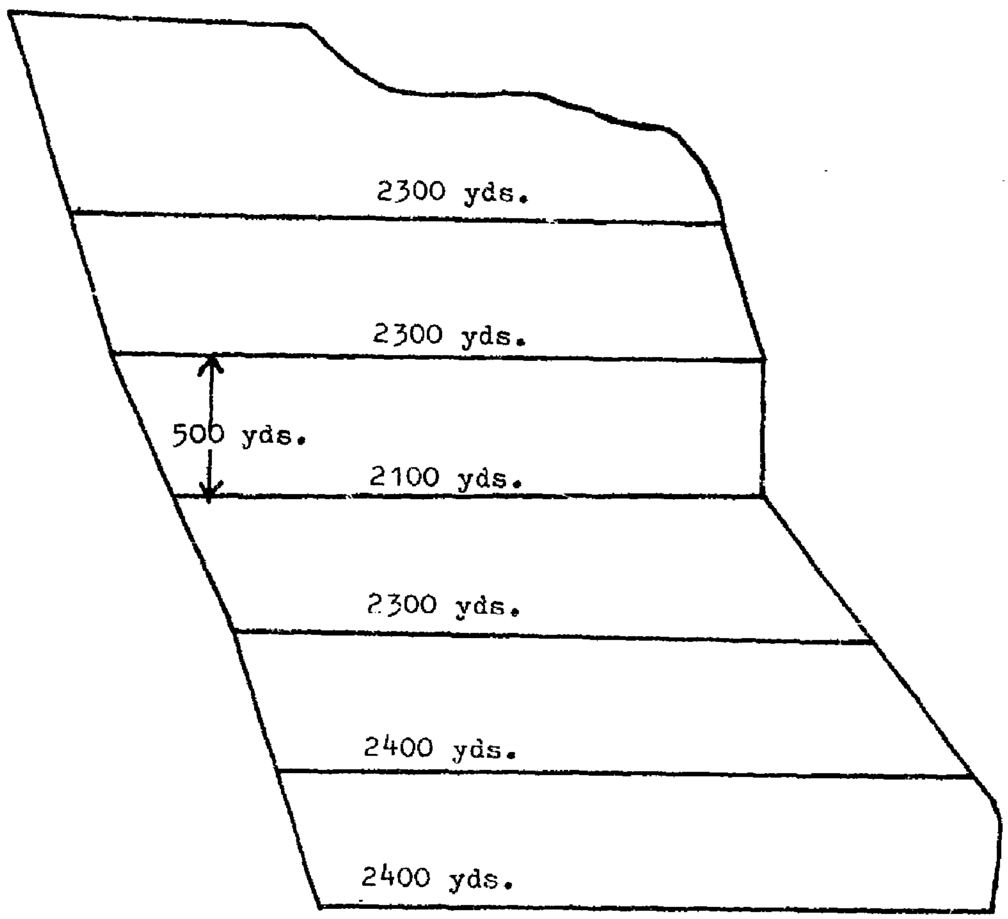


Figure 1. Pranburi test area containing approximately 1400 acres. Lanes have been cut at intervals of 500 yards.

Requirement: Psychological Warfare

Task: Psychological Warfare Equipment (2A)

Sub-Task: Audio-Visual Mobile Unit

MRDC is awaiting ARPA action in CONUS on recommended improvements based upon field test of the Willys Audio-Visual Mobile Units.

SUB-PROJECT VII

TECHNICAL PLANNING AND PROGRAMMING

SUB-PROJECT VII

TECHNICAL PLANNING AND PROGRAMMING

SUB-PROJECT OBJECTIVE

This sub-project provides for operations research in the identification of requirements for new or improved counterinsurgency weapons and equipment. Through data acquisition, analysis, and the application of inter-disciplinary scientific techniques to the analysis of military and related civil problems, this sub-project prints the way to new ideas and requirements, helps establish priorities, and helps integrate ARPA's counterinsurgency RDT&E effort.

Requirement: Data Collection and Analysis - Environmental

Task: Physical Environment Methodology (1A1)

Sub-Task: Water Resources

A draft paper on water resource problems in Northeast Thailand prepared by RAC staff, has been sent to ARPA, Washington.

Requirement: Data Collection and Analysis - Environmental

Task: Vegetation Study (1A2)

The importance of environmental factors in the design of equipment and techniques for use in Southeast Asia is now being realized increasingly by scientists and engineers involved in the various research and development tasks of Project AGILE. In particular, the relationship of vegetation to the design of new equipment, redesign of existing equipment, and the applicability or use of such equipment is of major significance. Factual data on forest canopies, tree heights, density, distribution, foliage mass, water content, associated undergrowth, and many other vegetation factors in the tropics has begun to take on new meaning in this context.

The demand for such data to meet the new recognized requirements of ARPA's various projects - especially in Communications and Mobility - has exceeded the capability of the existing field team. On 1 January 1964 another team will be added to meet the additional requirements and to provide greater long term flexibility.

During October, weather conditions prohibited movement off roads into the forests. Roads and trails were impassable. Several attempts were made, but efforts were unsuccessful. Time was spent reducing data previously collected and in preparing profile results on forest stands previously measured. Further work was accomplished on card indexing indiginous edible and poisonous plants for the joint MRDC-Royal Thai Army Jungle Survival Manual. Data collection of survival information should be completed in December.

During 4-11 November, profiles were run on 11 more sample plots bringing the total plots measured up to a total of 32. The 11 sample plots were made in Evergreen and Dry Dipterocarp Forest in the northeastern part of Thailand (Pakthongchai, Kabienburi and Aranynprathes). On 15 November, a trip was made to the Chantaburi area where measurements are to be made on the Beech Forest. On 17 November, a small team was sent into the Pranburi defoliation test site area and preliminary profile measurements were made. On 24 November, a reconnaissance flight was made over the MRDC general purpose field test site area in the Kao Yai National Forest. Aerial photos of the test site will be studied and correlated with data collected by vegetation team ground parties who will spend 2-3 weeks conducting a complete vegetation study with floristic composition profiles.

Soil samples and terrain data will be added to the environmental data necessary for the various propagation tests and other electronic studies being planned at the site. It is expected that profile samples will be made along the transmission paths chosen for test by Jansky and Bailey.

In all profile plots to date, photographs have been taken to collect data on visual obscuration from ground to air for use in the Surveillance tasks. When reduced the data will indicate whether an optimum angle of penetration through the canopies of the various types of forest configurations does exist. If there is an angle of optimum penetration, such information will be great value to those working in surveillance, ordnance delivery systems, aerial resupply, and air/ground delivery systems in general. An explanation of the technique being used is covered in the Surveillance portion of this report. At the same time, measurements of forward visibility are being made in each type of forest. Data being collected gives not only the average distance one can see, but also gives the percentage of the time that one can see a given distance in the undergrowth. The composition of the undergrowth by botanical identification of plants, shrubs and vines are also being made as part of the profile plot. Additional information relative to the degree of difficulty of troop penetrability can be analyzed. The existance of types of vegetation such as throny rattan, lawyer vines, or other plants which cause excruciating pain, skin irritation, or other hazards to troops are being recorded.

CHANTABURI

Type Forest	Frequency						
	10-20 (m)	20-30 (m)	30-40 (m)	40-50 (m)	50-60 (m)	60-70 (m)	70-80 (m)
Moist deciduous Forest at 220 m	2	1	4	1			1

Moist Deciduous Forest at 220 m

Total no. of observations	=	14
No. in class 1 (10-20 m)	=	2
% in class 1	=	2/14 x 100 = 14%
No. in class 2 (20-30 m)	=	6
% in class 2	=	6/14 x 100 = 43%
No. in class 3 (30-40 m)	=	4
% in class 3	=	4/14 x 100 = 29%
No. in class 4 (40-50 m)	=	1
% in class 4	=	1/14 x 100 = 7%
No. in class 5 (50-60 m)	=	
% in class 5	=	
No. in class 6 (60-70 m)	=	
% in class 6	=	
No. in class 7 (70-80 m)	=	
% in class 7	=	1/14 x 100 = 7%

Distance	No. Cases	Per cent
10-20 m	2	14
20-30 m	6	43
30-40 m	4	29
40-50 m	1	7
50+ m	1	7
Totals	14	100

UBOL RACHATHANI

Type Forest	Frequency 5-10 (m)	10-15 (m)	15-20 (m)	20-25 (m)	25-30 (m)	30-35 (m)
Dry evergreen forest at 200 m	1	3	2	4	1	1

Dry Evergreen Forest at 200 m

Total no. of observations	=	12
No. in class 1 (5-10 m)	=	1
% in class 1	=	1/12 x 100 = 8.3%
No. in class 2 (10-15 m)	=	3
% in class 2	=	3/12 x 100 = 25%
No. in class 3 (15-20 m)	=	2
% in class 3	=	2/12 x 100 = 16.7%
No. in class 4 (20-25 m)	=	4
% in class 4	=	4/12 x 100 = 33.3%
No. in class 5 (25-30 m)	=	1
% in class 5	=	1/12 x 100 = 8.4%
No. in class 6 (30-35 m)	=	1
% in class 6	=	1/12 x 100 = 8.3%

Distance	No. Cases	Per cent
5-10 m	1	8.3
10-15 m	3	25.0
15-20 m	2	16.7
20-25 m	4	33.3
25-30 m	1	8.4
30+ m	1	8.3
Totals	12	100.0

Distance	No. Cases	Per cent
1-5 m	4	30.8
5-10 m	2	15.4
10-15 m	4	30.8
15+ m	3	23.0
Totals	13	100.0

Hill Evergreen Forest at 1300 m

Total no. of observations	=	16
No. in class 1 (1-5 m)	=	1
% in class 1	=	1/16 x 100 = 6.25%
No. in class 2 (5-10 m)	=	2
% in class 2	=	2/16 x 100 = 12.5%
No. in class 3 (10-15 m)	=	8
% in class 3	=	8/16 x 100 = 50%
No. in class 4 (15-20 m)	=	4
% in class 4	=	4/16 x 100 = 25%
No. in class 5 (20-25 m)	=	1
% in class 5	=	1/16 x 100 = 6.25%

Distance	No. Cases	Per cent
1-5 m	1	6.25
5-10 m	2	12.5
10-15 m	8	50.0
15-20 m	4	25.0
20+ m	1	6.25
Totals	16	100.0

PHU KRADUNG

Type Forest	Frequency 5-10 (m)	10-15 (m)	15-20 (m)	20-25 (m)	25-30 (m)
Hill evergreen forest at 1250 m	2	5	6	3	1

Hill Evergreen Forest at 1250 m

Total no. of observations	=	17
No. in class 1 (5-10 m)	=	2
% in class 1	=	2/17 x 100 = 11.7%
No. in class 2 (10-15 m)	=	5
% in class 2	=	5/17 x 100 = 29.4%
No. in class 3 (15-20 m)	=	6
% in class 3	=	6/17 x 100 = 35.3%
No. in class 4 (20-25 m)	=	3
% in class 4	=	3/17 x 100 = 17.7%
No. in class 5 (25-30 m)	=	1
% in class 5	=	1/17 x 100 = 5.9%

