

THE SURVEY SERVICE EASTERN AND 14 ARMY 1942 – 1945.

Report by Col. G. Bomford.

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THE SURVEY SERVICE EASTERN AND 14 ARMY 1942 – 1945.

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PART 1. March 1942 to December 1942.

1. Summary.

This period covers the retreat of the Army from Burma, preparation for the defence of India, and the earliest preparations for a return into Burma. It provides few lessons in how the Survey Service should operate, being more an illustration of the condition in which the Service should not be found at the outbreak of war.

2. Survey Organization.

In March 1942 the war in Burma was clearly going badly, and it became necessary to consider the defence of India. The Eastern and Southern Commands were accordingly converted into field armies with the titles of Eastern Army and Southern Army, and they moved their HQs to Ranchi and Bangalore respectively. At this time the Military Survey Service consisted of : -

- (a) A Director of Survey at GHQ, a post held by Col. E.A. Glennie CIE, DSO, in addition to his duties as Director Frontier Circle, Survey of India. He had no military staff.
- (b) Three Indian Field Survey Coys and associated HQs and small units, which had been in Iraq since 1941, and were still there.
- (c) One Indian Field Survey Coy and HQ which had recently been raised in Burma.
- (d) The Survey Depot at Risalpur, NWFP.

3. Raising of DD Survey.

On 15 Mar 42 a small establishment (WE 119/1942) as below, was raised to provide for survey representation at the HQs of the Eastern and Southern Armies.

DD Survey	(Col. G. Bomford)
DAD Survey	(Maj. S.E. Evans)
Assistant	(Capt. K.S. Curtis MBE)
2 Subedars	i/c Map Depots
2 Surveyors	
1 Computer	
3 Clerks	
5 Draftsmen	
5 Record keepers	
31 IORs.	

In addition to his duties in Eastern and Southern Armies, the DD Survey acted as the D Survey's deputy in connection with surveys in Assam, and for liaison with China. He was also originally intended to exercise control over

The Survey units in Burma, but the operations in Burma had come to an end before this had begun to be possible.

4. Survey Position.

The mapping position at this time was that the whole of Burma and Eastern and Southern India had been surveyed at the 1-inch scale, except for a belt covering the Chin and Naga hills where the ½-inch scale had been adopted, although in some parts the surveys were very old. Compiled maps also existed at the quarter-inch scale, and generally at the half-inch scale in addition. The position is illustrated in Chart I. All these maps had been published before the war, all except some of the old maps being well printed in 6 or 7 colours.

5. Map Stocks.

Whilst the country had thus been very reasonably well surveyed, the map stock position was deplorable. In peace the normal printing was 500 of each edition, enough to last 20 years or more, and even this small stock was looked on by the Department's auditors as capital improvidently locked away. In 1940-41 additional stocks were printed of certain areas in southern Burma and the Shan States and stored in Rangoon, but by March 1942 these areas had been overrun by the Japs and the stocks had been lost. The Survey of India Department's presses were busy printing stocks of northern Burma, keeping pace with the rapid movement of the war as best

they could, and these maps were flown over to Burma, where they were either used, destroyed, or abandoned as circumstances dictate.

6. Resources.

The position in India in March 1942 was thus that there were neither maps nor survey troops. There was, however, the civil Survey Department, depleted by the raising of units which had gone overseas, but still with considerable printing power at Dehra Dun and Calcutta, and with some reserve of surveyors and draftsmen from which further military units could be raised.

7. Reprint of ¼ & ½ inch.

The first task of the newly raised Survey Directorate was to procure maps for the threatened defence of India, and to make arrangements for their storage and distribution. An early reprint of all the 1-inch sheets that might be required was clearly impossible, and the first priority was a reprint of the ¼-inch, followed by ½-inch or 1-inch where the ½-inch did not exist or was inadequate, to be followed eventually by a reprint of the remaining 1-inch. (Chart II illustrates the first demand. Scored through). Roughly speaking they demanded from 3000 to 4000 copies each of 142 ¼", 320 ½" & 200 1". In addition, until the end of April, there were demands to be met by the Army in Burma. Seven colour printing was out of the question and the style adopted was black outline and brown contours, with an additional colour (purple grid or green trees) in a few areas. The whole job (1/4, ½ & selected 1") was completed by about 1 Oct 42.

8. Farming.

Attempts were made to increase the Survey of India's capacity by farming out work to Provincial Government presses. The Bombay Government's press at Poona laid other work on one side and offered to print 70 sheets a month, but difficulty in procuring the Survey of India's original fair sheets, shortage of paper, and other trivial but collectively insuperable difficulties prevented satisfactory use of the press. The Madras Government similarly placed their press at DD Survey's disposal, but a threatened Japanese invasion of Madras decided them to evacuate it from Madras the next day, and it was not in working order again until the worst need was past. Work was also accepted by the Bihar and Assam Government presses, but they had no photographic department and could not be used for the printing of standard sheets.

9. Map Depots.

Map Depots were set up at Ranchi, Barrackpore and Bangalore. The main Eastern Army Depot was at Ranchi in school buildings with a capacity of 2,000,000 maps, later extended to 4,000,000. Barrackpore was initially a small Depot with a capacity of 500,000 in a private house, for serving 15 Corps whose HQ was located there. The Bangalore Map Depot with a capacity of 1,500,000 maps was located in the office of the civil party (No. 5? Detachment), whose staff looked after it. A small depot was also opened at Poona. As maps were printed by the Survey of India, they were railed to Ranchi or Bangalore, where they were either stored or issued to Divisions. These map depots supplied maps to the RAF as well as to the Army.

In the beginning maps were stored in racks, in spaces about 24 x 2 x 6 inches to hold 1000 maps, a rack about 10 feet long, 3 feet deep and 6 feet high holding 4,000 maps. Later they were stacked in piles on the ground up to 6 feet or occasionally 10 feet high. For despatch and issue to units, maps were packed in bundles of 50's folded into three. In this way 300 get into a sandbag or 1200 into a flour sack, weighing 70-80 lbs. The latter has always been the normal means of despatch and is considered very convenient.

For the holding of maps at Div HQ and for distribution within the Division one 3-ton lorry, one Survey Record keeper and one survey sepoy storeman were introduced into the WE of Div HQ. They work under the G III (I) of the Div, not under the Survey Directorate.

10. Distribution.

DD Survey made his HQ with Eastern Army at Ranchi with DAD Survey and most of his establishment, while Capt. Curtis, late of the Madras Survey Department, who was recruited at short notice in Mar 1942, represented DD Survey at Southern Army. The Barrackpore map depot was run by a small detachment of 1 Subedar, 1 clerk, 2 Recordkeepers and 10 IORs and the Ranchi depot by a CEM, 3 sergeants and a Corporal, late of the SW Pacific Survey Directorate, who were held in lieu of corresponding Indian ranks. Distribution of maps to formations was by rail, or by the formation's own vehicles, or by liaison officers from Army to Corps or Div HQ's. It was soon learnt that rail consignments into Assam did not arrive unless escorted, but despatches from the presses at Calcutta and Dehra Dun to Ranchi and Bangalore arrived comparatively safely.

11. Burma Units.

An account of the work of the Burma Survey Units will be better written by Lt. Col. H.W. Wright OBE, AD Svy, but a summary is included here. An Indian Fd Svy HQ (AD Survey's HQ, General Section and Drawing Section), an Indian Fd Svy Coy on a special establishment (HQ, General Section, Air Survey Section, one ground svy section, and two photo-zinco sections with small hand presses) were raised in Burma late in 1941 under WE's 52/1941 and 53/1941. A Map Supply Section was also raised under the orders of the Government of Burma, and there were present in Maymyo some residue of the Burma (Civil) Survey Party and a Reproduction unit with a camera and flat-bed machine press. Up to the outbreak of the Japanese war the Burma Survey Party had been usefully employed revising the maps of Burma including the alignment of almost all motorable roads. As the Japanese advanced field work had to close and the newly raised military units could do little but map distribution and emergency printing. In April they had to evacuate Maymyo. Some proceeded to India via Monywa, Tamu and Imphal, being involved in a railway accident on the way with some casualties, while others moved to Myitkyina where it was intended to spend the monsoon. They had no sooner arrived, however, when they had to leave for India. Most made their way out via Homalin and Imphal : a few via the Hukaung Valley, and some (including Lt. G.D. Jardine i/c Map Supply Section) remained in Burma. Lt Jardine has been reported to be a prisoner of war, but there has been no news of the others.

12. Salvage.

The fair sheets of the Burma maps were sent back to India in good time, but the original planetables and manuscript triangulation records (no duplicates existing in most cases, except of the primary and secondary triangulation) went up to Myitkyina and were lost. They were last seen stored in the Forest Bungalow at Pidaung and almost certainly have been destroyed. No trace having been found by the US Forces who have since re-occupied the area.

13. Reconstruction.

No. 6 HQ & 6 Coy arrived in India in small parties, without equipment, below strength and in bad health. The units were posted to Eastern Army and located at Ranchi, where they were reformed in July 1942 under Major I.H.R. Wilson, and gradually brought up to strength. No. 6 Coy was converted to a normal WE (II/32/3), with HQ, general section, air section and two ground sections, the two PZ sections being retained as separate units. Administration and military training absorbed some time during their stay at Ranchi, but productive work was carried out in making a start on 68 unpublished ½-inch sheets of Burma, provisional editions of which were begun by mosaic-ing and reducing the 1-inch sheets concerned. At the time the task of reprinting the 1-inch maps of Burma seemed greater than could probably be done before the necessity for the maps arose. At that time it could not be foreseen that the Army would not return to Burma for 3 years, and then with such survey resources as would provide 1:25,000 scale maps almost wherever operations were to take place.

14. A.A. Survey.

In 1942 and 1943 a considerable amount of work was put into surveying of A.A. sites. The normal routine was for a heavy A.A. battery of 8 guns to be divided into two separate 4-gun sites a mile or two apart. Only one of these sites had a G.L. Set (Radar). Requirements were therefore

- (a) A bearing at each site correct to 2 minutes
- (b) The fixing of the coordinates of a point in each site, relatively correct within 50 yards
- (c) Where possible some ranges to a point 2000 or 3000 yards away, correct to 1 part in 500, for checking range-finders.

Items (a) and (b) then enabled the one G.L. set to control all 8 guns. Where several pairs of sites were located within Radar distance of each other, the coordinates of all had to be linked up within 50 yards to enable all the guns to bear on a target fixed by any one G.L. set.

This work was carried out by many methods. Bearings from the gun presented no difficulty, and tables were got out whereby batteries could check their bearings from Polaris whenever they wished. The range points were often difficult in close country, but were never looked on as essential. Coordinates were fixed from large scale maps where such existed, or by traverse. Triangulation was seldom possible.

Initially the work was done by civil detachments. Mr. H.G. Banerjea in Calcutta, Lts Anand Singh, Verma and Paintal & Mr. A.T. Shakir in Calcutta, Bihar and Assam, Mr. Murti & members of 6 Detachment in S. India. Later the work was taken over by military units.

A few coast defences were also fixed in a similar way. In all about 110 AA sites were fixed in 1942. The work is of no permanent value.

15. Ground Surveys.

In Mar 1942 urgent demands arose for ground surveys to start off the construction of airfields and base installations in Assam. The first and most urgent job was location surveys for the base at Bedo, the railhead and store depot for the new China road. The base at Manipur Road was also wanted very soon. Both these jobs continued intermittently for about two years, more and more surveys being required at each stage of their development. Surveys for new airfields were also undertaken at several sites in Assam notably Dinjin, Mohanbari and Chabua.

To deal with this work No. 12 Party, Survey of India under Mr. W.H. Strong MBE was placed at DD Survey's disposal and took the field in Assam at the end of March. The party consisted of 7 assistants and 28 surveyors, levellers and traversers, with some reinforcement from the Assam Survey Department. They laboured under many difficulties – thick jungle, rainy weather and leeches while the general breakdown of all transport and supply arrangements in Assam bore upon them as civilians more heavily than upon the Military. They never the less accomplished much valuable work, although subsequent development of all the sites concerned has now made it of little or no permanent value.

The work is included in Chart II.

A number of new roads were also surveyed for inclusion in revised editions of the 1", ½" & ¼".

16. Liaison with China.

The Chinese troops operating between Mandalay and Lashio had been reported as shewing some interest in maps, and with a view to contacting them, arrangements were put in hand for DD Survey to visit them at the end of April. Difficulty was experienced in obtaining an air passage to Lashio, but it was understood on advice from Delhi on 25 Apr that a passage could easily be obtained from Dinjan to Myitkyina whence the Chinese armies could be visited by rail via Mandalay. This small incident is an extraordinary side-light on the extent to which India was ignorant of the state of affairs in Burma at this time. DD Survey duly went to Dinjan, arriving on 2 May, where he was offered a passage to Myitkyina readily enough, but without any expectation of a return passage. The offer was not accepted, which was fortunate as the Japanese entered Myitkyina on about 9 May. Later attempts to contact Chinese were a little more successful. On 10 July an air passage was arranged in Chungking, where it was hoped that a set of Chinese maps would be procurable in exchange for samples and offers of bulk supplies of Burmese maps, DD Survey visited the HQ of the Chinese survey at Kweiyang and Pinpa 200 miles south of Chungking on the Chinese road, and ascertained the existence of a great volume of survey, ancient and modern, much of it at 1:50,000 but was able to obtain practically nothing in the way of copies of it. It was also arranged for a Chinese liaison officer, Col. Chang to visit India to arrange the preparation of Chinese names-plates for surprinting on maps of Burma.

The visit involved an absence from HQ of 20 days. A full report was sent to D Survey GHQ (I) under letter 600/25 of 30 July 42.

17. Military Organization.

(i) During the monsoon of 1942 the Eastern Army consisted of : -

Army Reserve.	5 & 70 (British) Divs at Ranchi.
15 Corps.	HQ Calcutta. 14 Ind Div Comilla and Chittagong. 25 Ind Div Bengal
4 Corps	HQ Jorhat. 17 Ind Div) 23 Ind Div) Assam and Manipur 39 Ind Div)

(ii) Southern Army consisted of 19 & 20 Ind Divs.

18. Preparation for return to Burma.

With the onset of the monsoon and the arrival of reinforcements from Europe it began to be clear that the Japanese could not invade India successfully, and the 1" reprint of India (see para 7) was cancelled, and a reprint of all Burma and the Assam frontier substituted, namely : - 14500 of all 1/4-inch and ½-inch sheets (95 and 304 in number respectively) and 7000-10000 of all one? Inch (about 800 in number). As in India, the style was necessarily black and brown. The programme was undertaken by the Survey of India and begun in Aug 42. It was completed early in 1943.

At the end of October, HQ Eastern Army moved from Ranchi to Barrackpore. Survey HQ obtained good accommodation, taking over the Boy's school, and the existing small map depot was moved into an excellent building of 10,000 square feet in the Kinnison Jute Mill, with a capacity of 5,000,000 maps. No. 6 Indian Field Survey Company moved to Silchar into a basha camp and No. 6 Ind Fd Svy HQ obtained a building at Baranagar half-way between Barrackpore and Calcutta.

In Sept 1942, a British Printing unit, 6 Ind Reproduction Group was posted to the Army, although great delay was experienced in getting its vehicles from Bombay, and the unit was hardly in operation by the end of the year.

These Rep groups were raised under WE II/32-A/1, with 2 Officers, 36 BORs, 48 IORs (drivers etc). They were equipped with two Crabtree demy presses in 14-ton Foden lorries (originally Leylands), two similar photomechanical vehicles, and 5 22 KW Lister Generator Trailers.

They were intended to have camera and process lorries, but these never arrived, and Hunter-Penrose portable cameras and a portable darkroom were used instead. The units also carried a grainer, guillotine, and arc lamps for the camera.

19. Organization of Dec 42.

At the end of December 1942 the organization and location of the Army Survey was as follows, each of the four items (a) – (d) being independently controlled by DD Survey.

- (a) AD Survey 6 HQ (later renamed 9 HQ) Lieut-Col H.W. Wright, OBE i/c drawing and printing, 6 Rep Group, a drawing section, two PZ Sections. And as many non-air trained surveyors and draftsmen of 6 Coy, as could be spared from other work.
- (b) 6 Ind Fd Survey Coy, Major I H R Wilson, HQ at Silchar with the equivalent of one ground section undertaking rapid revision of roads in the Chittagong area and between Manipur Road, Imphal and Kalemio. OC 6 Coy also took over the AA gun fixing and control of the civil party working in Assam. A Map Supply section, which had just opened Depots at Jorhat and Imphal, was also under OC 6 Coy's control.
- (c) OC HQ Air Section (Lt K.V. Stringer) in charge of all the air trained surveyors in the Army with a proportion of ordinary draftsmen.
- (d) DAD Survey (Major Sams, who relieved Major Evans in Sept) i/c Map distribution from Ranchi, Barrackpore and Titagarh depots.

20. During Sept and Oct 1942 Col. G. Bomford acted as D Survey at GHQ for two months in a vacancy arising from the annual leave of the Surveyor General and D Survey, and Col J B P Angwin MBE acted as DD Survey Eastern and Southern Armies in his place.

21. Southern Army. In Nov 1942 Col Angwin proceeded to Bangalore to take over the duties of AD Survey at HQ S Army, to which survey units were beginning to be posted. From 1 Jan 43, this post was up-graded to Deputy Director, and came under the direct control of GHQ India, DD Survey Eastern and Southern Army thus becoming responsible for Eastern Army only.

PART II – January 1943 to January 1944.

22. Summary.

Military operations during this period included the unsuccessful offensive in Arakan in the first half of 1943, the Wingate expedition of 1943, and the inconclusive offensive-defensive in the Kabaw Valley and the Chin Hills around Tiddim and Fort White.

The Army Survey Service received reinforcements and was built up into an effective organization which was able to look after the Army's map supply during the busier times which were to follow.

23. Arakan.

In Dec 42 14 Div had moved southwards and captured Maungdaw and Buthidaung. They then advanced rapidly southwards along the coast towards Foul Point, where they were held up at Donbaik, while another Brigade further inland was held up at Rathedaung. In spite of reinforcements they never got further; and a Japanese counter-offensive in March and April pushed the Division back to the north of Maungdaw. A seaborne landing on Akyab Island was also planned but never took place.

The maps available in Dec 43 were the pre-war 1-inch, printed in black and brown, and a 3-inch air survey map of Akyab Islands. The 1-inch survey was of indifferent quality in the densely jungle-covered hills, and contained one particularly unfortunate error in that the Donbaik Chaung, in which the Japs stood, was shown as rising in the outer ridge of the hills, all the hill streams which actually drain into it being shown as draining elsewhere.

With the very small number of air-trained surveyors available, it was impossible to start making normal 1:25000 maps and "photo-mosaics" were produced as a substitute (see para 33). A number of these were made and were considered a very valuable addition to the 1-inch map, although their quality left much to be desired. A new edition of the Akyab 3-inch map was also prepared, and a trace showing enemy defences was kept and added to weekly, with a view to sun printing just before the assault on the island.

The Japanese counter-offensive raised an urgent demand for 1-inch surveys north of Maungdaw in an area (84 C/7 & 8) where pre-war survey had been at the ½-inch scale, and these two sheets were hurriedly surveyed from 1:20,000 air photos.

In January a small Map Depot was opened at Chittagong which supplied maps to 14 Div. It has been maintained ever since.

24. 4 Corps in Manipur.

Early in 1943 HQ 4 Corps moved up from Jorhat to Imphal, whence it conducted operations with 17, 23 & 39 Divs, holding Tamu and Fort White, while the motor road from Manipur Road to Palal was improved and continued to Tamu. A motor road was also constructed from Imphal to Fort White, but no satisfactory alignment was ever found. Much work was also done on the development of bases and airfields.

In Feb 43 an AD Survey (Lt. Col. I H R Wilson) was appointed to 4 Corps, with an establishment of one Captain and 22 VCOs and other ranks (WE II/31-F/1), and on 1 April 6 Coy moved its HQ from Silchar to Imphal, although about half the drawing strength of the Coy remained detached at Army HQ. 'A' PZ Section was posted to Imphal, with two hand presses, and 33 Map Supply Sectioned opened a Map Depot at Imphal, leaving a small detachment at Jorhat. AD Survey 4 Corps also controlled the civil detachments working in Assam.

During the year 6 Coy carried out many medium and large scale surveys of important localities, notable 2-inch surveys of strips 2 to 4 miles wide along the Palel-Tamu and Imphal-Tiddim roads, which proved very useful during the fighting of 1943. Triangulation was carried out round the Imphal plain and between Imphal and Tamu, which in the absence of any existing 1-inch surveys also proved valuable as control for 1:25,000 maps and block-plots prepared in 1943. Apart from these two items, ground survey was mostly done for administrative purposes. See Chart II.

The pre-war map covering the Manipur Road – Imphal – Fort White – Tamu was on the ½-inch scale, and based on exceptionally poor quality triangulation, but as a matter of policy all possible effort was put into air survey of more forward areas and no effort was put into rear areas except the revision of main roads and the triangulation mentioned above.

25. Wingate Expedition.

77 Brigade operated on a small number of ½-inch maps, which were flown out from its base at Aggartala airfield as required, and a small map depot was opened at Aggartala for this purpose. During the return journey it appeared that a portion of the Bde would pass through the very difficult country lying to the north of the Uyu River, where the existing ½-inch map was known to be exceptionally inaccurate, and a special 1-inch map was hurriedly prepared for their use when crossing the watershed.

26. Base Map Production.

The main survey activity of 1943 was the building up of a map production establishment near Calcutta. In Jan 42 the units available were an AD's HQ (No. 9), 6 Ind Rep Group (later renamed 66), B PZ Section, a drawing section (later named 53) and some surveyors and draftsmen detached from 5 Ind Fd Svy Coy. 22 Park Section also arrived in July.

In June the establishment was reinforced by the arrival of 2 Ind Fd Svy Coy, which had returned from Iraq, and 63 Ind Rep Gp arrived in July, although its technical vehicles did not arrive until September. A very good house and compound for the Offices and reproduction vehicles was obtained at 43 Barrackpore Road, at Baranagar, but living accommodation was less satisfactory, in scattered houses at some distance from the offices.

Many difficulties were experienced by 66 Rep Group before they could start printing satisfactorily, notably the sickness of both their officers during Jan, Feb, Mar and the almost complete breakdown of their power plant (Two old Tilling-Stevens generating lorries). Power shortage was temporarily remedied by the installation of two small stationary diesel generators, but the position was not satisfactory until the unit's Lister generator trailers began to arrive in Aug 43. During the first 3 months they also had unaccountable difficulty in producing a fine black plate. The trouble was eventually got over, but the cause was never discovered. Until April the group, with 2 presses, was only able to produce 200,000 or 300,000 pulls a month, but in May this was increased to 600,000 and in June to the reasonable figure of 850,000.

The map production work done in 1943 mainly consisted of :-

- (a) New editions of the ½-inch and ¼-inch in Arakan, Manipur and the Chin and Naga Hills, incorporating new roads and introducing more than the bare two colours of the 1942 reprint.
- (b) 1:25,000 maps produced by the air survey section. See para 30.
- (c) New editions of the 1-inch in Arakan and in the Kabaw valley, air-revised and in colours.
- (d) Target maps for the RAF.
- (e) Outline maps and background maps for sunprinting dispositions and administrative layouts.
- (f) Block-plots and large scale airfield surveys.
- (g) A little half-tone work.

The standard sheets published are shown on Charts III & IV.

27. Mapping material and style of maps.

Standard 1", ½" & ¼" sheets were variously reproduced by correcting existing fair-sheets, negatives or BPOs. Each sheet presented a different problem according to the material available and the amount of corrections.

Colours were added to the basic black and brown as follows :-

- (a) A pale red ribbon was surprinted over black roads and tracks. This is not as good as a separate red for communications, but colour separation was too laborious. Later, when sheets were entirely redrawn from air survey, a separate red original was prepared.
- (b) A pale blue filling was printed in the sea, tanks and "double-line" rivers.
- (c) Cultivated and other open areas were shown in yellow. In northern Burma and Arakan the country is almost entirely either jungle-covered hills or open cultivation, and no confusion resulted in showing open clearings in yellow whether they were cultivated or not. In the drier parts of Central Burma this system later had to be departed from, yellow being reserved for cultivation, forest being shown by black tree symbols or a green tint, and other land being left white with scrub or grass symbols as appropriate.

28. Map Catalogue.

An Eastern Army Map Catalogue was published in Feb 43, illustrating the maps of eastern India & Burma. Addendum lists were subsequently published every month, listing newly published sheets, and new editions with orders regarding supersession's of old editions.

A Fourteenth Army Map Catalogue was published in Sept 43, with a second edition in Dec 44.

29. Maps for Chinese Army.

In Oct 42 Col Chang the Chinese Liaison Officer, reached India and arranged for 1000 or 2000 copies of the ½-inch and 1/4 -inch maps of northern Burma to be surprinted with Chinese names. These name originals were prepared by Col Chang in Calcutta, and the necessary surprinting was farmed out to the Bihar and Assam Govt presses. A total of 252,000 maps were so surprinted between November 42 and April 43.

30. Air Survey.

Throughout 1943 and most of 1944 the Army suffered very severely from a shortage of surveyors trained in air survey, and in Dec 42 when work was begun for the Arakan operations only 6 were available. Between Jan and Mar they were reinforced by a section (5 surveyors) of 5 Ind Fd Svy Coy, and from Jan by another 5 surveyors of 3 Coy, reduced to 2 in April. Three men of 2 Coy's air section joined in May, but it was a long time before this section was up to strength.