Distance	No. Cases	Per cent
5-10 m	2	11.7
10-15 m	5	29.4
15-20 m	6	35.3
20-25 m	3	17.7
25-30 m	1	5.9
Totals	17	100.0

KHAO YAI

Type Forests	Frequency 1-5 (m)	5-10 (m)	10-15 (m)	15-20 (m)	20-25 (m)
Tropical rain forest at 800m	3	5	3	1	
Hill evergreen forest at 1000m	4	2	4	3	
Hill evergreen forest at 1300m	1	2	3	4	1

Tropical Rain Forest at 800 m

Total no. of observations	=	12
No. in class 1 (1-5 m)	=	3
% in class 1	=	3/12 x 100 = 25%
No. in class 2 (5-10 m)	=	5
% in class 2	=	5/12 x 100 = 41.7%
No. in class 3 (10-15 m)	=	3
% in class 3	=	3/12 x 100 = 25%
No. in class 4 (15-20 m)	=	1
% in class 4	=	1/12 x 100 = 8.3%

Distance	No. Cases	Per cent
1-5 m	3	25
5-10 m	5	41.7
10-15 m	3	25
15+ m	1	8.3
Totals	12	100.0

Hill Evergreen Forest at 1000 m

Total no. of observations	=	13
No. in class 1 (1-5 m)	=	4
% in class 1	=	4/13 x 100 = 30.8%
No. in class 2 (5-10 m)	=	2
% in class 2	=	2/13 x 100 = 15.4%
No. in class 3 (10-15 m)	=	4
% in class 3	=	4/13 x 100 = 30.8%
No. in class 4 (15-20 m)	=	3
% in class 4	=	3/13 x 100 = 23.0%

Requirement: Data Collection and Analysis - Sociological

Task: Studies of Northeast Thailand (1C1)

Work continues on the bibliography of uncatalogued and generally unknown reports and papers dealing with Thailand which are relevant to MRDC research activity, and the directory of social scientists and their work in Thailand.

RAC ELEMENT OF MRDC

RAC work is discussed in this Sub-Project and in Sub-Project III: Ground Mobility/ Logistics Analysis.

RAND ELEMENT OF MRDC

The lecture course on the Application of Operations Research to the RDT&E Process given by Mr. Arnold Kent in September, was discussed in the last CDTC-T. Quarterly Report, pages 71 and 72. Additional material has been provided to help prepare the Thai language version of the lecture notes for use as a study text for officers in the Thai military commands.

Other RAND work is discussed under the appropriate Sub-Project headings: Mobility Research for road capacity tests, Combat Surveillance and Target Acquisition Systems for visual search tests, and Remote Area Mobility and Logistics Systems for airfield data analysis and classification.

SUB-PROJECT VIII

RESEARCH AND EXPLORATORY DEVELOPMENT

SUB-PROJECT VIII

RESEARCH AND EXPLORATORY DEVELOPMENT

SUB-PROJECT OBJECTIVE

To initiate, or conduct in support of one or more of the other AGILE projects, technical feasibility studies, research or exploratory development to fulfill those requirements which necessitate preliminary investigation to either establish the state-of-the-art or to explore the means of extending the state-of-the-art. Efforts of this nature are undertaken within Sub-Project VIII to obtain sufficient data to determine whether or not a development program oriented toward the achievement of a specific end item should be undertaken. This sub-project also encompasses takes complementary to other AGILE sub-project objectives which are not within the scope of their primary programs.

Requirement: Clothing and Equipment

Task: Improved Individual Combat Equipment (1A)

Sub-Task: Individual Combat Clothing and Equipment

Preliminary field test of several prototype items of individual clothing and equipment was conducted in September and October by soldiers from the RTA Ranger Bn. The test items were designed by experts from the United States Quartermaster Research and Engineering Center and were manufactured in Thailand by the RTA Boot and Clothing Factory, assisted by the QM R&E technician.

The field tests were designed to achieve a limited field evaluation of certain items of individual clothing and equipment prior to commencing a longer, more detailed field evaluation. It was intended that the tests would disclose any faulty equipment design features, validate evaluation techniques, and provide other information which would assist in planning and conducting the more comprehensive field evaluation.

Accordingly, twelve sets of test items were issued to twelve RTA Army Rangers. The items were: jungle hat, jungle boots, trousers and jacket, multipurpose net, nylon and lightweight wool blanket, and load carrying equipment (the latter is discussed as a separate Sub-task). The items were worn and used on a 45 day field training exercise conducted near the Burma border in west central Thailand. Test subjects were required to complete a questionnaire in Thai and English for each test item. A team composed of Thai and US officers from MRDC and the RTA Army QM. Also questioned test subjects orally concerning their use of the test equipment at the completion of the training exercise. The oral discussions amplified and supplemented information obtained from the questionnaires. The field tests revealed undesirable features in the design of several of the prototype items which will be corrected in future test models. General impressions of troop acceptability of the prototype items were obtained. Definite conclusions could not be drawn from this limited evaluation because of the relatively small quantities of items involved and the short duration of the test period.

Specifically, the multipurpose net was very popular with the troops. It was used in a variety of ways - litter, cache, load carrier, fish net - but was most appreciated when used as a hammock, thereby getting the soldier off the ground.

The nylon blanket was also extremely popular. This is hardly surprising when one compares this blanket to the present RTA standard issue cotton/wool blanket. In terms of dry weight, the former weighs 525 grams and the latter weights 1670 grams - over three times as much. The disparity is even greater under wet weather conditions: wet weight of the nylon blanket is 1475 grams and that of the wool blanket is 5700 grams.

The wide brim jungle hat was generally accepted, although one of its new features - a component insect net stored in the crown - was unsatisfactory. The net idea was tried because a replacement from the currently issued standard insect net is needed. The latter weights 625 grams and is very bulky. It was hoped that the new net could be lowered from the hat to cover the face while sleeping, thus eliminating the requirement for a full length net. It was also intended that it could be worn during normal operations when insects are a problem (there is no standard net issued or available for this purpose).

The field tests showed that the new net could not give adequate protection to the face while sleeping. The surface of the net tended to lie directly against the skin and insects could bite through it. Furthermore, the rest of the body had no protection beyond ordinary clothing. In the role of a protective device during operations, troops complained that it obscured vision too much and tended to snag and hand up on brush. Storing the net in the crown of the hat also raised the height of the crown, thereby contributing to an undesirable silhouette.

The jungle boot differed from the standard issue in that it was a canvas/leather combination rather than all leather and had drain eyelets, sole and heel cleats, and shorter tops designed for use with draw-string bottomed trousers. The boots were acceptable, although given a choice, the troops generally preferred the standard boot. The sole and heel cleats, however, were unanimously approved. The drain eyelets were unpopular because troops complained that they let the water that would not otherwise enter the shoe; apparently they did not encounter conditions requiring them to move through water high enough to come in over the boot tops, i.e., they had no drainage requirement on this particular operation.

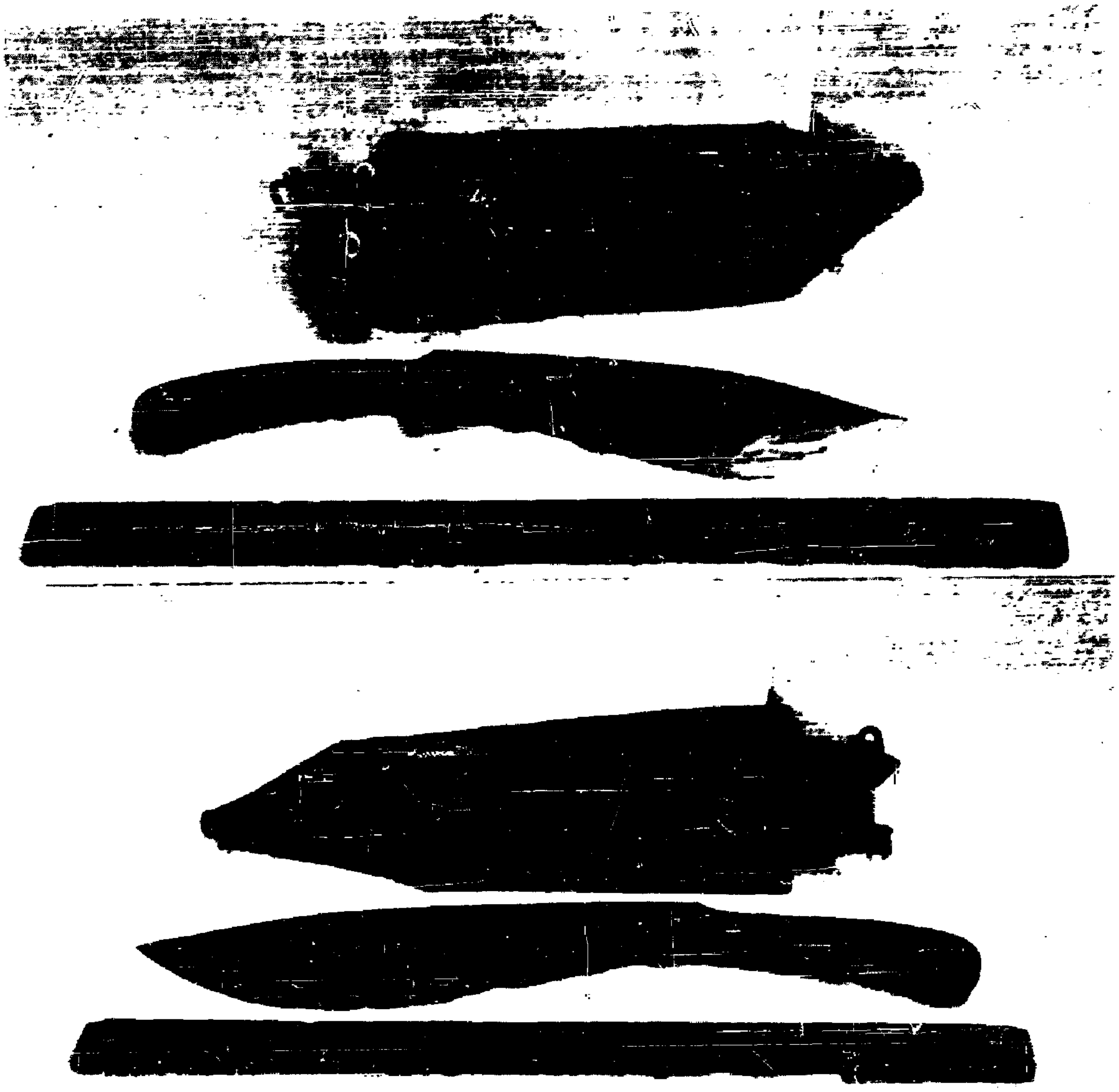
The high top boot/tuck in trouser combination was preferred to the prototype low top/draw string combination. This will not be taken as conclusive evidence, however, because there is some indication that the troops were not properly briefed and instructed in how to wear the new boots and trousers. This deficiency will be corrected in future tests.