All available air surveyors, except 2 to 4 in Imphal, were combined into a HQ Air Survey Section under Captain Stringer, whose strength fluctuated between 8 and 16 men, reinforced by half a dozen non-air-trained surveyors and draftsmen and at times by 4 or 5 civilians from Messrs Indian Air Svy & Transport Ltd, see para 32.

During the first few months of 1943 this section was employed on making photo-mosaics of Arakan and on 1:25,000 sheets around Kalemyo and Kalewa in the Chindwin valley an obvious battle locality when 4 Corps should advance. They also surveyed the 1-inch sheet around Tamu (88 L/8) and revised a number of other 1-inch in the Chindwin area. Later in the year they took up 1-inch original survey and 1-inch revision in Arakan, and an extensive programme of 1:25,000 maps in Arakan, see para 37. A number of photomosaics of rear areas were also prepared for training purposes.

In the absence of recognisable trig points, or frequently of any trig at all, 1:25,000 air surveys were based on a large number of points selected from the 1-inch map as probably having been accurately fixed by plane-tables. The possibility of error in such points was recognized, and attempts were always made to get a near fit with a number of them, rather than a perfect fit with fewer. Maps so controlled have generally been in correct position within 100 yards, but errors of 200 yds have occurred.

31. Supply of Air Photographs.

During this period no facilities existed for the provision of air photographs for survey purposes, but it happened that large areas in Burma had been photographed before the war by Messrs IAS & T Coy for the Burma Oil Company, and by good fortune these photographs covered areas in Arakan and the Chindwin valley where map revision was most required. Where these did not exist use had to be made of bi-lens and tri-lens low obliques, which were taken for reconnaissance purposes. Such photographs are much better than nothing, but accuracy of position suffers and contouring is made difficult. Mosaicing is possible, but also not easy.

32. Messrs Indian Air Survey & Transport Ltd.

This Company was located at Dum Dum, and during the early part of 1943 was of great assistance to Eastern Army. Members of the staff worked in the Air Survey Section, indexing and making mosaics, at which work they were expert, and they also undertook a large photographic programme (8000 square miles in 1943) for possible revision of the 1-inch map of Bengal. They supplied prints of their pre-war photography and undertook occasional special photographic flights. In March this Company was taken over by the Survey of India, under a Charter, and its connection with the Army lapsed.

33. Photo-mosaics.

The photo-mosaics referred to in para 23 and 30 were prepared from ordinary bromide mosaics, scale of about 1:15,000, touched up as below and reproduced as half-tone lithos. The touching-up consisted of :-

- (a) Adding a grid by comparison of map detail with the 1-inch gridded maps.
- (b) Contouring in black.
- (c) Touching up roads, tracks, streams, river banks and buildings in black or white as appropriate, where the natural contrast was insufficient.
- (d) Names.

The photography was generally done through a 133-line screen (no improvement being got with a 300-line), sometimes by the Magenta process and sometimes not. Most of those produced in 1943 were printed in the Survey of India Offices in Calcutta.

In contrast to the rather inaccurate 1-inch map, these 4-inch photo-mosaics were much appreciated, and the battles of Donbaik and Rathedaung were largely fought on them. As compared with a 1:25,000 map they had the advantage that they required less work from air-trained surveyors, the photographs inspire confidence in the user, who does not report that the map is wrong when he misidentifies his position, and in some types of country the map gives a good picture of the vegetation. There are, however, serious defects : -

- (a) Unless the bromides are of good quality and evenly matched, and the reproduction process free from fault, the result is an almost useless smudge.
- (b) In jungle covered hills and some other types of country, nothing shows except what the draftsman draws on the mosaic, and this would be clearer with the normal white background.
- (c) The grid is distorted, although not necessarily inaccurate.
- (d) For clear reproduction the scale has to be 1:15,000 which is inconveniently large from the distribution point of view.

After 1943, these mosaics were little used.

34. Block Plots.

The block plot is a device introduced in Mideast for the battle of El Alamein. It consists of a set of photographs each with its principal point and those of adjacent photos marked up in white ink. With the photographs is a gridded map or plain piece of gridded paper on which the photo centres are plotted. With the help of a piece of transparent talc any target which can be recognized on two photos can be cut in on the plot sheet and so located, on the ordinary radial line principle. The device is of special value in country (like the Egyptian desert) where there is little detail to mark on a map, but where an aeroplane can locate a target on a photo by reference to such features as changes in colour of the ground.

A block plot was first prepared in India in May 1943 for the defence of Maungdaw, but the place had been evacuated before it could be brought into use. In 1944 and 1945 block-plots have been most extensively used, and a Division considers itself ill-equipped if it has to fight without one. Like surveyed maps, block plots have been based on the 1-inch map for control (see para 30), and they share a map's liability to error of 100 yards or more.

Originally, the complete block-plot consisted of sets of maps showing the area covered by each photo, but as the work covered larger areas this was reduced to a set of photos and simple list of coordinates of centres which the RA plotted on their artillery boards as required. At first only 3 or 4 sets were supplied per Corps, but this was later increased to 8, itself a far from generous supply.

As an attempt to increase the available number of sets to an unlimited extent, litho productions of the photos were prepared, but the quality was insufficiently good, and the lithos have never been used.

35. A.A. Survey.

The surveying of AA sites continued throughout 1943, during which 169 sites were fixed. After Dec 43 little more of this work was required (24 sites).

36. Civil Survey parties.

Work on airfields in Bengal and Assam continued. The detachment f No.12 Party closed work in July 1943 and handed over to detachments of No.20 Party which had recently moved into the area. The work done is included in Chart II. Jobs were very numerous, the largest being 16-inch surveys of the large airfields at Chittagong, Fenni, Comilla, Dacca & Aggartala, a 12-inch survey of the Manipur Road Base (in 12 sheets), and much work around ledos.

37. Arakan, Preparations for 1944.

The failure to take Akyab in 1943 necessitated very extensive preparations for 1944. Maps had to be provided for a Division on land, who were estimated to require 12,000 copies of all 1-inch maps, and for a sea-borne landing of two divisions (under GHQ India) who estimated their requirements as 20,000 copies. Requirements of 25,000 were about half as much.

After careful consideration it was decided to drop the photo-mosaics and to adopt a series of ordinary 1:25,000 maps. These were solidly prepared from Bawli Bazaar, north to Maungdaw, to Akyab inclusive, a series of 22 sheets, afterwards much extended to the north, East and SE. These are shown on Chart V.

The 1-inch maps were revised and reprinted to incorporate the air survey from which the 1:25,000 had been prepared, and block plots were also prepared to cover most of the area. In the Kaladan Valley, where only ½-inch maps existed, enlargements were made at the 1-inch scale. No extra detail was shown, but the larger scale was appreciated.

A photo mosaic of Akyab Island was prepared from rectified prints. This successfully eliminated the skewness of the grid, but the quality of the photography was indifferent and the 1:25,000 map was preferred.

38. Fourteenth Army Move to Comilla.

In November 1944 the Eastern Army changed its name to the Fourteenth Army, Lt. Gen. W.J. Slim was appointed Army Commander and the HQ moved to Comilla. At Comilla Survey secured an excellent camp site on a range of low hills near the village of Maynamati. There was one small house for the DD's office, and bashas were built for offices and living accommodation. The drawing and reproduction offices and some of the map depot bashas had cement floors, and the drawing offices were well designed with good windows and verandahs on the south side. Drawing offices covered 7,000 square feet and map depot bashas 8,000 square feet. This camp was originally intended for DD's HQ, one Rep Group, the combined air survey section and 155 (East African and Southern Rhodesian) Survey Company. This latter was a very large unit with 20 officers, 55 WOs and British NCOs and 444 Africans. It contained two presses, and all the officers and non-reproduction NCOs were reported to be trained in air survey.

155 Coy was expected in December, 1943 but there were prolonged delays (It eventually arrived in Apr 44), and it was therefore decided to bring forward all the remaining units from Calcutta except 22 Park and 34 Map Supply Section. The units moved in several echelons, the last arriving in Jan 44, and little loss of production occurred.

The move of the heavy vehicles was troublesome. Standing 12'4" high they cannot ordinarily go by rail, while at 14 tons they are too heavy for many road bridges and nearly all ferries, and there is no road from Calcutta into Eastern Bengal anyway. The route was by ship from Calcutta to Chittagong, special slings having to be made for loading and carried to Chittagong for unloading, and thence by rail to Comilla surreptitiously crossing a series of Class 9 bridges over the Fenni River.

36 Map Supply Section joined the Army in Nov 43 and opened the Comilla Map Depot.

39. Map Depots.

Before the move to Comilla, the Army's main map Depot was in the Kinnison Mill at Titagarh (see para 18) with a retail map depot at DD's HQ in Barrackpore. The Ranchi depot was holding stocks of southern Burma but most of its maps of northern and Central Burma had been either superseded or brought forward. The Imphal Depot held stocks (about 5000) in the Manipur and Chindwin areas, the Chittagong depot held small stocks of Arakan, and the Jorhat Depot held a reserve for Imphal and for local use.

With the opening of Comilla all stocks of Arakan and all of northern and central Burma not likely to be superseded before use, were brought forward. Ranchi soon contained nothing of value to 14 Army, and Titagarh was gradually brought to the same position.

40. Organization Jan 44.

With the reopening of the Arakan offensive in Jan 44, an AD Survey's HQ was raised for 15 Corps. Major R.C.A. Edge being appointed as AD Survey.

The West African Brigade Survey Sections joined the Army in advance of 81 (WA) Div in Oct 43.

Lt Col H.W. Wright handed over the post of AD Survey 9 Ind Fd Svy HQ to Lt Col C A K Wilson in June 42, Major Edge having carried out the duties of the post for the preceding 6 weeks.

In Oct 43 the old establishment of DD Svy and 9 Ind Fd Svy HQ were abolished and reformed into : -

- (a) A new DD's HQ on WEII/31/4.
- (b) 36 Map Supply Section.
- (c) 54 Drawing Section.

The new HQ contained DD, AD, DAD, Captain and Lieut, and in this, and all other essential respects, the reorganization introduced no change in duties. The Lt Col and Lieut remained detached from the rest of the HQ until they joined at Comilla. Even their separate existence was to some extent preserved with a view to future moves in two echelons.

The Survey organization of the Army in Jan 44 was thus :-

- (a) AD Svy 4 Corps (Lt Col I H R Wilson) controlling :-
 - (i) 6 Ind Fd Svy Coy. Up to strength except in air surveyors.
 - (ii) 33 Map Supply Section.

- (b) AD Svy 15 Corps (Lt Col R C A Edge)
 - (i) Detachments 2 Ind Fd Svy Coy.
 - (ii) 3 & 4 WA Bde Svy Sections.
 - (iii) Detachment 36 Map Supply Section.
 - (iv) B PZ Section.

- (c) AD at HQ. Lt Col C A K Wilson (known domestically as AD 9).
 - (i) 2 Ind Fd Svy Coy (less Air Svy)
 - (ii) 53 & 54 Drawing Sections.
 - (iii) 61 and 63 Ind Rep Groups
 - (iv) 22 Svy Park (at Dum Dum)

- (d) Combined Air Svy Section at HQ, all available air surveyors and attached draftsmen.

- (e) 34 (at Barrackpore) & 36 Map Supply Section.

PART III Feb – Nov 1944.

41. Summary.

This period covers the Japanese counter-offensives at Ngakyeauk and Kohima, the siege and relief of Imphal, the subsequent advance to the Chindwin and preparation for the reoccupation of Burma.

42. Arakan Feb-May.

As mentioned in para 37, the preparations in Arakan were massive, although nothing came of the sea-borne landings. 5 & 7 Ind Divs advanced southwards on Maungdaw and Buthidaung, while 81 (WA) Div advanced down the Kaladan River on the east flank, and 26 Ind Div was in reserve. On 3 Feb the Japanese counter-attack cut in behind 5 & 7 Divs, and 7 Ind Div HQ was overrun. The position was restored and the Japanese force destroyed by 26 Div coming in from Reserve and 36 Div being brought up from India. 25 Ind Div also moved in from India soon after.

During the advance on Maungdaw, RA Survey who were being employed for the first time, carried out a certain amount of triangulation (based on two primary stations which happened to be available) and their work provided an opportunity of checking the accuracy of the block-plot. Errors of up to 120 yards were found as was expected (see para 30), and revised coordinates of photo centres were issued. A new edition of the 1:25,000 map could not be issued in time, nor would the labour have been justified, but a skew-gridded edition was issued, showing the grid (in red) in correct relation to the topography.

Two RE triangulators worked in association with the RA Survey at this period, but their work illustrated the uselessness in this theatre of RA – RE Survey Cooperation of the orthodox kind.

When the Japanese counter-attacked, Lt Peters of 2 Ind Fd Svy Coy who was triangulating in 7 Div's forward area, had to evacuate his camp hurriedly. He and part of his squad then took part in the defence of the well-known 7 Div "Admin Box" at the east end of the Ngakyedauk pass. Hav Nautial, the 7 Div Recordkeeper was in camp when Div HQ was overrun and has since been missing.

The loss of 7 Div's maps in their HQ (subsequently recovered intact), the forward move of the reserve 26 Div, and the arrival of 25 & 36 Divs from India, put a strain on map stocks. Eight one-inch sheets and four 1:25,000 had to be hurriedly reprinted (10,000 copies), but the task was very comfortably within our plant's capacity.

Later in the season a section of 155 EA & SR Coy (see para 50) carried out some triangulation south of the Maungdaw-Buthidaung Road, but the discrepancies found were not such as to give the work much value.

A four-inch survey of the Maungdaw Port area was carried out, and all roads and paths in accessible forward areas were revised.

In May the Corps Survey Directorate and all survey units were withdrawn to Army HQ at Comilla.

43. 4 Corps, Kohima and Imphal.

In March the Manipur-Chin Hills area was held by 17, 20 & 23 Ind Divs and 50 (Paratroop) Bde, opposed by the Japanese 15, 31 & 33 Divs, and at the end of the month the latter opened their offensive along the Tiddim and Tamu roads and across the hills to Kohima, cutting the Assam-Imphal road and eventually surrounding Imphal.

To meet the situation, 5 Ind Div was flown from Arakan into Imphal, 2 Div (from India) and 7 Ind Div (from Arakan) moved into Assam largely by air, with 23 Bde of 3 Ind Div. HQ 33 Corps also moved into Assam to control 2 & 7 Divs and 23 Bde in their advance from Manipur Road to Imphal.

The rapid transfer of more than three Divisions into Assam and Manipur, the outbreak of heavy fighting in rear areas where large stocks were not being maintained, and the threat to areas further back whose stocks were very small indeed, put some strain on our printing capacity. Fortunately (for survey) the area was almost entirely one of half-inch surveys, as a reprint of 1-inch maps, four times as numerous, would not have been possible. During April, 25 half-inch sheets were hurriedly reprinted, a total of 340,000 maps (1,400,000 pulls), a weighty addition to other commitments. All were, however, delivered in time. In addition the Survey of India were asked to reprint and despatch maps of some threatened areas further back, but they were fortunately not required.

The operations for the relief of Imphal and the subsequent advance to the Kabaw Valley produced a demand for 1:25,000 maps and block-plots over a large area. Six 1:25,000 sheets were surveyed in April, 13 in May, 18 in June and 21 in July, after which the effort was diverted to areas further forward. See Charts VI and VII.

Some maps were surveyed by AD Survey 4 Corps in Imphal, where editions of 200-400 were immediately printed off on the hand presses, while the originals were flown back to Comilla where a normal edition (8000-12000) was printed), of which 4000 were at once flown back. The Comilla edition generally reached Imphal about 10 days after their own initial publication, an important delay as mapping had great difficulty in keeping ahead of the troops. Maps for 33 Corps, and some for 4 Corps, were surveyed and printed at Comilla, 1000 generally being flown to Manipur Road and a further 3000 being sent by passenger train.

To ease the supply position in Imphal 6 Ind Fd Svy Coy, less one section, was flown out to Comilla. This left AD Survey 4 Corps with his own HQ, A PZ Section (2 hand presses), 33 Map Supply section, and a Section of 6 Coy which contained all his air surveyors. Three extra air surveyors were also flown in from Comilla.

A section of 155 (EA & SR) Coy under Capt. Lincey was attached to 33 Corps during April and May to assist RA Svy up the road from Manipur to Imphal, but they had little opportunity of doing useful work. Their experience was, however, of value in that it put an end to waste of RE Survey resources in this way.

Lt J. Kerr with a small establishment was attached to HQ 33 Corps during April, May & June to control Map Distribution. See Para 45.

During the siege of Imphal, Survey units were much inconvenienced by changes of camp sites and by having to move the Map Depot. Perimeter defence also interrupted production.

44. 3 Ind Div & NCAC.

3 Ind Div was a formation of six Bdes (successors of the first Wingate expedition) of which four operated behind the enemy lines in northern Burma, and NCAC was an American-Chinese force under Gen Stillwell. These formations were both under command of 14 Army at this time, but NCAC had its own map supply organization, based on Chabua, and 3 Divs map demands were to some extent met by 11 Army Group.

The supply of maps for 3 Div was troublesome. At a late moment they asked for 300,000 maps which were to be trimmed to minimum size and waterproofed. The maps were mostly supplied from the Titagarh and Ranchi Depots, and sent to Delhi where the trimming and varnishing was done. They were then flown to the Div's air base at Sylhet, where 14 Army provided an officer to assist distribution. The varnishing was considered valuable, although not perfect. No more has since been done.

45. Base Map Production at Comilla

Apart from calls for 1:25,000 maps and reprints of 1" & ½" for current operations, the Comilla organization was busy preparing air-revised or "modernised" 1" and ½" maps of Burma north of Lat 21 degrees, against our eventual return.

All these maps would have been much the better for revision from air photographs, but shortage of air surveyors and also of the necessary photos themselves, prevented this. Including a few sheets done in 1943 and a little work carried over into 1945, but excluding Arakan, 25 1" and ½" sheets in northern Burma were completely re-surveyed from air photographs, 25 1-inch were extensively revised including redrawing of the whole sheet, and 49 1-inch were revised for serious changes and errors only.

In addition to the above, 95 1-inch & 53 ½-inch sheets were "modernised". This process of modernisation consisted of :-

- (a) Recasting old double-size sheets to the normal single sheet size.
- (b) Drawing communications in modern symbols.
- (c) Printing in 4 or 5 colours, instead of the two colours of the 1942 reprint.
- (d) Printing adequate quantities (16000 or 20000).

That all this work should have been done without the great improvement at small cost which would have been derived from a quick air revision was deplorable but unavoidable.

The above is illustrated in Charts III and IV.

During the year considerable extensions were made to the Arakan series of 1:25,000 maps both to the north of Maungdaw and south eastwards towards Myebon, a number of sheets were surveyed near the Chindwin Valley around Kalamyo and Mawlaik, and in September work was begun on a series of 1:25,000 maps in Burma from Kalewa to Ye-U and beyond.

46. Air photos.

During 1942 and 43 there were no arrangements for the provision of vertical "survey" photography in Burma, but a great change for the better occurred in Feb 42, when some Mosquitos at Dum Dum were fitted with K-17 cameras (9 x 9 plate, 6-inch or 12-inch focal length), with a Survey Liaison Section (an Army Group unit) at HQ Photo-Recce Force. Between April and November inclusive there is very little good photographic weather in Burma, and all that could be hoped for before April was 1:50,000 cover of most of northern Burma between Myitkyina and Rangoon. This was obtained and was of great value. To get this, demands for current operations had to be kept to a minimum. We avoided any serious waste of effort in Arakan, but the Japanese offensive in Manipur resulted in some unavoidable calls for photography there, both for 1:25,000 mapping and for block plots.

The 1:50,000 cover provided is excellent for revising the 1-inch map, provided it is clear. It is better than nothing for 1:25,000 and for block plots, but is a very far from satisfactory substitute for 1:25,000 photography for these purposes. For mapping, the 1:50,000 photos have in many cases been enlarged to 1:25,000. In hilly country with little detail but streams and contours, this gives a fair result, but in inhabited country with town and village details the result falls very far short of the standard required, unless large scale recce photos (not necessarily true verticals) are available for improving details by sketching.

47. Block Plots. See Para 34.

As soon as survey photography began to be available, from Kohima southward, block plots were provided for the advance of 33 Corps and for the 4 Corps battles around Imphal. It was not possible to get more than 3 sets of bromides from Dum Dum, so bromide copies were made at Army HQ by photo-graphing Dum Dum prints.

In April and May 875 photos were copied, 6100 prints being made. These prints were better than nothing, but of second rate quality. To improve matters for the future, arrangements were made for duplicates of the negatives to be supplied to Army or Corps HQ, where prints could be made as required, but eventually nothing came of it and Dum Dum has remained the source of supply for all prints.

In June 1944 a slotted template apparatus was obtained for the mechanical radial-line combination of photographs. It was used for many thousands of square miles, but the results were unsatisfactory on account of :-

(a) Absence of reliable trig data and difficulty in adapting the mechanical process to control by unreliable map points.

&

(b) The cardboard templates softened in the damp climate and so prevented the pins sliding properly in the templates.

48. Ground survey .

The detachment of 20 Party (Civil) continued to work in Eastern Bengal until Nov 44, when they left the area. The amount of work for them had been falling off considerably, and in November responsibility for all areas was handed over to L of C Command.

49. Map Distribution.

During this period Comilla was the main Army map Depot. Chittagong fed 15 Corps, and a gradually increasing Depot at Imphal fed 4 Corps, the latter presently being expanded into another depot at Palel to reduce risk of loss of all stocks. The Assam L of C was fed by a small depot at Jorhat, and for the operations for the relief of Imphal, map depots were temporarily opened at Manipur road and at 33 Corps HQ.

Distribution from Calcutta to Comilla and from Comilla Forward was normally by passenger train in lots of about 40 sacks (50,000 maps) in charge of sepoy courier. Large consignments of 200,000 maps or over were sometimes made by full wagon, and during the siege of Imphal and also towards the end of the year, some use was made of air transport, see Para43.

Rail transport along the Assam L of c, even with couriers, was always unreliable, and care had to be taken in giving the couriers letters addressed to all intermediate Movement Control Officers, and in circularizing MCO's asking them to forward all Couriers without delay and not to separate them from their consignments. Jan 44 was the worst month, in which 92,000 maps from many different Consignments went astray.

50. 155 (EA & SR) Coy. See para 38.

This unit eventually arrived at Comilla in April 44, having been preceded by a small advance Party from Ceylon in Feb. The Mynamati camp being filled they were accommodated in a camp on the same ridge of hills about 6 miles to the south. One section was detached to Arakan en route and another moved up to Manipur Road (paras 42 and 43), while half another section was detached from Ceylon, so the unit was much below strength until June.

It soon became apparent that the unit was too large for use with any one Corps under Indian conditions, and also that the proportions of non-technicians, and personal servants was too high. The unit was accordingly re-organized into a much smaller company (WE Estcom 201/66) two small reproduction Sections (WE SEA/94/1/44) of one press each, and an independent Air Survey Section (WE SEA/93/1/44). To simplify administration the smaller units were provided with Indian IORs instead of African. The total saving was 8 officers and 260 African ORs, with an increase of 65 Indian ORs. The substitution of 4 small units for one large made it much easier to place men where they were actually wanted.

The new units were known as 155 (EA & SR) Coy as before, 67 and 68 Rep Sec (Type C) and 17 Air Survey Sec. As the result of repatriation of BORs, 68 Rep Sec was not raised until Mar 45, and 17 Air Survey Sec remained 50% under strength throughout the Burma Campaign.

A number of surplus Africans were absorbed into a Map Supply unit (91 Map Depot) in Calcutta.

51. Stores.

Survey stores have throughout been obtained from the Survey Stores Officer at Dehra Dun, via 22 Park at Calcutta. The Park has generally held about 6 months supplies (except paper which is made locally) and it indents quarterly on the SOS. For normal consumable supplies Rep units have automatically received a monthly packet which is designed to cover their normal consumption. This packet has from time to time been modified:-

- (a) Temporarily to cover accumulation of deficiencies in unit stocks.
- or
- (b) Permanently as the result of experience or changes of practice.

The monthly packets of all units in the Army have been sent out from Calcutta in two or three wagons. The big item is 8 tons of paper per Rep Group, or about 25 tons a month for the Army.

From early 1943 onwards the store position has been good and crises have been comparatively rare. Especially, we have been fortunate in being able to get ample supplies of excellent paper direct from the Titagarh Mills at Calcutta.

Absence of spares for Lister Generators and Foden printing vehicles, unreliability of grainers and shortage of reliable arc lamps have been the worst store troubles.

52. Organisation.

(i) In Nov 44 15 Corps was detached from Fourteenth Army, coming direct under command ALFSEA. It took with it :-

- (a) A D Survey & his HQ. Lt-Col A J Seax.
- (b) The new 155 (EA & SR) Coy.
- (c) 68 Rep Sec Type G. (Not raised until March 45).

(d) 34 Map Supply Section, which was replaced in Calcutta by the new 91 Map Depot.

(e) The Bde Svy Secs of 81 & 82 Divs, which were reorganized into two Divisional Survey Sections.

(ii) Until the end of 1944 the Army was still much handicapped by shortage of surveyors trained in air survey, although improvement was gradually taking place as follows :-

(a) In Apr a section of 5 Ind Air Svy Coy was posted to the Army with one officer and 12 surveyors.