During the evaluation all test items were weighed and compared with comparable standard issue RTA items whenever possible. It was determined that a Thai soldier will carry approximately 65 pounds when equipped with current standard items of individual clothing and equipment, including two canteens of water, M1 carbine with basic load of ammunition, and 3 day rations (radios, demolition, medical kits, and other specialized items are excluded in this calculation). The MRDC anthropometric survey conducted earlier this year found that the average Thai soldier weighed about 135 pounds. Load carrying studies have determined that a soldier can carry 1/3 of his body weight and still be effective in combat. An increase in this load will decrease his combat effectiveness correspondingly. This 1/3 body weight rule will, of course, vary somewhat with individuals and will be effected to some degree by environment; nevertheless, as a general rule, it serves as a reasonable guide in determining optimum combat loads.

Therefore, one can conclude that if the average Thai soldier carries more than approximately 45 pounds his combat effectiveness will be reduced. Assuming all the items carried are essential, or highly desirable, the problem which remains is to reduce the weight of individual items sufficient to reduce overall load to something around 45 pounds. The bulk of the weight is composed of weapons, ammunition, and rations. Recommendations have been made to consider the AR-15 as a replacement for the M1 rifle and carbine. MRDC is participating in research designed to produce a lightweight combat ration. The field tests discussed above indicate possibilities for reducing the weight of clothing and other equipment items. The following table of weights (expressed in grams) is provided for illustrative purposes.

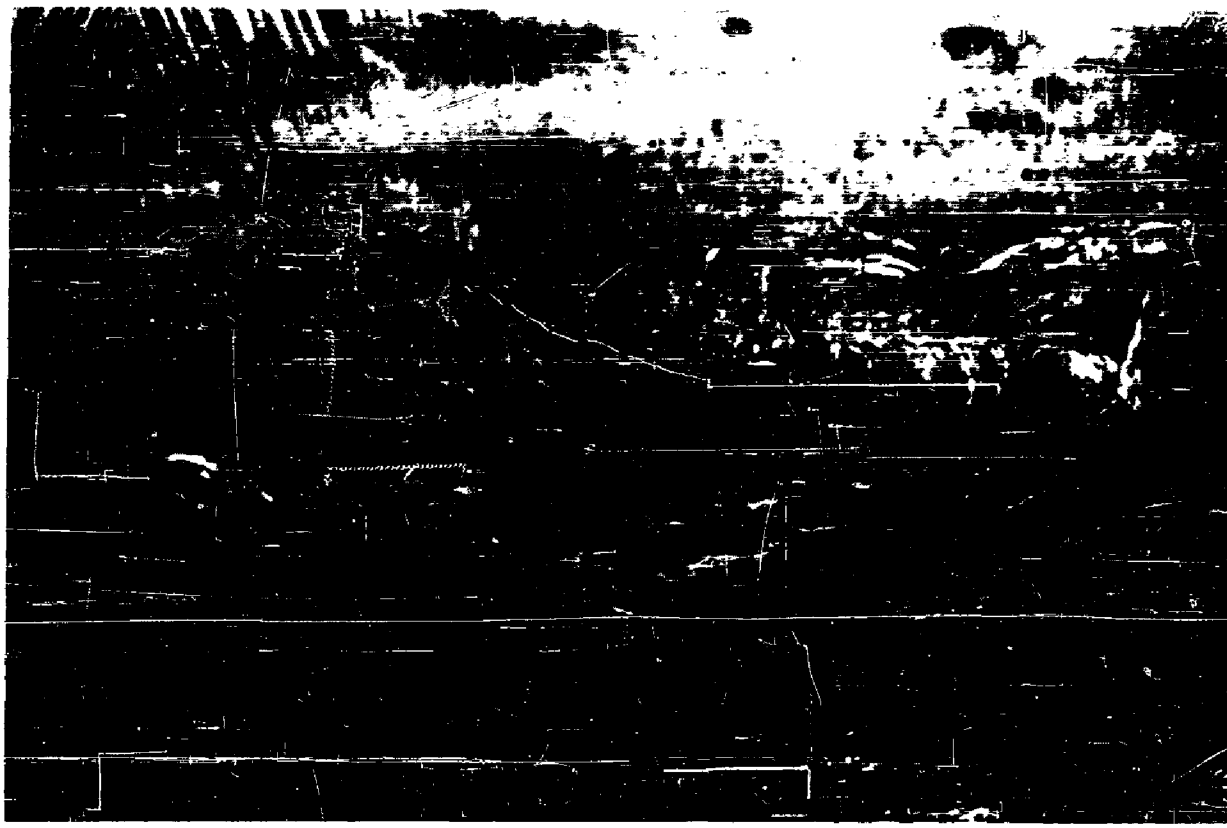
Item	Dry Weight	Wet Weight
1. Shelter Half	1250	
2. Multipurpose net	525	
3. Currently Issued Thai blanket	1670	5700
4. Nylon blanket	525	1475
5. Currently issued mosquito net	625	
6. MRDC Head Net	20	
7. Currently Issued Pack (M1945) with suspenders	1150	
8. Nylon MRDC large pack with frame and suspenders	1260	

Future evaluations will be conducted with items suitably modified and fabricated locally by the RTA Boot and Clothing Factory or obtained from the U. S. Quartermaster Research and Engineering Center, in the case of specialized items. The Center will continue to provide technical data and advice to relevent Thai agencies. The Ranger Battalion and other RTA units will participate in the field tests. It is estimated that they will commence during the first quarter of CY 1954.



Knife and machette designed by MRDC. The knives are based upon traditional Thai designs but are made lighter and more functional than those currently issued.

MRDC experimental canvas/leather boots. Boots are worn with trousers having draw string bottoms. Cleats on sole and heel were very popular with Thai Rangers



Multipurpose net was very popular. Here a Thai Ranger is using one as a hammock. Net was also used to catch fish and carry miscellaneous loads.

Jungle hat made in RTA Clothing factory from U. S. Army design. Hat has component insect net, carried in crown when not in use. Rangers did not like the high crown and insect net, but liked the wide brim.

Requirement: Clothing and Equipment

Task: Improved Individual Combat Equipment (1A)

Sub-Task: Load Carrying Systems

A new pack design, developed in Thailand by a representative of the U. S. Army Quartermaster Research and Engineering Center and fabricated locally, was tested in the field at the same time as the items of clothing and other equipment discussed in the preceding Sub-Task. The same troops and general test procedures were used. A sample of the test questionnaire used is attached.

The pack was generally accepted, although some changes in the design are clearly warranted. The formed rattan frame performed adequately; however, the lower curved portion of the frame dug into the hips and the pack itself rode too low on the frame. Several men also expressed a desire for wider shoulder straps. The troops appreciated the additional cargo space provided by the pack design, but the locally available canvas material used in the pack was much too heavy. A single pack made of nylon material was also used at the same trials and was considered to be far superior to the canvas item. It was lighter in weight, water resistant, and of equal size.

Appropriate modifications in pack design will be made in accordance with this experience and the new items subjected to field test by Thai troops.

Load Carrying Equipment

1. It is comfortable?
   Yes No
   If no, explain.

2. Which method of adjusting the front shoulder straps is preferred, the system using cord and grommets or the system using straps and buckles? Why?

3. Does it fit well?
   Yes No
   If no, explain.

4. Can you carry all of the items in it that you normally carry into the field?
   Yes No
   If no, explain.

5. Is the frame comfortable?
   Yes No
   If no, explain.

6. Do you prefer using this pack for normal field operations with the frame or without it.
   Yes No
   Give reason for either answer.

7. Are the shoulder straps easy to adjust?
Yes No
If no, explain.

8. Is the frame without the pack adequate for carrying loads such as radio, ammunition, water cans, etc. ?
Yes No
If no, explain.

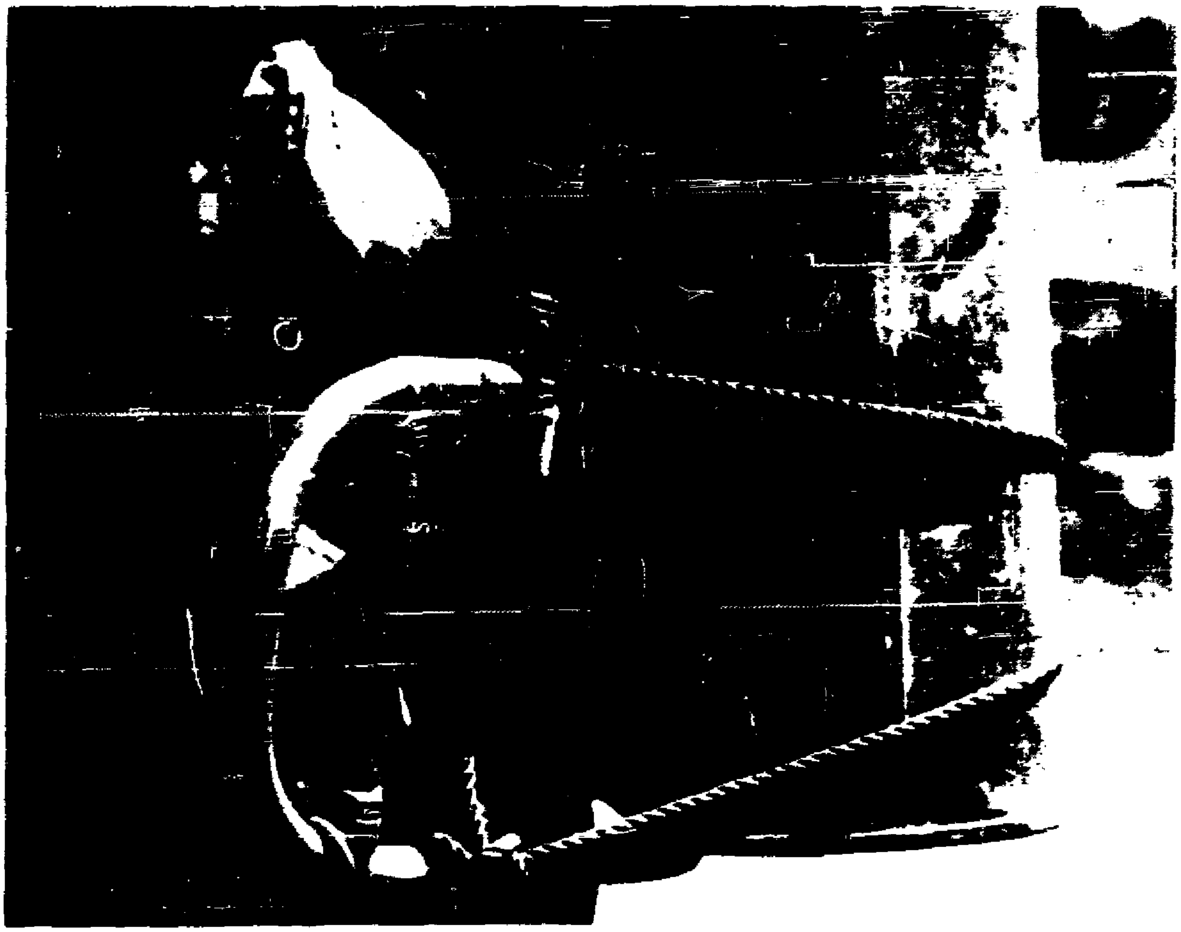
9. Is it a great deal better than present issue equipment?
Yes No
Give reasons for either answer