(b) 155 Coy brought in about 12 or 15 air-trained men, although few were available for air survey until June.

(c) A number of Indian surveyors and draftsmen were being trained in air survey within the Army and were picking up the work well.

In April 44 the distribution of air surveyors (excluding those of 155 Coy on other work in detached sections) was :-

Det 5 Coy	12
Army HQ	6
155 Coy	3
With 4 Corps	7
With 15 Corps	2

By the end of the year, the Army was in fairly good balance, the proportion of air surveyors, semi-trained air surveyors and ordinary draftsmen and surveyors being about what is suitable, namely equal numbers of each.

(iii) 6 Ind Fd Coy returned to Imphal from Comilla in October.

In 15 Corps Lt. Col Biddle relieved Lt-Col Edge as A D Svy in May, but it was soon afterwards decided to keep the post of A D Surveys in abeyance during the rains, and Lt.Col Biddle returned to S Army. Lt Col A J Seax was appointed A D Survey when the 15 Corps Svy Directorate re-opened in October 1944.

In July 1944 the 4 Corps Svy Directorate was transferred to 33 Corps when the latter took over Imphal and 4 Corps moved out to Ranchi. In September Lt Col I H R Wilson, A D Survey 33 Corps, was transferred to the Air Survey Directorate in S India, and was replaced by Lt Col C A Biddle in October.

Col G Bomford and Lt Col C A K Wilson remained as D D Survey & A D Survey at HQ throughout the year.

(iv) In Aug 44 66 Rep Group, which had been in the Army since Dec 42 was exchanged with 61 Rep Group from S India.

53. Advance to the Chindwin.

At the end of Nov 44 Army HQ moved from Comilla to Imphal, with 4 & 33 Corps under command. The Army Survey HQ moved with them, preceded by 67 Rep Sec and followed during the next 2 months by all the units and useful map stocks in Comilla, thus turning Imphal into the Army's main map production centre and map supply base.

During the monsoon 5 Ind Div advanced southwards to Tiddim and Fort White, while 11 (EA) Div moved down the Kabaw Valley from Tamu. The two Divs met and captured Kalemio in Nov 44.

5 Div moving through the Chin Hills only had old ½-inch maps, except that 1:25,000 or 2-inch maps covered the whole length of the road. Southwards from Tamu to within 25 miles of Kalemio 11 Div had no 1:25,000, but was provided with recently revised 1-inch maps.

PART IV – Dec 1944 to May 1945

54. Summary.

This period covers the advance into Burma, the destruction of the Japanese 15th, 28th & 33rd Armies, and the capture of Mandalay and Rangoon.

55. Military Narrative.

(i) In December 5 Ind and 11 (EA) Divs (33 Corps), who had captured Kalewa and crossed the Chindwin. These two Divs were then withdrawn for rest while 2 Div passed through along the road to Ye-U. 20 Ind Div which had come down the Chindwin from Mawlaik crossed the 2 Div's line of advance and made for Budalin & Monywa.

(ii) In the meantime 19 Ind Div (originally 4 Corps) crossed the Chindwin and advanced rapidly through Pinlebu and Banmauk to the railway at Wuntho, making contact with 36 Div (NCAC) near rail Indaw. They then passed under command 4 33 Corps and moved southwards to Shwebo.

- (iii) By Feb 33 Corps had reached the line Monywa (20 Div) - Sadaung (2 Div) – Kyuakmyaung (19 Div) where a small bridge-head was formed across the Irrawaddy. This Corps also contained 254 Tank Bde & 268 Ind Inf Bde.
- (iv) During Jan & Feb 4 Corps with 7 Ind Inf Div Leading, followed by 17 Ind Div, moved down the Myitha Valley to Gangaw and thence towards Pakkoku. 17 Div with 255 Tank Bde then crossed the Irrawaddy near Pagan and moved rapidly to Meiktila, where it was presently reinforced by 5 Ind Div. 26 (EA) Bde held the right flank on the west side of the Irrawaddy.
- (v) In March 20 Ind Div & 2 Div crossed the Irrawaddy and turned eastwards on Mandalay, which was entered by 19 Ind Div from the North, Maymyo having already been captured. Heavy fighting developed in the area Mandalay-Meiktila-Myingyan during which the back of the Japanese army was broken.
- (vi) In March NCAC (36 Div & Chinese) had captured Lashio & Hispaw. 36 Div then came under command 14 Army, moved south through Mandalay and advanced Kalaw. It was then flown out to India. 2 Div and 28 (EA) Bde were also flown out in April.
- (vii) In April the Army regrouped. 5 & 17 Divs with 255 Tank Bde followed by 19 Div moved rapidly southwards from Meiktila. After heavy fighting at Pyawbye the Japanese Army became disorganized, and Pegu was reached by 1 May. On 2 May 26 Ind Div (15 Corps) landed in the Rangoon River and occupied Rangoon without opposition on 3 May.
- (viii) While 5 and 17 Ind Divs moved south from Meiktila, 33 Corps (with 17 & 20 Ind Divs and 254 Tank Bde) advanced on the Yenangyaung oilfields, Magwe and Prome, joining up with 26 Div in the middle of May.

56. Survey Tasks.

During the operations Svy's main tasks were : -

- (a) Surveying and printing 1:25,000 mps.
- (b) Completing some 1-inch revision, and reprinting 1-inch maps as stocks ran out.
- (c) Map Distribution. The most important and often the most difficult task.
- (d) Preparation of block plots.
- (e) Ground surveys and levelling for airfields in forward areas.

Details are given in paras 58 to 65.

57. Organization.

While Army HQ had been in Comilla, with Corps in Imphal and Arakan an AD Survey had been necessary in each Corps. When 15 Corps passed out of the Army and both 4 & 33 Corps concentrated around Imphal, a new Corps Svy Directorate was raised for 4 Corps, but the post of AD Survey was kept in abeyance.

The Survey organization was then :-

- (a) At Army HQ. DD Survey (Col Bomford), and AD Survey (Lt Col Biddle) (nominally 33 Corps), with units as below :-

Army Directorate
67 Rep Section (one press)

1 Section 5 Ind Air Svy Coy
B PZ Sec.
Detachment 6 Ind Fd Svy Coy
Detachment 33 Map Supply Section.

- (b) At Imphal. (Initially partly at Comilla. Concentrated at Imphal in Feb and March. All moved to Myingyan in April 45).

AD Svy Lt Col C A K Wilson
2 Ind Fd Svy Coy
6 Ind Fd Svy Coy, less considerable detachments.
53 & 54 Drawing Sections
61 & 63 Ind Rep Groups (4 presses).
A PZ Section
17 Air Section.
33 & 36 Map Supply Sections.

- (c) With 4 Corps. Capt (Svy), Capt A N Barker, relieved by Capt Fort in March, with part of 4 Corps Svy HQ and a detachment of 6 Coy (Capt Birrell) for airfield surveys.

- (d) With 33 Corps. DAD Svy (from Army HQ) Major J F F Lathbury with part of Corps Svy HQ and a detachment of 6 Coy (Capt E du R Botha) for airfield surveys.

Army HQ moved successively from Imphal to Indaingyi (Jan) to Manywa (Feb), to Meiktila (April), and to Rangoon (May).

The move of the main production and supply centre from Imphal to Myingyan took place in five flights by road and river in L of C transport, and in three flights of Survey transport. The guiding principle was that not more than half map socks and two presses should be out of action at any one time.

The total survey strength of the Army at this time was 33 officers and 1070 VCOs and Ors, the latter including 86 BORs and about 170 VCOs and Havildars.

58. 1:25,000 Maps.

Starting in Sep 44 a series of 1:25,000 maps were begun which eventually extended southwards to Nyaunglebin (85 miles NE of Rangoon) & Prome, where they joined a series of 1:25,000 maps known as Hind 601 series prepared in India for a possible landing in the Rangoon area. Apart from a break of 8 miles at Imphal and another of 15 miles north of Myingyan, and a stretch along the Tiddim road where the scale was 1:31,680, the 1:25,000 sheets prepared between April 44 and April 45 thus extended continuously from Manipur Road in Assam to Rangoon. During May 45 the series was extended to Moulmein and beyond it to the Siamese frontier near Kawkaeik. This work is illustrated in Charts VI and to XI.

These maps were made at high pressure a short distance ahead of the troops. Sheets were very seldom ready a month before they were required, and were sometimes delivered with a margin of only a few days, but of the sheets completed in 14 Army, not more than 2 or 3 were delivered too late, although about a dozen sheets which had been started were dropped before completion.

This lateness in preparation was not wholly due to lack of resources. Unless resources are almost unlimited it is essential to work closely ahead of the advance, or else an undue proportion of work goes into sheets which never get used. The Hind 601 series is an example. The Army passed through this great series of 188 sheets against slight opposition in a matter of days. If it could have been planned on the spot closer to the date of the operation, the actual lines of advance would have been covered by a series of 60 sheets, with much saving in surveying and printing, and with a greater hope of effective distribution.

Attempts were made to get over late changes of plan by getting help from India, but it is very difficult to lay on short-notice work at such a distance. Southern Army produced 12 sheets for us near Pakkoku & Chauk of which most arrived in time (the operation having been delayed a fortnight), but 14 sheets prepared by US Topo Bn at Dehra Dun, covering the railway south of Wuntho, arrived a few days too late. Even in the 601 series, which had been surveyed in good time, there were many cases in which stocks or kodelines for local printing arrived too late for distribution.

Many of the early sheets were made from 1:50000 photos enlarged to 1:25,000, much loss of quality resulting, but south of the Irrawaddy (and in many cases north of it) 1:25000 photos became available in time.

59. 1" Maps.

The 1-inch map of Burma north of Lat 21° had been got into fairly good order before the advance started, although about 25 sheets remained to be finished off during the period. 16,000-20,000 were printed, and this generally proved to be sufficient except where a proportion of the stocks had had to be sent out to NCAC. South of latitude 21° revised 1-inch maps had been prepared in India, and sufficient stocks were generally provided, although about 36 had to be reprinted locally to make up stock. The unexpectedly rapid advance to Pakkoku and Meiktila brought on a crisis, and for some days we had no 1-inch map 15 miles ahead of the advance, but they arrived just in time.

60. Distribution.

All available maps likely to be required were concentrated at Imphal, where presses were producing new maps and were available for reprints if required. Until 20 April all distribution was direct to Divs and sometimes Brigades by air. Corps Svy Captains kept Divs informed of what was available and Divs signalled their requirements direct to the Imphal Map Depot and to the RAMO (Rear Airfield Maintenance Organization) responsible. Maps were then flown to them, generally the next day, with their mail, ammunition, rations etc.

As the Army advanced, Divisions began to depend more on RAMO's in Chittagong and Akyab, and supply from Imphal would have eventually become impossible, but until April 20th, when the Myingyan Map Depot opened, all Divisions were getting at least some supplies from Imphal and no difficulty arose.

At the beginning of April half stocks of all the Imphal maps were sent forward to Myingyan, by road to Kalewa and thence by river, followed by the other half as soon as the first had arrived, and Myingyan map depot opened as the source of supply on 20 April. Supply from Myingyan, except in special emergency, was by road, via Corps HQ.

Until the end of April, maps prepared in India were railed from Calcutta to Manipur Road and thence forwarded by road to Imphal. In May, when Imphal closed, maps were shipped from Calcutta to Chittagong and thence flown to Myingyan. In the first half of May, 20 tons of maps were so supplied, after which little remained to come.

For the advance on Rangoon, a special reserve of a 1000 copies of each map under 4 Corps control was opened at Meiktila, in case supply from Imphal should break down before Myingyan opened. For this and other and other similar large transfers special full-loaded Dakotas were obtained.

The tonnage of maps sent out to Divs & Corps troops between Dec & April was as follows:

	By air	By road
Dec 44	4 tons	11 tons
Jan 45	12 tons	½ ton
Feb 45	21 tons	1 ton
Mar 45	27 tons	8 tons
Apr 45	24 tons	12 tons
Total	88 tons	32 ½ tons

These figures exclude the transfer between depots during April of 15 tons by air and 110 tons by road and river. 30,000 maps weigh one ton, so the forward troops' consumption of maps for the advance from Kalewa to Rangoon (450 air miles) was 3,500,000. The Army averaged the equivalent of 6 Divs in the line, so this gives a consumption of 120,000 maps per Division per month, with a similar quantity in addition transferred forward, but not actually issued.

61. Block Plots.

The absence of 1:25000 photography (see para 46) made the supply of block plots impossible until the new year's photography began to come in. (Note a 1:50000 block plot is not much valued when a 1:25000 map exists) No block plots were thus available for the capture of Kalembo and Kalewa, and in the advance down to Ye-U & Swebo the troops soon outstripped the block-plots being prepared from newly received photos.

By the time the Irrawaddy crossings were made, block plots were available all along the Irrawaddy and supply remained easy during all the fighting around Mandalay and Meiktila, and for most of the advance to the south, 4 Corps got the block plots as far as Rangoon, but 33 Corps ran off theirs at Magwe. The subsequent fighting was however so slight that they were not required.

It was generally possible to supply 8 sets. But sometimes only 5 or 6.

62. Photomaps.

American enthusiasm in the Photo Recce Force reintroduced photomaps south of Mandalay, and a considerable number were prepared by PRF and sent forward. They were welcome as insurance against it not being possible to prepare 1:25000 line maps, but in point of fact the latter did not get made and the photo maps were little used.

Difficulty was experienced in getting the photomaps grid to agree with the 1-inch and 1:2500 maps, and an arbitrary one inch square grid was therefore printed on them.

63. Gridded Vertical Photographs.

For liaison between those who can identify a target and those who deal with it, air photos supplied to troops and RAF require some kind of reference grid. This can be either an arbitrary 1-inch grid, or alternatively the theatre grid can be transferred to the photo. It is arguable which is best, but practicability of supply has enforced the general use of the arbitrary grid. Photos with the theatre grid were issued in a small experimental area around Sagaing, but when the time came there was only light fighting there.

64. Defence Overprints.

Very slight use was made of defence overprints, since in the jungle enemy defences are not visible and in the dry belt operations moved too fast. A few were prepared in the oilfields area.

65. Ground Surveys.

In an advance, ground survey can do nothing to improve the maps on which fighting is done, and no such work was undertaken. Each Corps was provided with a survey detachment of one officer, a computer and 3 to 5 surveyors for surveying airfields and possible cooperation with the RA. These airfield detachments proved very useful and they were almost continuously employed levelling and surveying (at 6" or 8" scale) new light aircraft and Dakota strips.

The RA called for no assistance, although a little triangulation was carried out, but not used, for 2 Div's Irrawaddy crossing.

66. Summary.

The preceding four Parts cover the history of the campaign. The remaining two parts comprise statistics and the lessons to be learnt

PART V. Statistics.

67. The Charts

illustrate the work done as follows : -

Chart I shows the state of survey in Eastern Bengal, Assam and Burma in Jan 1942.

- (a) Red. Modern 1"
- (b) Blue. Old 1" published in double-sheets.
- (c) Yellow. Only 1/2" available.

Areas to the north and east were covered by 1/4" maps.

Compiled 1/2" maps covered most of the area covered by 1-inch surveys, but 68 sheets remained to be compiled.

Chart II shows the location of ground surveys at a scale larger than 1:25,000 carried out by Eastern & 14 Armies and associated civil detachments. Where the area is small it is indicated by a red dot, larger areas of survey being given their correct outlines. Typically, a red dot indicated 1 or 2 square miles of 16" to 8" survey, while the larger areas will generally have been covered at the 3" to 6" scale.

A few surveys were carried out beyond the limits of this index but not many.

Chart III shows work done on 1-inch maps.

- (a) Red solid. Original air survey.
- (b) Red cross. 75% or more resurveyed from air photos.
- (c) Red diagonal. Hurriedly or partly revised, generally from air photos.
- (d) Yellow. Modernised. See para 45.
- (e) Blue cross. Drawn elsewhere & printed in 14 Army.
- (f) Blue diagonal. Printed elsewhere.

Some sheets in items (b) & (c) went through 2 or more editions as additional revision material was obtained.

Chart IV shows work done on 1/2" and 1/4" maps in 14 Army.

- (a) Red solid. 1/4" & 1/2" modernised & printed in 14 Army.
- (b) Blue solid. 1/4" & 1/2" reprinted with little change in 14 Army.
- (c) Blue diagonal. 1/2" compiled from 1" (see para 13), & not subsequently modernised.

Other sheets were printed by the S of I in black and brown in 1942.

Charts V to XI show 1:25,000 maps.

- (a) Red solid in corner. Prepared by 14 Army.
- (b) Red bar in corner. Prepared elsewhere and printed by 14 Army.
- (c) Blue solid in corner. Prepared & printed elsewhere.

68. Air Survey and printing.

The table below shows the totals completed each month of the following : -

- (a) 1:25,000 sheets surveyed from air photos.
- (b) 1" or 1/2" sheets surveyed or revised from air photos in whole or part.
- (c) Different Maps of all kinds printed.
- (d) Copies of maps printed.

None of these classes of work were done before Dec 42.

Month	1/25000 Air Survey	1" & 1/2" Air revision	Standard sheets printed (1:25,000, 1", 1/2", 1/4")	Other maps printed	Machine pulls	Copies printed

Dec 42	-	-	-	-	-	-
Jan 43	3	-	1	8	21,000	7,000
Feb	-	3	5	-	202,000	66,000
Mar	11	5	13	3	373,000	136,000
Apr	-	-	6	-	324,000	83,000
May	1	2	9	14	625,000	153,000
June	3?	2	17	6	852,000	258,000
July	1	3?	13	11	757,000	180,000
Aug	6	1	16	23	1,189,000	295,000
Sep	8	9	22	18	1,481,000	397,000
Oct	-	4	25	85	1,204,000	373,000
Nov	4	3	21	45	1,188,000	329,000
Dec 43	2	5	22	53	916,000	200,000
Jan 44	4	2	32	45	1,575,000	438,000
Total 18 months	43	39	203	311	10,707,000	2,914,000
Feb 44	6	-	27	114	1,400,000	386,000
Mar	8	8	30	71	2,027,000	543,000
Apr	10	4	44	56	2,104,000	532,000
May	16	2	46	76	1,823,000	542,000
June	18	5	36	39	1,996,000	492,000
July	21	12	43	36	2,219,000	536,000
Aug	6	18	41	39	3,021,000	663,000
Sept	7	9	43	63	3,076,000	705,000
Oct	15	7	42	61	3,114,000	697,000
Nov 44	32	2	62	65	2,484,000	592,000
Total 10 months	139	62	413	620	23,264,000	5,688,000

Month	1/25,000 Air Svy	1" & ½" Air Revision	Standard sheet printed (1:25,000, 1", 1.2", ¼")	Other Maps printed	Machine pulls	Copies printed
Dec 44	26	6	59	51	2,882,000	638,000
Jan 45	38	7	87	75	2,581,000	591,000
Feb	41	13	64	61	1,998,000	469,000
Mar	52	5	97	89	3,002,000	689,000
Apr 45	28	-	84	48	2,369,000	520,000
Total 5 months	185	31	391	324	12,832,000	2,907,000
Grand total 28 months	377	132	1,007	1,255	46,803,000	11,509,000

Of the 1,007 1:25000, 1", ½" & ¼" sheets which have been printed, 509 have been surveyed or revised from air photos (Cols 2 & 3), while the balance of 490 sheets have either been modernised without air revision or reprinted without correction.

The 1255 other maps prepared include RAF Target maps, photomaps, town plans, large scale maps of airfields and installations, and overprints showing defences, dispositions, communications, forest boundaries, malarial belts etc. Non-topographical plans and diagrams are excluded from this total.

In addition to the 1 1/2 million maps printed within the Army, about 2 1/2 million maps of Southern Burma (1" and 1:25000) were received from India in Feb to May 1945, and about 1 million of the Survey of India's 1942-43 black and brown reprints (para 7 & 18) were at one time or another sent forward from Calcutta. The total of maps made within the Army, or made outside and sent forward of Calcutta was thus about 15 million. Of these, 3 1/2 million were issued to Divisions during the last five months of the campaign, but monthly consumption during the previous 2 years had been very much less.

As a rough estimate it may be said that half and two thirds of the 15 million maps supplied were actually issued to the troops, and the rest had either been superseded by new editions before issue, or remained in Depots at the end of May 1945. These figures exclude 1:1,000,000 and 1:500,000 maps prepared in India and principally sent forward for use of the RAF.

PART VI Lessons.

69. Warning.

The lessons learnt in any one campaign are not necessarily applicable to any other, still less to the next war. They must be read in relation to the particular conditions under which they have been learnt, and their permanent value is to indicate the factors which require consideration. Under different conditions the factors must be differently weighted and different conclusions may result.

In the following paras lessons learnt in Eastern & 14 Army in 1942-45 are grouped under the general heading "Organization", "Maps", "Distribution", & "Miscellaneous Technical".

A. Organization.

70. Organization in Peace.

The first lesson, learnt more in the years 1939-42 than in 42-45, but conveniently included here, is that there must be a regular full-time military survey service in peace. This did not exist before 1941 and the resulting troubles have been grievous. If the war had come to India less gradually, the result would have been disastrous. Even in 1942 paras 2, 5, 6, 8, 11, 12 & 16 of this report show that much remained to be done.

Troubles resulting from there being no military service in peace included the following : -

- (a) War Establishments in 1939 (on mules and with practically no printing power) had no relation to probable needs.
- (b) We had no doctrine (bearing any relation to facts) about what the probable employment of the survey service would be.
- (c) Officers and men in the civil survey department (including officers of the regular army_ had no, or practically no, knowledge of military organization and routine procedure. There was no military training, and no realistic survey training.
- (d) The Army had no knowledge of the Survey Service: what it can do for them, and what facilities it requires in return.
- (e) It was no one's duty to collect maps and other survey data of adjacent countries, and still less to study them.
- (f) The civil department had no knowledge of map printing under field conditions, and very few officers had any knowledge of printing at all.
- (g) Map distribution had never been considered.
- (h) A depot, the terms and conditions of service, and a stores organization had all to be improvised.
- (i) Recruitment was wholly dependent on civilians volunteering for work under military conditions, which they were under no obligation to undertake. The response was actually good, but it very well might not have been.

It is not suggested that a future military organization can exist independently of the civil survey Department. The cost would be prohibitive. But there must be a survey planning and training Directorate responsible directly to GHQ (India) rather than to the Surveyor-General and the Department of Education, Health & Lands. There must exist at least one or two regular survey units with no duties other than training for war and experimenting with methods and equipment. And a large proportion of the members of the Civil Department must be persuaded to accept a binding obligation to serve in the Army when called on.

71. Chain of Responsibility.

Early in the war, the Survey Service was run more or less as a private army under the Surveyor General. The Surveyor General's functions gradually passed to the Director of Survey at GHQ, but the latter drew his pay from, and held a post in, the civil Department. In 1942 and 1943 the DD Survey in Eastern Army was as much

the deputy of the D Survey at GHQ as a member of the Army Commander's staff. This is all wrong. A DD Survey at Army HQ is primarily the servant of that HQ. His responsibility is to the Army Commander and not to the Director of Survey. This has at last come to be the actual state of affairs, but not without friction within the Service, which could have been avoided if the principle had been accepted from the beginning. The same applies to the relations between DD Survey and AD's Survey at Corps HQ's.

72. Service versus Cost.

The duty of the survey service is to render maximum service to the Army at minimum cost, and proper enthusiasm for maximum service must not lead to neglect of the question of cost. A survey service which butts in here it is not wanted may be a greater loss to the Army than one which fulfils its essential duty of providing maps, but which lets a certain amount of non-essentials slide. Cost takes the form of :-

- a. Transport lift for men and equipment and their maintenance. This is especially unwelcome in forward areas.
- b. Road space and camp space.
- c. Security. Survey must have advance information, but the risk of leakage is an item in the Service's cost.

One of the DD's chief problems is the maintenance of a proper balance between service and cost.

73. Tasks.

The duties of the Survey Service are :-

- (a) The making or procuring and revising of maps, and their distribution. All other duties are trivial in comparison with this the main task.
- (b) The surveying of airfields and sites for other installations.
- (c) The preparation of block-plots, and of theatre-gridded verticals (para 63) if the latter are required. But not the actual provision of the photographs.
- (d) The provision of tidal and beach gradients information for combined ops.
- (e) The drawing and printing of defence overprints, but not the interpretation of photographs for this purpose.
- (f) The printing of plans and diagrams drawn by staff and services for their own purposes. Assistance may be given with drawing, but that is not a Survey duty.
- (g) The provision of trig data for the R.A. See para 95. Doubtfully included. Also the fixing of AA sites.
- (h) The guiding of troops, where absence of maps or of natural feature makes it impossible for troops to find the way themselves. This will seldom or never arise in SE Asia in the present war, and still less so in the next.
- (i) Perimeter defence of their own installations.
- (j) When the role of the Army is the preparation of defensive positions, as in Iraq in 1941-42, there may be great scope for ordinary ground survey and triangulation.

74. Relations with the General Staff.

In an Army HQ, the DD Survey is responsible to the Chief of Staff (BGS), not specifically to either the Ops or I Branches. In practice in 14th Army DD Survey has obtained his information indiscriminately from Ops, I and Plans, checking over his programme with the BGS once or twice weekly. On principle, though we have never done it in 14 Army, it is desirable that some one officer (probably G1 Ops) should be charged with the duty of seeing that DD Svy receives all information which it is necessary for him to have.