10. Is the belt buckle an improvement over the present buckle?
Yes No
If no, explain

11. Did you experience any difficulty with:

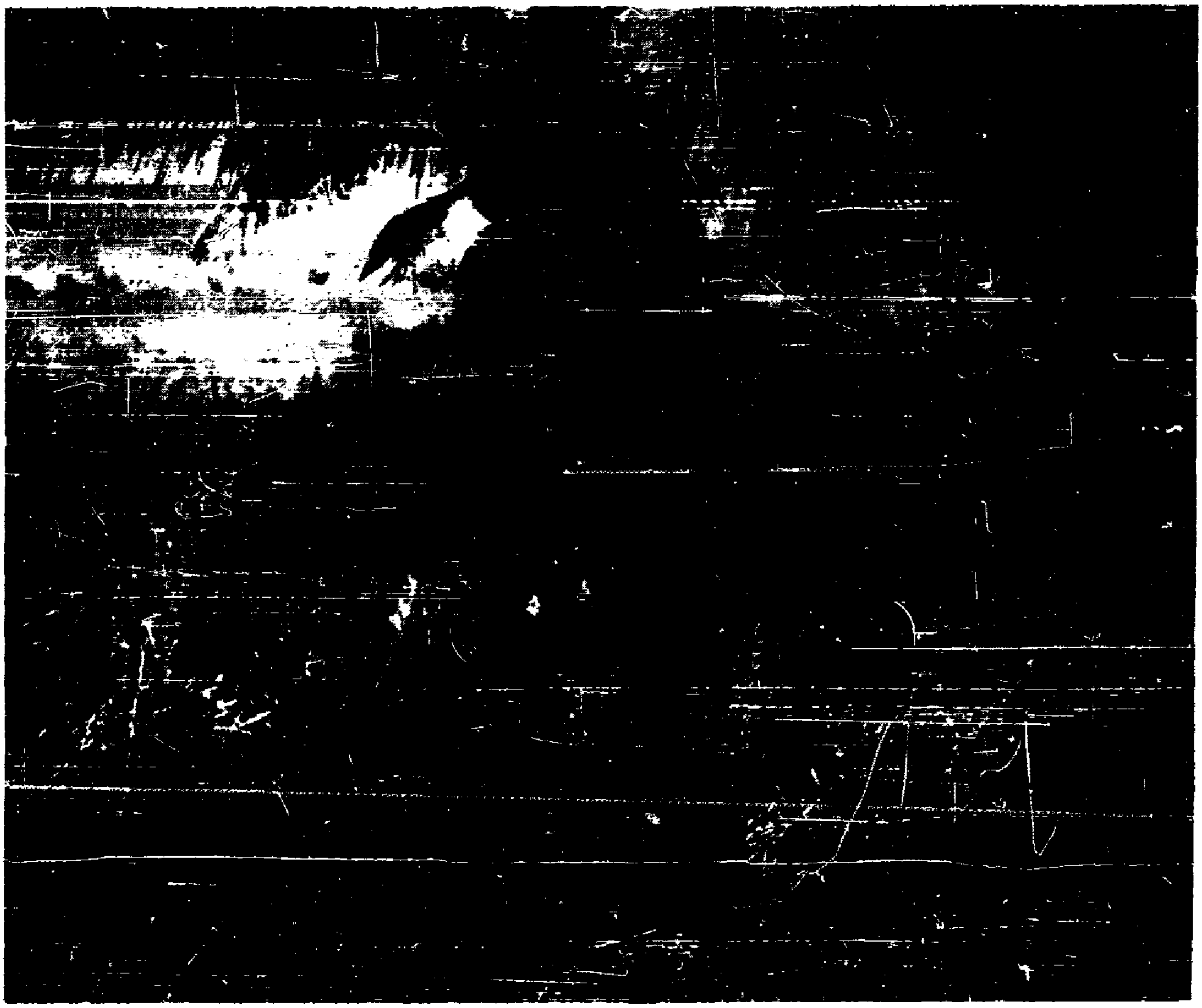
a.	Belt buckle	Yes	No
b.	Frame	Yes	No
c.	Suspenders	Yes	No
d.	Attachment of Components	Yes	No
e.	Wearing	Yes	No
f.	Putting and taking off	Yes	No

If answer to any of the above was yes, explain.



Rangers objected to the lower sides of the frame protruding beyond hips. Later versions of the frame will eliminate this protrusion.

Thai Ranger wearing MRDC experimental pack, hat, jacket and trousers. These items were made in Thailand, based upon latest U. S. Army design.



MRDC experimental frame used to carry 5 gallon can. Radios, rations and other such heavy items can be carried on the frame when the pack is removed.

APPENDIX A

APPENDIX A: FIELD REPORT ON WET SEASON TRUCK TEST TO SUPPORT NEW ROAD CAPACITY METHODOLOGY

L. P. Holliday
The RAND Corporation

Introduction

Road tests were conducted in November, 1962 with Royal Thai Army trucks and personnel. This was described in a field report included in the CDTC-T Monthly Letter Report for November, 1962. Based on these tests and other work, a new method of calculating road capacity and truck requirements suitable for use in Southeast Asia has been developed.

The previous tests in November 1962 had taken place after the rains had stopped although some wet season effects, such as washouts and road deterioration were reflected in the selection of test courses and in the results. It was desired in this case to operate during the rains and determine additional restrictions that might exist. In this way the use of the new method under this more difficult condition could be verified. A preliminary report on these latter tests, conducted during the week of 6 October, 1963, is given here. The full report on the road capacity study is published in Ref. 1.

Personnel and Equipment

The author and Lt. Prong Dong of the Royal Thai Army Transportation Corps were accompanied by a mechanic and two drivers. Two RTA 2-1/2 ton trucks were used. One was a cargo truck loaded with sixteen 55-gal. drums of water and the other was a wrecker without cargo. Both trucks were equipped with tachographs as reported in the reference to make permanent records of speed and distance versus time.

Test Itinerary and Observations

It was planned to make one run over the route extending from Bangkok to Udorn to Sakolnakorn to Ban Pai to Bangkok. Earlier attempts to reconnoiter this route from the air failed because of weather and availability of aircraft; nevertheless, it was decided to strike out and see how far the trucks could go. A period of seven days was planned for the test and RTA logistical support was to be obtained at Lop Buri, Korat, and Khon Kaen.

On October 7, Lop Buri was reached as scheduled. Much better time was made than last year; the distance from Don Muang to Lop Buri was covered in less than three hours including stops. Progress in road construction between Bangkok and Sara Buri was the reason for this improvement.

On October 8 the team headed northeast to cover the former test courses from Lop Buri to Khok Samrong to Nong Bua Khok to Korat (see fig. 1 for layout of former courses). Again considerable improvement in the roads was noted, especially beyond Khok Samrong. Some parts of the road were soft mud on the sides (see fig. 2) and therefore were a hindrance to two-way traffic. Also hindering two-way traffic were stretches like that shown in fig. 3, familiar in Thailand, where piles of laterite were dumped on the side of the road for future resurfacing. At a point 10 km southwest of Lamnarai, however, a flooded stretch was encountered. This was about 2 km long (see fig. 4) followed by water up to 8 ft deep according to reports from bus drivers. Flooding had occurred in this area last year but was even more extensive this

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*The author was able to scout the Bangkok-Chiangmai route from the ARPA Caribou which was being ferried to Chiangmai. No traffic stoppages or especially difficult stretches were seen, hence the decision to operate on the other route.

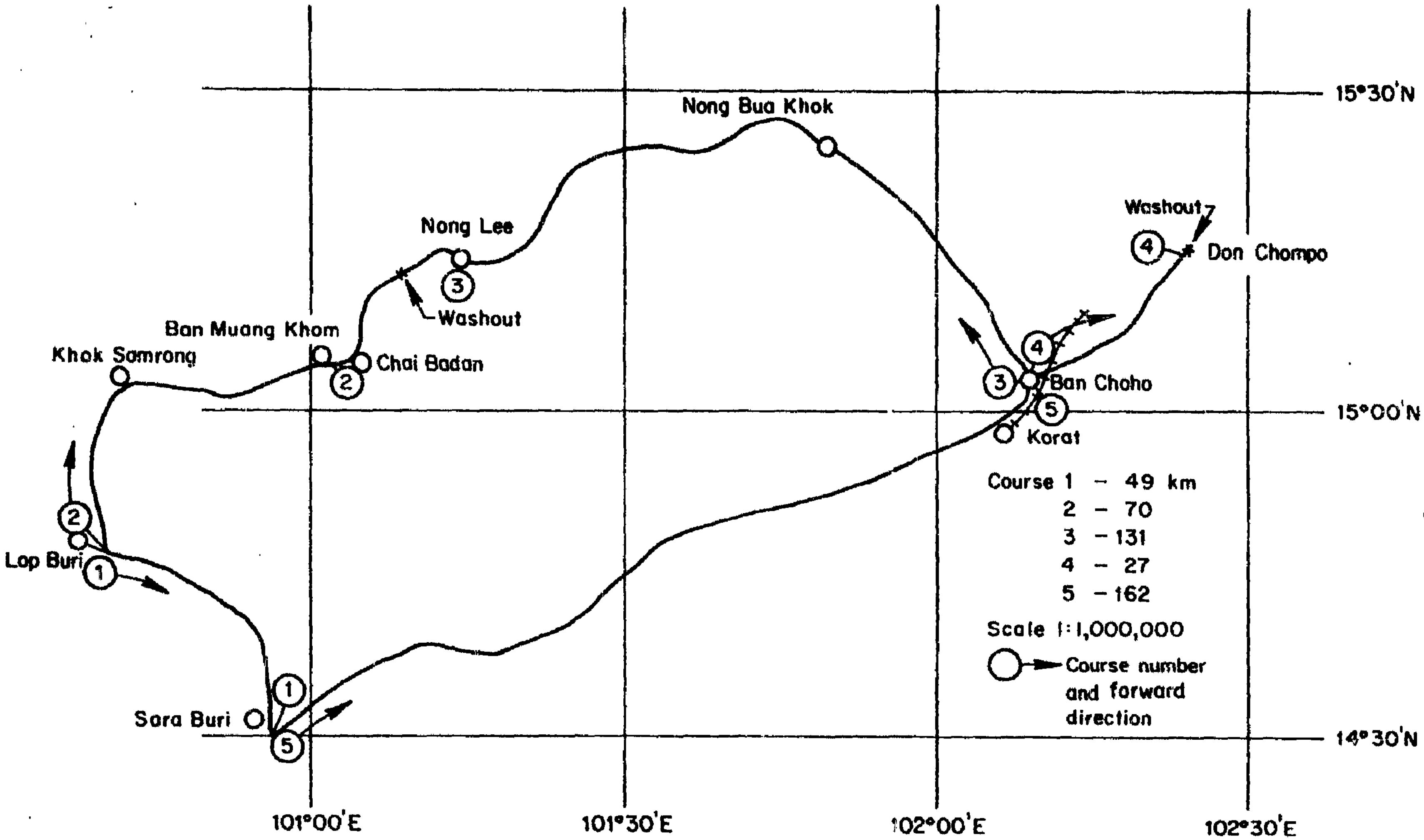
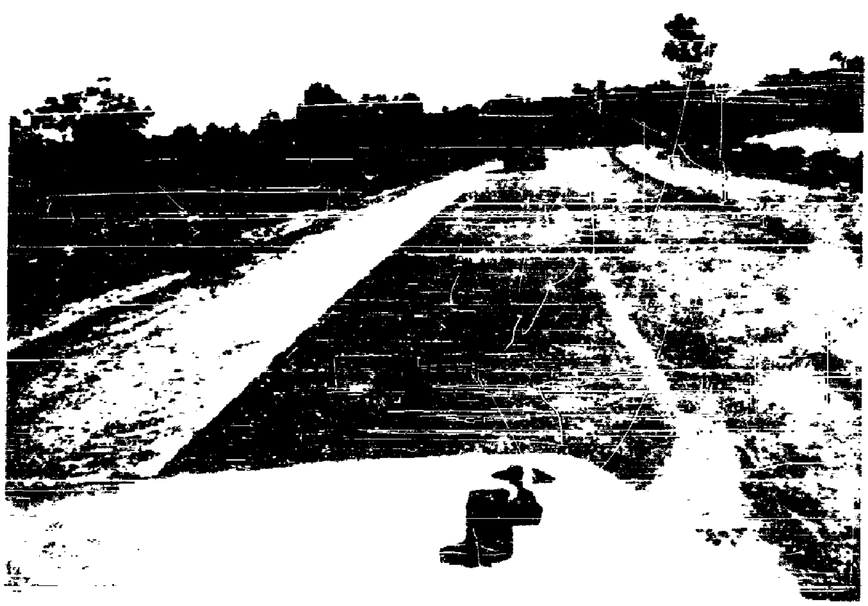


Fig. 1 —General layout of test courses

View of northeast of Khok Samrong showing mud at roadside.

View north of Khok Samrong showing piles of laterite
on side of road.

View of flooded but passable road south of Lamnarai.



New paved highway northeast of Korat.

Speed-reducing wet season road deterioration.

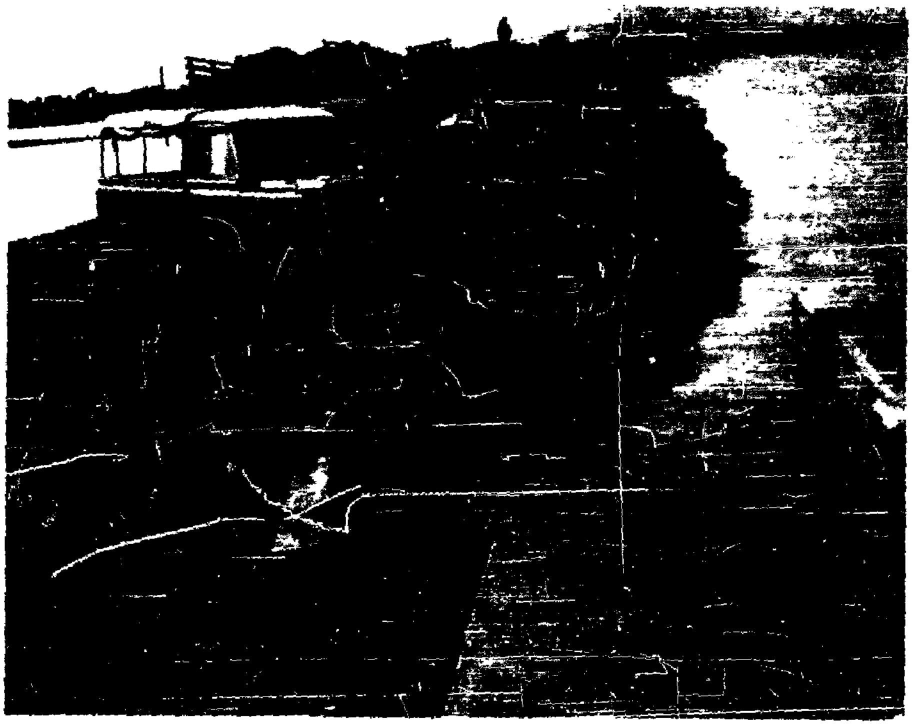
View showing laterite dust held to moderate intensity by seasonal moisture.

time. There was no choice but to turn back and proceed to Korat via Sara Buri and the Friendship Highway. No difficulties were encountered along this latter route.

On October 9 the team started northeast from Korat toward Ban Pai. For the third time there was marked improvement due to road construction; this time what had been rough laterite was now smooth paving (see fig. 5) for much of the way. While throughout the trip the roads appeared either to be quite passable or else blocked by wet season conditions, nevertheless there was noticed a deterioration (fig. 6) due to the rain that probably reduced average speeds below dry season values. The laterite roads northeast of Korat gave an indication of the effect of the wet season on the dust of laterite-surfaced roads, sometimes dense in the dry season. The moisture held the dust to a light or moderate density, as can be seen in figure 7.

At a point 35 km from Korat a totally unexpected washout was encountered (see fig. 8). This time the approach to a concrete bridge had been washed away to a width of about 10 ft, apparently quite recently. Because the roadway was elevated, the embankments were too steep and too soft for fording; also the currents were swift near the bridge. At a point just above water level the soil was a very soft clay which would barely support a man's weight. The washout appeared to be quite recent and wooden barriers were being erected to protect the roadway from further erosion (see figs. 9 and 10). The usual practice is to bridge such gaps with logs and planks, and this was probably done within a few days.

We had previously been advised by the 44th Engineer Group that the road to Ubon was impassable; also, we had noted from the air that side roads branching off from the main routes tended to be washed out and left unused during



Wooden barrier and backed-up trucks at washout.

Washout at concrete bridge northeast of Korat.

Wooden barriers at washout.

the wet season. It was therefore decided to terminate the test and return to Bangkok.

Other Comments

A "go, no-go" situation probably exists in Thailand during the wet season. Either the road is adequately drained, being elevated above flood level and equipped with properly designed bridges and culverts, or it is not adequately drained and subject to complete blockage by washouts. It is very difficult to keep a road open by expedient means when it is not designed and constructed for the wet season. This does not mean that all-weather roads must be paved; laterite and laterite-crushed rock roads function very nicely in the wet season if properly built and maintained.

The washout 35 km northeast of Korat might have been prevented if the approaches to the concrete bridge had been protected against erosion during the wet season. Extensive flooding occurs in this area, which means that large volumes of water are funneled in (see diagram, fig. 2). Erosive vortexes occur at the point where the water flowing parallel to the road is forced to change direction 90 degrees and flow under the bridge. These vortexes eat through the soft bank of the roadway and finally cut off the approach completely, requiring temporary planking. The side of the bridge extends only a few feet past the main channel. These bridges could probably be modified to protect the embankment and turn the water more smoothly. Similar erosion was noted at culverts for the same reason and a similar modification could be made.

Recorded Data

Table 1 summarizes the observations that were recorded on tape. The calculations of segment speeds will be based on the tachograph data which has not yet been analyzed.

Limited data on the consumption of diesel fuel by the Toyota 2-1/2 ton trucks was obtained:

	Fuel economy (km/liter)	
	Cargo truck	Wrecker truck
Khok Samrong to washout 10 km south of Lamnarai, then returning to Korat via Friendship Highway (92 km rough laterite, 90 km fair-good bituminous, 154 km excellent bituminous).	4.10	4.60
Korat to washout 35 km northeast, then returning to Bangkok via Korat and Sara Buri (154 km excellent bituminous, 170 km fair-good bituminous, 8 km fair laterite).	4.37	5.05

This is a small sample, but a rough check was made on the variation of fuel consumption with type of road as given in Table 27 of Ref. 1. If the bituminous sections are assumed to average out as "good" condition and the laterite sections as "fair", we obtain 4.38 km/liter for bituminous and 3.42 km/liter for laterite. These values (for the loaded cargo truck) agree with both the data above and the relative fuel consumptions in the Reference. It is also clear, as expected, that the cargo truck used more fuel than the somewhat lighter wrecker truck.

Conclusions

This test, although limited, indicated that the following assumptions on wet season road capacity made for the new road capacity method in Ref. 1 were esentially correct:

a. Average speeds would be reduced somewhat below dry season values because of occasional road deterioration (see fig. 9).

b. Dust would be less of a problem because of moisture in the road surface; light dust conditions could be assumed.

c. Adequate engineer support would be required at critical spots such as washouts; otherwise, road capacity would be limited by fords, ferries, and transloading points.

Reference

Holliday, Lee P., A Method for Estimating Road Capacity and Truck Requirements, RM-3331-ARPA, November 1963.

SUMMARY OF WET SEASON ROAD OBSERVATIONS

7 October 1963 - Don Muang to Lop Buri

Minutes	Km	Remarks
0	0	Left Don Muang
21	13.8	Fairly smooth paving, 55-60 kph
24	20.4	Bridge under construction, by-pass (one of several)
27	22.4	Construction work, road damp, 45 kph, paving with laterite layer, some holes
64	49.7	Rougher, 35-40 kph
91	76.1	Rest stop lasted 20 minutes because battery connection was loose
172	130.3	Minor flooding of road (first encountered) just outside of Lop Buri
173	130.9	First traffic circle, Lop Buri

Recapitulation: 130.9 km in 2.88 hrs; average 45.5 kph including stops.

8 October 1963 - Lop Buri to a washout 10 km south of Lamnarai

0	0	Left inner traffic circle, Lop Buri, paved
5	2.8	Turn left on divided highway (former Course 1)
15	11.6	Left at Royal Artillery School
25	19.1	Marker 18 (18 km to Khok Samrong), fair to good paving
32	27.2	Marker 10
61	36.5	Start again after refueling stop near Khok Samrong
65	38.5	Leaving Khok Samrong, paving, muddy shoulders

SUMMARY OF WET SEASON ROAD OBSERVATIONS (CON'T)

Minutes	Km	Remarks
	41.5	Laterite, rougher, crushed rock piles on left, mud on right, passing difficult because of restricted width, 25-30 kph, light dust, 2nd truck 200-300 ft back
82	49.1	Laterite; dry, hard, one-lane track, wavy, mud on either side, 20-25 kph
91	53.1	Paved, drier, 35-40 kph
95	57.0	Rolled laterite with crushed rock, good condition, 45 kph, Marker 36 (km to Lamnarai)
107	65.1	Rough, hard laterite, some material piles, 20 kph
118	70.3	Railway (end of former Course 2)
	79.1	Signs of cobblestone
133	81.5	Marker 12, 20-25 kph
136	82.5	Flooded as far as eye can see, just past Marker 10. Deep water ahead, according to bus driver. Turned back.

Recapitulation: 82.5 km in 2.27 hrs; average 36.3 kph, including stops.

9 October 1963 - Ban Choho to a washout 35 km northeast of Korat

Minutes	Km	Remarks
0	0	Leave Ban Choho on new paved road, 60 kph
4	4.0	Railway
	14.2	Now one-way, other half being prepared for paving
	14.8	Laterite, some washboarding

SUMMARY OF WET SEASON ROAD OBSERVATIONS (CON'T)

Minutes	Km	Remarks
	15.9	Washboarding worse, 35 kph
	18.4	Light to moderate dust
	20.7	Road elevated about 5 ft
32	27.4	Variable dust. Washout of approaches to concrete bridge.

Recapitulation: 27.4 km in 0.53 hrs; average 51.7 kph, no stops.