In a theatre as well mapped as SE Asia, it is practically never necessary for DD Survey to attend a conference, in the true sense of the word, namely a meeting at which plans are discussed and decisions made as to what is practicable. This is because Survey should always be able to supply minimum essentials whenever required, and no operation should ever be influenced by a "Cannot be done" from Survey.

On the other hand it is most essential that survey should get the earliest possible news, not only of what is decided on, but of the various plans that map possibly be put into operation. The latter are most important, for hard experience has shown that putting all resources into the plan of the moment, to the exclusion of alternatives which probably get adopted later, will result in misfortune. Survey must prepare for all possible plans, with only quite a slight bias towards that currently accepted. The extent to which he should legislate for changes if plan is another of DD Survey's chief problems. The Staff will generally press too strongly for all to be concentrated on the current plan.

Close relations with Q(Ops) are also essential for map distribution purposes.

75. Administrative duties of DD.

The DD Survey does not command the survey units, but in 14 Army there are certain administrative matters for which heads of arms and services have specifically been made responsible (in the position of Bde Comdr) in respect of Army Troops. These are :-

- (a) Postings and inter-unit transfers.
- (b) Honours and Awards.
- (c) Leave.
- (d) Repatriation and release.

Additions to the list may be unavoidable, but they are not desirable.

76. Unit WE's and organization.

Survey tasks are extremely variable, both in their nature and magnitude, and the first essential of all organization is flexibility. No WE's that can be got out are likely to fit all varying circumstances and temporary modifications must be possible, in units and sub-units, by some easier means than amendments to WE's.

The guiding lines should be :-

- (a) Keep HQ WE's on the large side and attach temporary surplus to some unit.
- (b) Keep the Survey Company as small as possible, in the hope that it will not have to be broken up, and hold independent drawing sections, air survey sections, and ground survey sections (if their use appears probable), for attachment to Coys as and when their tasks demand it.
- (c) Keep printing outside the Coy. A Corps may welcome a Svy Coy, when it may not welcome a printing establishment or when the latter may not be likely to get full time employment in Corps.
- (d) Retain PZ Sections for use in Corps and to relieve machine press groups of small miscellaneous jobs.
- (e) Use small Map Supply Sections rather than a large Map Supply Coy.
- (f) Keep the main body of printing and drawing as far back as circumstances admit, under the control of an AD Survey (Rear), who should be the most capable officer in the Army, and feed Corps with minimum survey troops, which may or may not amount to a whole Company.

To give effect to this policy it is necessary that units and sub-units should be trained and accustomed to having attachments and detachments continually made in a large way. Only by so doing can resources be accurately fitted to tasks, and useless mouths be kept out of forward areas where they are not wanted. With fighting troops, where unit morale is an overruling consideration, this ideal may not be practicable (although the Jap army do it), but with surveyors working happily at their own trade it can be done, and for the last three years, it has been done in this Army. To object is to admit an unnecessarily low standard of training.

77. Organisation of Survey HQ.

When the Army survey is divided into a small forward echelon with Army HQ and a large production centre in rear (as in para 76f), the organisation to control them has been:-

- (a) At Army HQ
 - DD Survey.
 - A D Survey for liaison with Corps (if Corps have no ADs), and for control of units at HQ.
 - DAD or Captain i/c Map Distribution.
 - Captain or Lieut i/c Air photos & records.
 - Lieut for administration.

The minimum units necessary at Army HQ comprise:-

- (a) An Air Survey Section with some attached draftsmen.
 - (b) A small (one press) Rep Sec.
 - (c) A PZ Section is convenient.
 - (d) Part of a Map Supply Section.
- (b) At Rear Survey HQ.
 - A D Survey
 - DAD or Capt M R P
 - Capt Map distribution (may be CC M.S.S)

Capt or Lieut Admin.

The W.E. of Army HQ is insufficient to staff both Rear and Forward HQs and attachments have to be made from units.

78. AD's Survey.

A Ds Survey are required:

- (a) At Survey Rear HQ
- (b) At Survey Forward HQ if Corps have not got A Ds
- (c) At Corps HQ only if the Corps has a reasonable number of Survey troops attached such as:-
 - (a) 1 Fd Svy Coy
 - (b) 1 Rep Group
 - (c) 1 Map Supply Section.

Otherwise it is sufficient to have a liaison Captain or DAD.

See the organisation in Jan 44 (para 40), and Jan 45 (para 57). In both these cases the organisation was satisfactory although the existence of an A D Survey 15 Corps in Jan 44 was a borderline case. An A D Survey was of course essential in 15 Corps after its separation in Nov 44 (para 52).

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79. Transport.

The following are the characteristics of transport supplied:-

- (a) Jeeps. Essential for touring officers, station-station running, small map deliveries and field survey under exceptionally difficult conditions.
- (b) 15 cwt 4x2. Almost useless in a wet climate.
- (c) 15 cwt 4x4. For field survey work.
- (d) 3 ton 4x2. Necessary for unit moves and for map supply when air transport is not practicable but it may be hoped that such moves will be along good roads.

In general, survey units should have enough transport to move them. To move 14 Army rear echelon requires 180 3-ton lorries in addition to unit transport and to lock this up for occasional work is absurd.

The Army Survey collectively requires:-

- (a) Enough Jeeps and 15 cwt 4x4 for field work with some extra at HQs.
- (b) Enough 3-ton lorries for station duties (rations and firewood), map deliveries and for the move of delicate and awkward loads (cameras, chemicals etc) which require to be driven with special care.
- (c) Ample spares.

80. Arms

Forward detachments must be armed and some arms must be carried for local defence of installations. Of late, all ranks have been armed, probably rightly, but it is worth putting the following on record:-

- (a) Own losses as a result of being armed
 - Killed 3
 - Wounded 1
 - Under arrest 1 for murder

1 for manslaughter

(b) Enemy losses	
Killed	Nil
Frightened	Nil

Arms do, however, have a moral effect and one cannot avoid them.

B. Maps

81. To be made in or outside the Army?

An Army which looks to a rear organisation in India for the preparation of maps at short notice is going to suffer anxiety, if no worse. An Army which prepares its own maps on the other hand knows where it stands.

It must of course be admitted that it will seldom be practicable for an Army to carry sufficient survey units to make all its maps. Layered 1:1,000,000 and 1:500,000 must be prepared outside and even 1-inch maps may have to be. And it is in any case comfortable to feel the existence of a large reserve in rear which can be called on in an emergency.

The point, however, is that maps prepared outside must be delivered to the Army in good time, preferably 3 months before they are required. Para 58, 3rd and 4th sub paras, gives examples of short term survey farmed out to India, additional items of difficulty being marginal adjustment and the despatch of photographs. Even maps such as the 1" and 1:25,000 around and north of Rangoon, which had been surveyed in Southern Army months before they were required, led to crises owing to delivery having been run very fine. Transport of some millions of maps from Bangalore to 14 Army via Imphal (or by air via Chittagong to Myingyan) presents serious difficulties and, when it is not known when and where maps will arrive (except that they will be only just in time), the planning of their quick distribution on arrival presents very grave difficulty. Disaster was avoided but it was sometimes a very near thing (para 59) and maps known to be en route often had to be hurriedly printed in Army, from BPOs to make sure of delivery in time.

Since it is generally impracticable to prepare 1:25,000 maps far in advance (para 58 3rd sub para), it follows that they must generally be prepared by Army. Smaller scales can be accepted from outside, provided that they are delivered in really ample time

82. Map Scales.

All admit the necessity for 1:1M and ¼" (or 1:250,000) maps and the desirability of 1:500,000 and 1:25,000. Controversy however centres around the ½" and 1" (or 1:100,000 and 1:50,000). There have been two schools of thought:-

(a) Those who say "Make a ½" or 1:100,000 and then put all your resources into 1:25,000"

&

(b) Those who say "Give us a 1 Inch or 1:50,000 map and we can get along. If you have resources left over, give us a 1:25,000 where you can"

Of these two schools the first is the best, if survey can thereby guarantee to provide a 1:25,000 absolutely wherever there is going to be anything more than skirmishing. The advantage of the second course is that the war can get along with a much smaller amount of 1:25,000, if that is unavoidable. It is, however, now generally recognised that a 1:25,000 is not far short of being essential, and anyone proposes to limit it to small areas will not be going far towards meeting the Army's needs.

It is not possible to make a general recommendation on the subject, which must be judged independently for each campaign in the light of the survey, printing and distribution resources and the mapping material available. If a 1" map exists, it would be hard to justify not printing it. But when no map previously exists, 1:100,000 and 1:25,000 may be the best target.

In Burma we have been fortunate in being able to supply a one-inch everywhere (outside the Chin-Naga hills), and a 1:25,000 almost where ever required. In addition a rather inferior ½ inch map has been available as insurance against failure to make or distribute the larger scales. As in all other matters, the DD Survey must insure and doubly insure against the unexpected.

Half inch maps are in some demand as wall maps at HQ's and armoured formations also have some liking for this scale.

83. Scales of issues and print orders.

The scales of issue have normally been :-

¼ inch 1500 per Div, but often not drawn in full.

1" 1500 per division.

1: 25,000 1000 per division.

Independent brigades have about one third as many and corps troops generally a little less.

This is not at all a generous scale and Divisions have sometimes asked for 2000 or 2500, but the figures of consumption in para 60 are such as could not easily have been much increased. Demands for replacement of wastage have been very small, on account of speed of movement, but intense operations in one area involving all units of the division continuously would probably necessitate a new issue every two or three months.

Much waste has occurred through Divisions drawing maps of areas in which they may possibly have been going to operate, and then actually have not, but one cannot afford to run the risk of discouraging this, and Survey have always been glad to map up any Division with as large an area as it is prepared to carry. The only remedy is a perfect system of distribution, which cannot go wrong, and in which all have confidence, but it is easier to print double map stocks than to promise that.

When framing printing orders the general rule has been to print such a figure that if an additional 4000 were printed, it would be an even chance that they would never be wanted. The guiding principle being that it is about as much work to put the work on the machine again, if necessary, as it is to print another 4000 in the first instance. Alternatively, multiply 1500 (for 1") by the number of Divisions which are at all likely to enter the area and then doubling it, the spares and wastage. For 1: 25,000 take two-thirds as many. In the ordinary way we have regarded 4000 as a minimum print order and 20,000 has seldom been exceeded. Reprints for stock have generally been 5000 at a time, or sometimes 10,000 when a special demand has been foreseen.

84. Sheet layout.

¼" ½" & 1" maps must of course have spherical limits, which with a demi press will be 1° ½° & ¼° respectively.

For 1: 25,000 there are two possibilities:-

(a) Spherical five minutes by 7½ minutes. Advantages:-

(a) A tidy lay-out.

(b) Possibility of a systematic nomenclature such as 93 D/1/4 on the Indian system or NB-45E/1/4 on the International system. Some, especially signals, may regard this as of doubtful full value.

(c) Some simplification if the 1: 25,000 are to be compiled into a 1 inch series. But the 1 inch series will always have been done first.

(b) Grid layout. Advantages:-

(a) Maximum size 15,000 x 12,000 (for demi) fills paper rather better than any spherical layout is likely to.

(b) Sheets can be staggered to fit the coastline or main communications, thereby doing a job in a minimum number of sheets. (Note: Spherical sheets must have a regular layout or it will be impossible to recognise their limits on the 1 inch map).

For maps prepared in 14 Army the grid layout has been adopted, and where sheets on a spherical layout had been supplied from elsewhere their layout has been regretted. See para 58 3rd sub para. See also Charts V to XI.

The irregular layout enforces a type of nomenclature such as "Monywa 5", sheets being grouped into blocks of 1 to 25 sheets and named after a well-known, pronounceable and uniquely named town or other feature in the

area. This nomenclature in itself has some advantages over (e.g.) NB-45/E/1/4, although difficulty would arise in localities devoid of all place names (not probable site for 1: 25,000).

85. Narrow margins.

It is most desirable that the actual map should cover the maximum possible percentage of the paper. Some footnotes are of course unavoidable, but no one reads many except the name and scale and possibly the road classification. They should be kept to a minimum. A 1" map of 17 x 15 miles for instance only covers 53% of the 20" x 27" sheet on which they commonly used to be printed. Tonnage figures in para 60 are relevant. See also para 44. This "Wingate expedition" insisted on a 300,000 maps being trimmed to the bare edge of the map leaving only the sheet number.

86. Simplification.

Active service printing may be rather a second rate, and the army uses its maps under adverse conditions. It is therefore essential to eliminate anything from the face of the map which does not earn its place there. Items which call for consideration are:-

- (a) Minor administrative and forest boundaries.
- (b) Spaced names. Administrative, forest, tribal and mountain.
- (c) Railway names "Assam and Bangor Railway (Tinsukia-Dibugarh Branch) metre gauge"
- (d) Rest-house, Market (Tuesday), and such items of information as are unlikely to survive the passage of an army.
- (e) Photo-centres and at trig data.