APPENDIX B

APPENDIX B: THAILAND AIRFIELD SUMMARY

1. SUMMARY

MRDC has a list of names and coordinates of 280 landplane and 8 seaplane air facilities in Thailand. These include a total of 296 runways (16 airfields have 2 runways). These totals will decrease as some of these fields are found to be non-existent, under construction, etc. The airfield runways are classified according to length, useability status, surface, and aircraft type or weight bearing capacity. Approximately 38 percent are unknown with regard to length; 55 percent are between 400 and 4999 feet and the remaining 7 percent are between 5000 and 9800 feet.

Useability status is given for 75 percent of the runways. The surface is given for 53 percent and the aircraft type and/or weight bearing capacity is given for 51 percent of the runways. The aircraft type or weight bearing capacity are based upon known construction factors and aircraft with single, dual and dual tandem landing gears that have been known or reported to have used these runways.

2. INTRODUCTION

Airfields are a vital necessity for logistic and air strike support of ground forces in areas of conflict. The ineffectiveness should be measured in terms of incountry location, combined ground support facilities, and location with regard to ground and water transportation. Their location within or close to the area of conflict should be known to relate to the radius mission capability of fixed and rotary wing aircraft. The capabilities of their facilities for supporting various aircraft in terms of logistical requirements, traffic rate, weights, and dimensions, depending upon the level of conflict, should be known. As a step in a study to provide this information, this report is a preliminary summary of current information on airfield runway characteristics in Thailand.

This work is preliminary to the final completion of the Thailand airfield study. It is being coordinated closely with JUSMAG, Thailand. Other important information concerning trafficability, logistics, and ground support facilities.is being summarized and organized. Locations and unknown or uncertain characteristics are being defined by ground and air surveys. An organization and classification system is being developed into which all of the characteristics of the fields can fit. The classification system includes data forms designed for efficient manual use and ready translation to machine data cataloging should this ever be found desirable. In these forms, complete information on Thailand's airfield facilities will be available for use in the variety of studies of military air systems and operations. Handy access will also be provided to specific information on airfield facilities for use in tactical planning. As information on unknown characteristics is checked out and refined, it will be used to update the classification tabulations. The work should also ultimately include the relating of airfield runway strength and length to specific aircraft characteristics. This will require soil strength measurements and other testing and correlation work.

3. DISCUSSION

A detailed analysis of airfields is necessary in order to estimate what their operational effectiveness is and what level of air strike and ground operations they can or may be required to support. This requires a knowledge of runway lengths, widths, useability, status, surface, aircraft types or weights that the runways can support and the additional ground support facilities that are presently available. Seasonal variation must also be considered.

This report presents a summary of 280 airfields* that have a total of 296 runways. They are summarized in terms of length, useability, status, surface and aircraft type or weights that the runways can support.

Table 1 shows the number of runways between 400 and 9800 feet in length. It gives the useability, status, surface and where available, the aircraft type or weights that the runways can support. It should be noted that the aircraft type or weights that the runways can support are based on the type of aircraft that have been known to operate from these runways or on known construction factors**, and single wheel loads (SWL).***

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* As of October 1963, CDTC-T Quarterly Report, 1 July-30 September 1963 reported 297 airfields. This number has decreased to 288 airfields and a further decrease is expected in the near future. Recent aerial surveys were unable to locate some additional strips reported to be in existence.

** Additional construction factors that must be known are the California Bearing Ratio (CBR) for flexible pavement and the flexural strength of concrete and modulus of Soil Reaction "k" for Rigid pavement in order to determine their weight bearing capacities for a variety of landing gear configurations.

*** The single wheel load is that load expressed in pounds which is transmitted to the runway by an independently acting isolated wheel.

The aircraft types are arranged according to increasing aircraft weight. Their maximum take-off weights cover the range from approximately 2400 to 130,000 pounds. The actual landing and take-off weights during these trials were not known. For example, one 3300 foot laterite runway is reported to capable of supporting a C-130 single wheel landing gear aircraft during the dry season and a C-47 single wheel landing gear aircraft during the wet season. Specific aircraft weights are on unavailable refinement.

Table 2 shows a variety of gross weights of aircraft with single, dual and dual tandem landing gears that may be required to operate from some of these runways. It shows selected aircraft, gross weights, landing gear configurations, tire pressures, and total ground control area. Ground contact area of the tires is based on 90 percent of the aircraft's gross weight, all of which is supported by the main landing gear. Tire pressures are approximately equal to the runway surface pressure in pounds per square inch. The ground contact area of the tail or nose gears are not considered because only 10 percent of the aircraft's gross weight is supported by this gear.

Figure 1 shows the number of runways that are greater than a given length in terms of 100 feet increments. Approximately 89 percent of the 184 known lengths are between 400 and 4999 feet in length and the additional 11 percent are between 5000 and 9800 feet in length.

Figure 2 shows the distribution of runway lengths in 1000 and 100 feet increments. Approximately 22 percent of the 184 known lengths are between 1000 and 2000 feet in length.

Figure 3 shows the qualification of the runways according to useability, status, surface, and aircraft type or weight bearing capacity or single wheel loads. The single wheel load is that load expressed in pounds which is transmitted to the runway by an independently acting isolated wheel.

Figure 4 shows the effect that aircraft gross weights and tire inflation pressure have on ground contact area and pounds per square inch runway surface pressure. This figure also approximates the ground contact area of selected liaison, fighter, bomber and cargo aircraft in terms of aircraft gross weights and tire inflation pressures. Table 2 shows these aircraft characteristics. For example, it can be seen that as aircraft gross weights decrease, tire imprint areas decrease when the tire pressure remains constant. If the tire inflation pressure is decreased and the aircraft gross weight remains constant, tire imprint area increases and surface pressure decreases. This figure provides a quick reference to approximate weight bearing capacities of tested laterite and natural surface runways provided the test aircraft weights, landing gear configuration and tire pressures are known. It does not premit estimates to be made of the maximum weight bearing capacities of laterite and natural surface runways.

FIGURE 1
CUMULATIVE SUMMARY OF RUNWAY LENGTHS IN THAILAND

NOTE:
Known Dimensions or Lengths = 184
Unknown Dimensions or Lengths = 112

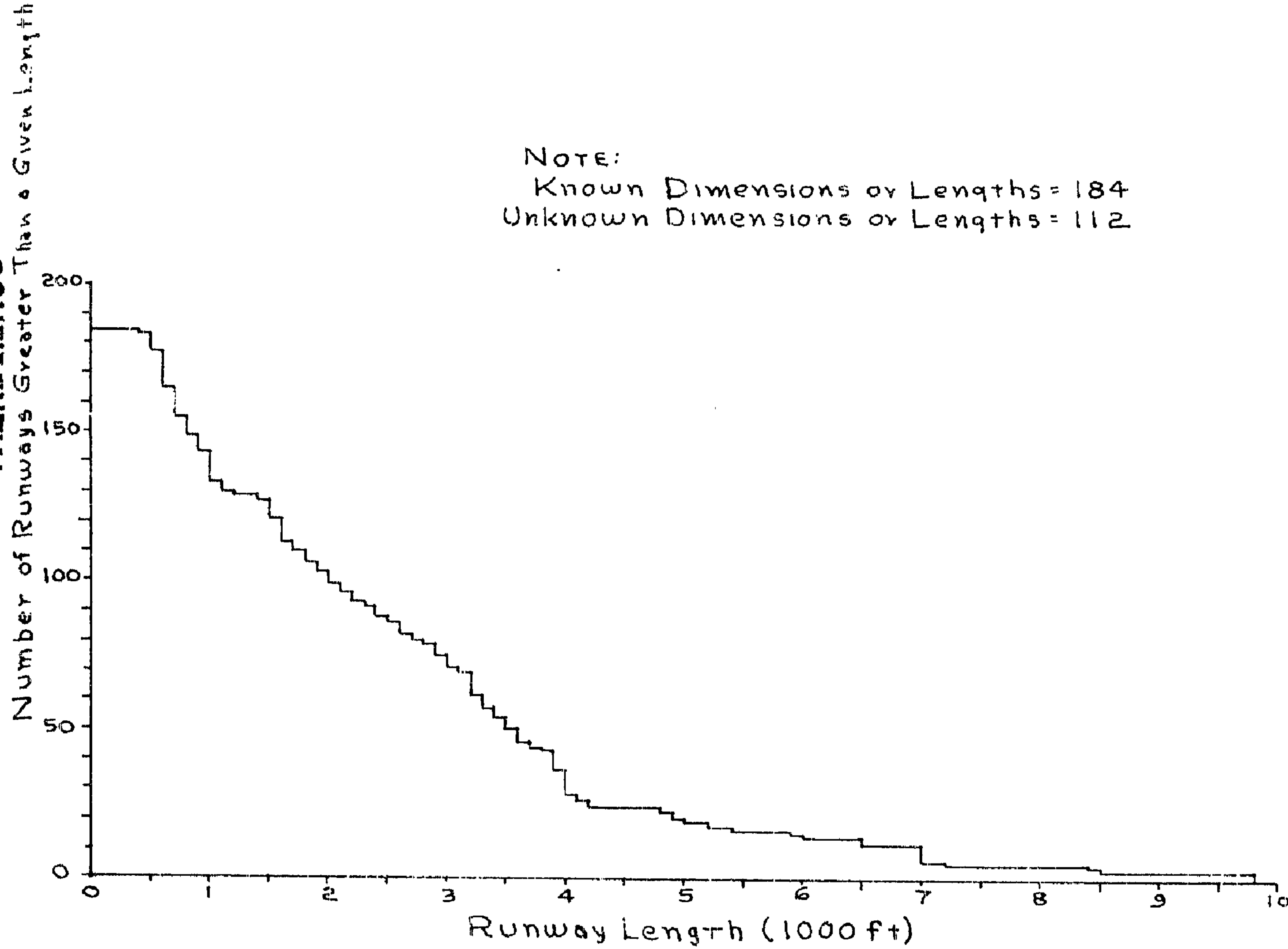

FIGURE 2
DISTRIBUTION OF RUNWAY LENGTHS
IN THAILAND

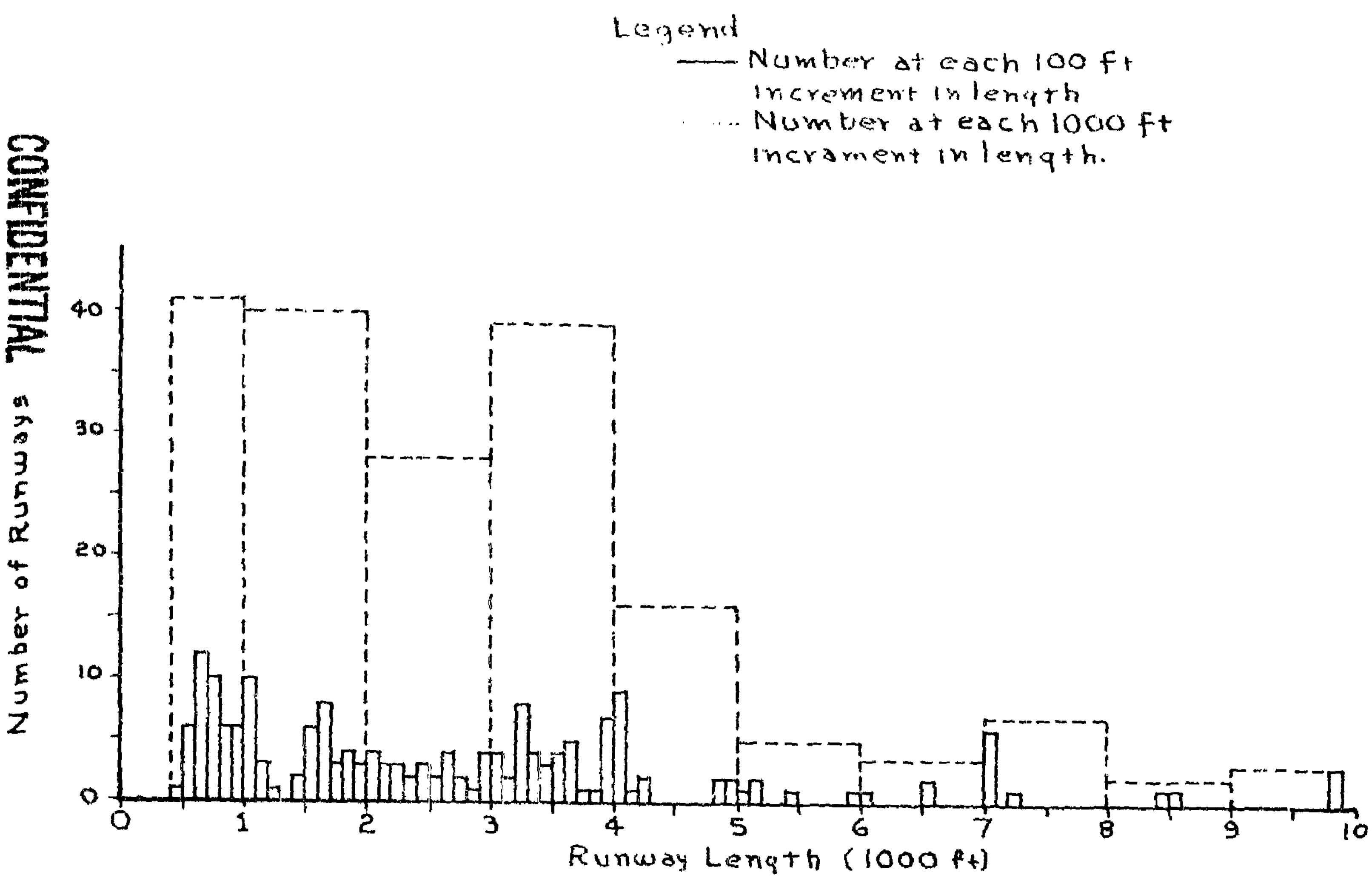

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FIGURE 3
QUALIFICATION OF RUNWAYS IN THAILAND

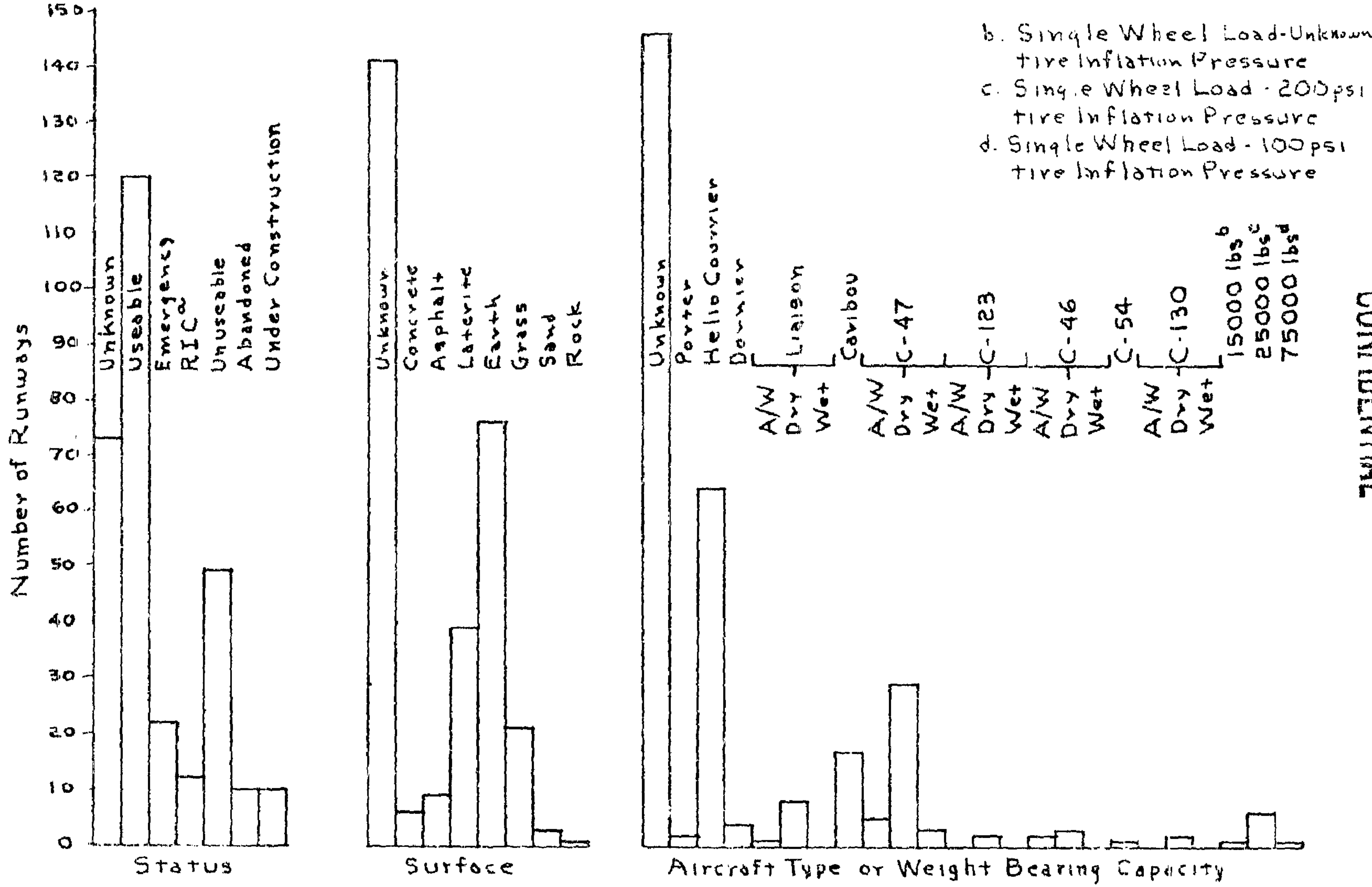

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FIGURE 4

Aircraft Gross Weight Corresponding To Tire Inflation Pressure and Tire Imprint Area

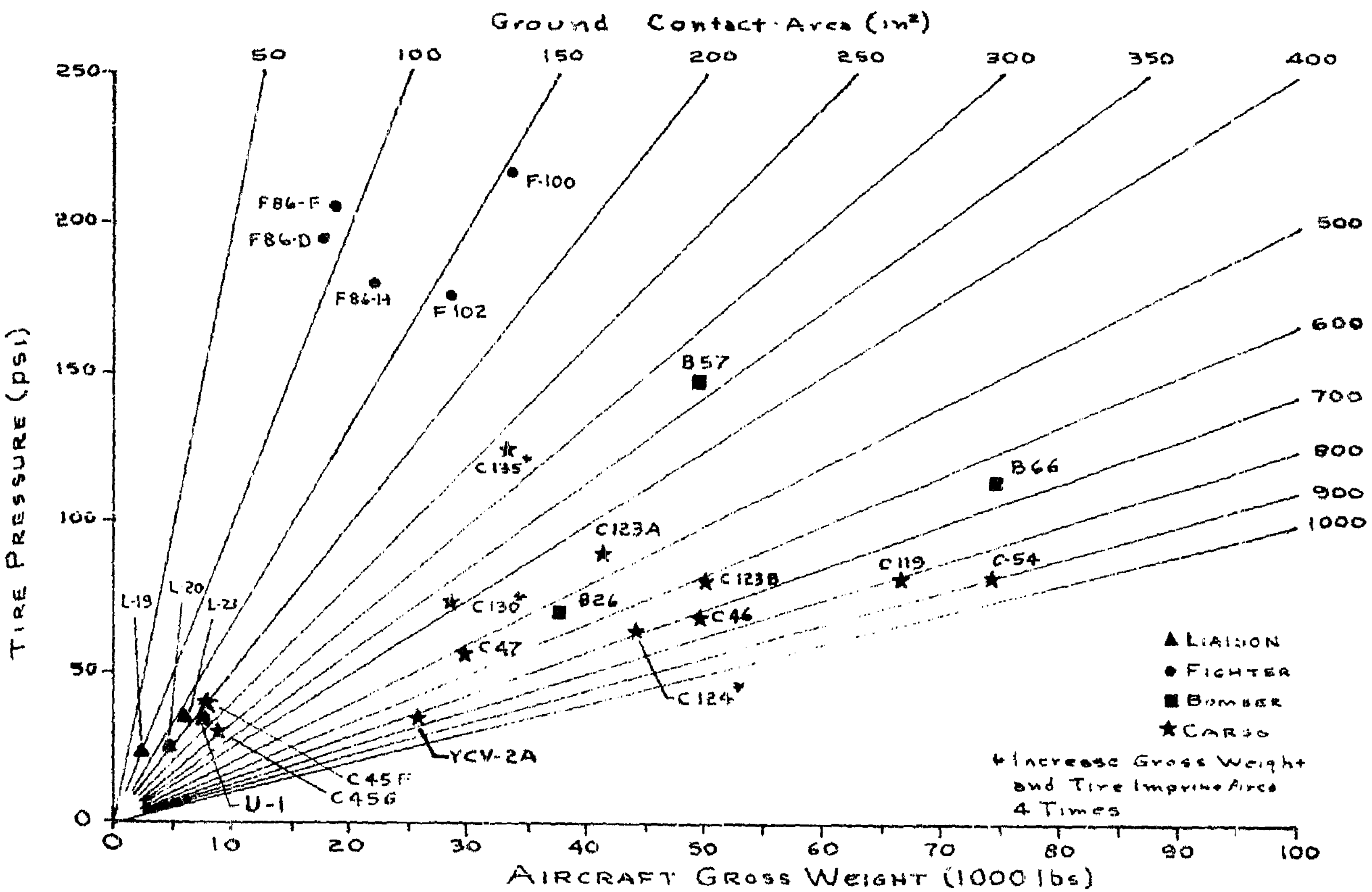

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Table 1

SUMMARY OF REPORTED AIRFIELDS IN THAILAND

Runway Length (ft)	No. of Rwys.	STATUS							SURFACE								AIRCRAFT TYPE OR WEIGHT BEARING C															
																					Liaison				C-47			C-123			C-46	
		Unknown	Usable	Emergency	RIC	Unusable	Abandoned	Under Constr.	Unknown	Concrete	Asphalt	Laterite	Earth	Grass	Sand	Rock	Unknown	Porter	Helio Courier	Dornier	All Weather	Dry	Wet	Caribou	All Weather	Dry	Wet	All Weather	Dry	Wet	All Weather	Dry
3000	4		4									2	1	1										1		3						
3100	2		1		1				2								2															
3200	8		2			6			4			1	3				6									2						
3300	4		3	1								3	1									1					1[g]		1			1
3400	3		2			1					1	1	1				1								1		1[g]					1[g]
3500	4		4									4														3						
3600	5		3			2			1			2	1	1			3									2						
3700	1	1											1				1															
3800	1	1											1				1															
3900	7		3			4			4			2	1				4									3						
4000	9		6			3					1	5	3				3								1	4						1
4100	1		1									1														1						
4200	2		1			1			1			1					1									1						
4800	2		2								1			1			1														1	
4900	2		2								1	1													1				1			
5000	1		1									1					1															
5200	2		2									2														1	1					
5400	1		1									1					1															
5900	1		1									[h]1														1						
6000	1		1									[i]1																				
6500	2					2			1					1			2															
7000	6		4			1		1	1	3	[a]2						1														1	
7200	1		1								[j]1														1							
8400	1		1								1																					
8500	1		1									1													1							
9800	3		3							3																						
Total	296	73	[illegible]	22	12	49	10	10	141	3	[illegible]	39	76	[illegible]	3	1	[illegible]	[illegible]	[illegible]	[illegible]	1	8	[illegible]	17	5	[illegible]		[illegible]	2	1	[illegible]	[illegible]

(a) Ready for inspection and certification; (b) ... (unknown tire pressures); ...
(d) 1... psi tire inflation pressure; (e) Alvey ... airfield--largest dimension given, (f) Classified as ...
(h) Includes sod, gravel and ... ft asphalt; ... laterite; (j) 1 under construction; ...

[redacted]

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Table 1

SUMMARY OF REPORTED AIRFIELDS IN THAILAND

	SURFACE									AIRCRAFT TYPE OR WEIGHT BEARING CAPACITY																								
													Liaison				C-47			C-123			C-46				C-130			SWL			
Under Constr.	Unknown	Concrete	Asphalt	Laterite	Earth	Grass	Sand	Rock	Unknown	Porter	Helio Courier	Dornier	All Weather	Dry	Wet	Caribou	All Weather	Dry	Wet	All Weather	Dry	Wet	All Weather	Dry	Wet	C-54	All Weather	Dry	Wet	15000 lbs[b]	25000 lbs[c]	75000 lbs[d]	Runway Length (ft)
				2	1	1										1		3															3000
	2								2																								3100
	4			1	3				6									2															3200
				3	1									1					1[g]		1			1				1[g]					3300
			1	1	1				1								1		1[g]					1[g]									3400
				4														3												1			3500
	1			2	1	1			3									2															3600
					1				1																								3700
					1				1																								3800
	4			2	1				4									3															3900
			1	5	3				3								1	4						1									4000
				1														1															4100
	1			1					1									1															4200
			1			1			1														1										4800
			1	1													1				1												4900
				1					1																								5000
				2														1	1														5200
				1					1																								5400
				h1														1															5900
				j1																								1					6000
	1					1			2																								6500
1	1	3	[illegible]2						1														1			1					3		7000
			i1														1																7200
			1																												1		8400
				1													1																8500
		3																													2	1	9800
10	141	6	[illegible]	39	76	21	3	1	144	2	6	4	1	8	2	17	5	[illegible]	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	1	

...rtification; (b) [illegible]ngle wheel load (unknown tire pressures); (c) [illegible] psi [illegible] pressure; ...ssure; (e) Alway Airfield--largest dimension given, (f) Classified as unusable; [illegible] runway. ...00 ft asphalt; [illegible] on laterite; (h) 1 under construction; [illegible] both ends.

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Table 1

SUMMARY OF REPORTED AIRFIELDS IN THAILAND

Runway Length (ft)	No. of Rwys.	STATUS: Unknown	Usable	Emergency	RIC?	Unusable	Abandoned	Under Constr.	SURFACE: Unknown	Concrete	Asphalt	Laterite	Earth	Grass	Sand	Rock	AIRCRAFT TYPE OR WEIGHT BEARING CAPA…: Unknown	Porter	Helio Courier	Dornier	Liaison: All Weather	Liaison: Dry	Liaison: Wet	Caribou	C-47: All Weather	C-47: Dry	C-47: Wet	C-123: All Weather	C-123: Dry	C-123: Wet	C-46: All Weather	C-46: Dry	C-46: Wet
Unk.	112	68	12	7	11	5		9	110				2				84		26					2									
400	1		1										1									1											
500	6		3	3					1				3	2				1	[illegible]														
600	12		9	2			1						11	1					1[illegible]														
700	10		6	3			1						4	3	2	1	2		8														
800	6	1	4	1									5		1			1	4	1													
900	6		5	1									5	1					1	2				2									
1000	10	1	8	1									10				1		9					4									
1100	3		2									1	2							1				2									
1200	1		1										1						1														
1400	2		1			1							1	1			1							1									
1500[e]	6	1	2				3				1	2	1	2			[illegible]					1		2									
1600[c]	8		1			5	2		4			1	1	2			6																
1700[c]	3		1			1	1						1	2			2					1											
1800[e]	4		3			1						1	3						1			1		1		1							
1900	3		1			2			2				1				2					1											
2000	4		1	1			2		1			1	1	1			2					1				1							
2100	3		1			2							[illegible]	1			[illegible]					1											
2200[e]	3			1	1	1			3								3																
2300[e]	2		1	1									2						1											1			
2400	3		1			2			1			1		1			2									1							
2500	2		2										2											1		1							
2600[e]	4					4			3			1					3									1							
2700	2		1			1							2								1					1							
2800	1		1									1														1							
2900[e]	4		1			3			2				2				3									1							

(a) Ready for inspection and certification; (b) Single wheel load (unknown tire pressures); (c) 100 psi tire in…
(d) 100 psi tire inflation pressure; (e) Alway Airfield--largest dimension given; (f) Classified as unusable: (…
(h) Includes sod, gravel and 900 ft asphalt; (i) TGI on Laterite; (k) 1 under construction; (l) Asphalt center…

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Table 1

SUMMARY OF REPORTED AIRFIELDS IN THAILAND

SURFACE								AIRCRAFT TYPE OR WEIGHT BEARING CAPACITY																								
												Liaison				C-47			C-123			C-46				C-130			SWL			
Unknown	Concrete	Asphalt	Laterite	Earth	Grass	Sand	Rock	Unknown	Porter	Helio Courier	Dornier	All Weather	Dry	Wet	Caribou	All Weather	Dry	Wet	All Weather	Dry	Wet	All Weather	Dry	Wet	C-54	All Weather	Dry	Wet	15000 lbs[b]	25000 lbs[c]	75000 lbs[d]	Runway Length (ft)
110				2				84		26					2																	Unk.
				1									1																			400
1				3	2				1	[illegible]																						500
				11	1					12																						600
				4	3	2	1	2		8																						700
				5		1			1	4	1																					800
				5	1					1	2				2																	900
				10				1		5					4																	1000
			1	2							1				2																	1100
				1						1																						1200
				1	1			1							1																	1400
		1	2	1	2			3					1		2																	1500[e]
4			1	1	2			8																								1600[e]
				1	2			2					1																			1700[e]
			1	3						1			1		1		1															1800[e]
2				1				2					1																			1900
1			1	1	1			2					1				1															2000
				2	1			2					1																			2100
3								3																								2200[e]
				2						1											1											2300
1			1		1			2									1															2400
				2											1		1															2500[e]
3			1					3									1															2600[e]
				2								1					1															2700
			1														1															2800
2				2				3									1															2900[e]

ification; (b) Single wheel load (unknown tire pressures); (c) .50 psi tire inflation pressure;
re; (e) Alway Airfield--largest dimension given; (f) Classified as unusable: (g) Dare runway;
ft asphalt; (j) PSP on Laterite; (k) 1 under construction: (l) Asphalt center concrete both ends.

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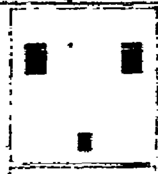
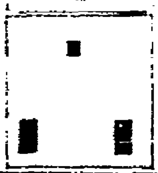
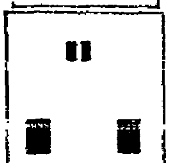
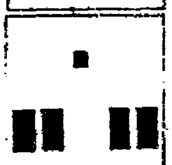
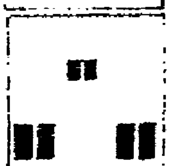
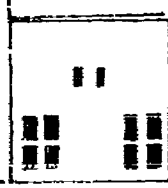
Table 2
Aircraft Characteristics

Aircraft	Landing gear Configuration	Gross Weight (lb)	Tire[a] Inflation Pressure (psi)	Tire Imprint[b] Area ($in.^2$) of all tires (main gears)
L-19		2,400	22	98
C-47		33,000	56	532
C-46		55,000	68	726
F-86D		19,000	195	90
B-26		42,000	70	538
B-66		83,000	115	648
C-123A		45,000	90	458
C-123B		55,000	81	620
B-57		55,000	148	334
C-119		74,000	82	812
C-54		83,000	82	904
YCV-2A		28,000	35	732
C-124		195,000	64	2740
C-130		124,000	74	1512
C-133		300,000	93	2896
C-135			125	2128

[a] Tire inflation pressure approximately equals surface pressure.

[b] Based on 90 percent of the aircraft gross weight on the main landing gear.

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CHMAAG, Vietnam	3
JOEG-V, Vietnam	2
ACTIV, Vietnam	2
OSD/ARPA R&D Field Unit, Vietnam	2
SD-2, FARELF, Singapore	2
Vice Chief Air Staff, Air Ministry, London	1
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Battelle Memorial Institute	2
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CINCPACAF	3
CINCPACFLT	3
COMPHIBPAC	3
CHJUSMAG, Thailand	15
CHMAAG, Vietnam	3
JOEG-V, Vietnam	2
ACTIV, Vietnam	2
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SD-2, FARELF, Singapore	2
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DIRECTORATE FOR FREEDOM OF INFORMATION AND SECURITY REVIEW
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Received 2-1-00

19 NOV 1999

Ref: 98-M-0165/A1

Mr. Michael Ravnitzky
612 Lincoln Avenue, #301
St. Paul, Minnesota 55102-2829

Dear Mr. Ravnitzky:

This refers to our letter to you dated October 7, 1999, regarding your appeal to the Information Security Oversight Office for 14 documents previously requested under Mandatory Declassification Review procedures.

The review of one of the documents you requested is complete. Document AD346727, "Military Research and Development Center Quarterly Report" (Joint U.S.-Thailand Organization), 1963, has been reviewed by the Department of Defense and there is no objection to its public release. The document is declassified and a copy enclosed. We will advise you as soon as the remaining reviews are completed.

Sincerely,

H. J. McIntyre
Director

Enclosure:
As stated

cc:
Defense Information Systems Agency
Defense technical Information Center
ATTN: DTIC-RSM (Ms. Akers, FOIA PM)
8725 John J. Kingman Rd Ste 0944
Ft. Belvoir, VA 22060-6218

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Director
OSD/ARPA R&D Field Unit

Singchai Menasuta
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Commanding General, Military
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[illegible]

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