C. Distribution.

87. Responsibility.

The survey service is responsible for the distribution of maps down to formations directly subordinate to the lowest formation at which there is a survey representative. Thus normally responsible for distribution to divisions, independent brigades, and Corps troops.

Responsibility for distribution implies not only the provision of what is asked for, but ensuring that formations do ask for what they ought to get.

Responsibility for distribution does not imply that the survey runs its own transport service-rail, ship, air, MT, mule or coolie. It makes use of whatever organisation exists, the only exception being that it is sometimes convenient to distribute maps by means of unemployed unit MT. Survey of course must provide couriers when necessary to ensure safe delivery.

88. Ideal system.

The ideal system map distribution is that all map stocks, with presses alongside making new maps and printing others, should be located in rear of army HQ but within range of the telephone, at the place whence transport planes carrying other supplies daily visit all Divisions. Divisions then signal in for maps together with their other needs, and receive them the following day. Survey also issue newly printed maps by this means, on their own initiative. This ideal system was in operation in Imphal during the critical months of Feb, March, and early April 1945. Para 60.

In theory, every formation entitled to demand maps should have an allotment which it is not free to exceed. This is necessary where map stocks are tight, but in practice it has very seldom been necessary to apply any restriction.

89. Difficulties.

The fundamental difficulties of map distribution arise from the fact that maps differ from other supplies in the following respects:-

- (a) Many have to be manufactured within the Army. See para 81.

(b) With most supplies, if last week's supply arrives today inconvenience may have been felt, but at least all is well tomorrow. With maps however this is not the case. Last week's maps are wastepaper next week.

These considerations tend to trip up the ideal system of para 88, in that the base for all other supplies can be switched laterally much more readily than (sic) the map supply base, and the map stocks and presses are consequently liable to be left high and dry at short notice, with no air transport system radiating from them.

The DD Survey must be continually on the look-out for changes of this kind, whether expected or not, and he must have plans ready to meet the risk.

These plans can take the form of :-

- (a) The prior placing forward within MT reach of Corps, of minimum reserves on which the Army can exist if the regular system breaks down.
- (b) By Liaison with Q, arranging that special full aircraft can be made available for supply to advance depots from the old base, if the latter should be left high and dry.
- (b) Carrying sufficient spare stocks and presses to enable him to carry on with half stocks and printing power if a move (in two echelons) should be forced upon him, and having a well considered plan for such a move ready to put into operation at short notice.

Such a situation as the above arose in April 1945 and was dealt with on the above lines. Para 60, and Para 57 pen-ultimate paras.

90. Divisional Map Lorry.

In 1942 a 3-ton map lorry was put into the WE of Div HQ. Its use has since tended to lapse, with the tightening of the transport situation, but it is most desirable that the Division should carry a reserve of 60,000 maps in this way. This not only constitutes an insurance, but by keeping maps in a fit state of recovery and reissue, it makes Survey less reluctant to issue maps well ahead, which may turn out to be required by another Division. Where there is no map lorry, all maps reaching the Div have to go out to their ultimate holders, and all hope of recovery has gone. See next para.

91. Map Recovery.

Corps Svy reps must work hard at map recovery, not only with a view to ultimate economy, but because it provides reserves on the spot for use in the event of an unexpected reverse, or for mopping up by formations in rear.

92. Duties of Map Distribution Officer.

After the AD Svy at rear HQ, the Map Distribution Officer needs to be next best man in the Army, in energy and intelligence. Seniority is fortunately immaterial.

His duties are :-

- (a) Primarily to be able to tell his DD at any moment, of any map sheet :-
 - (i) What stocks are in what Depots.
 - (ii) What expectations we have from India or our presses.
 - (iii) What formations already hold stocks, which are unlikely to have been consumed.
 - (iv) What promises to supply are outstanding.
 - (v) Whether any restraint should be placed on any formation's power to demand particular sheets from the base depot.
- (b) Under DD's orders, to arrange for such transfers of stocks as may be necessary.
- (c) To disseminate information about the map stock position throughout the Army.

All this is not as easy as it sounds.

93. Reports.

(a) Army HQ and Rear HQ issue daily news letters each other and to Corps stating :-

- (i) New sheets projected with probable date of completion.
- (ii) Sheets in hand gone to rep, with date of completion.
- (iii) Changes in estimated dates.
- (v) Actual receipts from India, each other, and the presses, with note re supersession or not of previous stock.
- (vi) Expected receipts from India, with date.
- (vii) Major despatches, quoting sack numbers and giving brief indications of quantities and area covered.

(b) Depots must render periodical map stock reports to the MDO. Normally monthly, but weekly or fortnightly reports may be called for in small areas where business is heavy.

It is an essential feature of such reports, without which they are apt to be meaningless, that the recipient should know (beyond doubt) which major issues have already been written out of stock and which major receipts have been taken into stock.

94. Acknowledgements.

A map depot must work on the assumption that all consignments will go astray, and those who call for or order the issue of maps must assume that their messages will miscarry. The daily news letter provides some insurance against such misfortunes, but it is essential that Map Depots should keep careful check of acknowledgements, not to support the "write off" of their stock, but to satisfy themselves that their duty has been completed. Depots must estimate the date on which acknowledgements are due, and when one is overdue immediately put enquiries in hand (if time admits) or make a second issue if stock admits. When it is clear that any such action (if it becomes necessary) will be too late, very special steps must be taken to see that the original issue does not miscarry. A pool of officers for courier duty on such occasions is necessary.

D. Miscellaneous Technical.

95. Co-operation with R.A.

This is a subject which has been much worked at in all training schemes, but which has subsided into insignificance in actual practice in Burma. Its attraction in training lies in the slight amount of equipment required (as compared with a map printing and distribution exercise), and in the very great improvement which can be attained by practice.

A common justification for this co-operation is that RE Svy go out to fix an origin for their mapping, and RA go out to fix one for their gun and target surveys. Clearly the two must be identical. This is true, but in Burma (and so far as can be foreseen in all future operations in S.E. Asia) the RE never have and never will go out to fix an origin for their own purposes, for we are advancing and our mapping must be done and finished with before we reach the area.

The requirements of an RA origin are (a) The co-ordinates of one point, (b) A bearing and (c) A base, unless the work consists of traverse. RA are perfectly able to observe the bearing and base, and with a good map prepared from air photographs, the recognition of an origin and the scaling of its map co-ordinates presents no difficulty either. On the other hand, where the map is bad, the selection of an origin which will result in trig based on it being in general agreement with the whole bad map calls for some planetabling skill, and there is room for an experienced Indian (IE) surveyor in the operation. The services of such a surveyor have been permanently on offer throughout this campaign, and such men have been present in Corps HQ or forward of it, but they have never been called on to assist.

With an origin established, RA Svy can do all that is necessary on a normal divisional front. If two Divisions come up in line, however, the two Divisional origins require to be brought into terms. Their connection by trig or traverse is a legitimate task for RE Svy, but unless the country is easy or the halt prolonged, their work is likely to be too late to be useful. The strength of such an RE party as can be kept on the spot for an occasional job of this nature is trivial compared with the trig strength of an RA Svy Regiment, and it is recommended that such a task should in future be an RA responsibility. In this campaign no call for such work has arisen, and parties sent to Corps to meet the possibility have wasted their time. Paras 42 and 43 refer.

Similarly, if the Army should advance in circumstances which call for continuous RA Svy, rather than in bounds which can be successively dealt with from independent origins, an RA Svy which starts in terms of the map may by accumulation of error get out of terms. The RA requirement is than an RE trig point or two thrown out ahead on to which they can adjust their own position. Such a demand arose once in this campaign in Arakan in late 1943. An RE party went out, but the jungle-covered hills were as difficult for them as for RA Svy and no useful work was done. Here again it is thought that the standing-by of a skilled RE party (semi-skilled is no use) is a waste of effort, and that the occasional case, if another ever arises, should be met by the selection of a new origin as soon as RA trig gets out of terms with the map.

This note is written by an officer who has made triangulation his life's work and who has much personal experience of triangulation in Burma.

96. Brigade Survey parties.

In almost unmapped country, as in the advance from East Africa to Abyssinia, the attachment of survey parties to Bde columns has proved of great value. They have guided the column by astronomical or other means through un-mapped country, and when a battle is foreseen they have been able to produce invaluable sketch maps from air photos, PT sketching and hurried trig.

In Burma, and such parts of S.E. Asia as operations are likely to take place in, the position is different. The country is by no means unmapped and careful map reading can keep the Army on its right course. Nor can hurried sketching, on the ground or from photos, produce a result which can beat maps previously prepared in rear. Such parties are therefore wasted with Bdes and Divs, and are better employed on regular map-making in rear.

The only examples of Bde Svy parties having been employed in this theatre are the Bde Svy Sections of 81 (WA) Div in Arakan in 1943. They did little useful work and on the proposal of themselves and their Div Comdr they were abolished before the next year. Para 72 should be read in connection with paras 95 & 96.

97. Block Plots.

See para 34. Block plots at 1:25,000 scale are much valued. Minimum distribution should be 8 sets per Corps.

98. Photomaps.

See paras 33 & 62. They are better than nothing if time presses, and in particular types of country they have definite value of their own, but in general their use is not recommended.

99. Gridded Verticals.

See para 63.

- (a) In favour of theatre grid :-
 - (i) Easy comparison between map and photo, which makes the photo of maximum utility in amplifying the information given on the map.
 - (b) In favour of arbitrary 1-inch squares.
 - (i) Can be of optimum size for estimation of tenths to give a suitably precise reference. The 1000 yard square of the theatre grid may have 2½ inch sides and the square is skew. This makes referencing imprecise.
 - (ii) The grid can be put on automatically in the photo-printing section without the delay that must inevitably arise if the photos go to Svy for theatre gridding.

The arbitrary grid has been used and is recommended.

100. Photographs

Much trouble and delay has occurred through the source of photographs for surveying, block plots and gridded verticals being located near Calcutta at a great distance from all Army Svy operations. This has no doubt been unavoidable but much advantage would arise from the Svy photo base being further forward.

101. Grid Junctions

The question of RA procedure when crossing over from one grid to another was considered a difficult one in 1940. The grid junction must be a hard and fast line and no map references must over-step the line and give references to either grid outside its proper area.

RA on the other hand require gun and target co-ordinates to be in terms of the same grid so that they can calculate or measure ranges and bearings.

The difficulty is solved if the RA Artillery Boards can show both grids superimposed on both sides of the junction. To facilitate this process, 1:25,000 charts were issued showing the relative positions of the two grids at their junction. Simple rules were given whereby RA could then draw up the two grids in correct relation to each other by copying from the diagram.

No difficulty has been reported and it is believed that RA passed over the junction without noticing it much.

102. Paper Seasoning.

The paper shortage in 1942 was much aggravated by a supposition that colour registration could only be achieved when printing on "seasoned" paper. Paper received straight from the mills was described as "green" and only to be used by operators of exceptional skill such as those in 13 Wood Street Calcutta and then only with great difficulty and doubtful success.

This has been found to be fallacious.

Paper straight from the mill is in first class condition only differing from older paper in being exceptionally dry and in being free from incidental damage. The object is to keep it dry and more especially to avoid changes of moisture content between separate colour printings. This is achieved by:-

- (a) Keeping the paper baled until the last possible moment
- (b) On opening the bales the paper is stacked in the press vehicle (the driest place we have) with a weight on top such as a few unopened reams to protect the top sheets and to keep all well compressed.
- (c) Colours are run through as quickly as possible without delay and the paper is similarly stacked between printings.

Creasing of the paper is successfully eliminated by putting the yellow cultivation on as the first colour. If the pale yellow is out of registration with its bounding dotted line no one will notice and no harm is done. This first run takes the creases out and no further difficulty arises.

103 Air Survey Out-turn. We have considerable experience of this but it of course refers only to survey of the quality and intricacy (or absence of it) which is typical of the work we have produced.

On average the production of a 1:25,000 sheet of 50 square miles has required 30 man days of men actually present on the job. This is in terms of men who are one third of them fully skilled air surveyors and able to contour, one third semi-skilled air surveyors unable to contour but capable of other processes and one third plain non-air-trained draftsmen. This figure is for man days actually on the job. If on the other hand we take a section of given strength multiply it by 365 to get the man days in the year and divide by the above number of man days per sheet, we will get too large a figure for the section's annual out-turn. The actual out-turn will in fact be half the figure so obtained the difference arising from:-

- (a) Rest days
- (b) Sickness
- (c) Leave

- (d) Indexing and recording small jobs
- (e) Slack work between jobs
- (f) Mis-management such as the miscarriage of photos and jobs taken up too late to be finished.
- (g)

The area of a 1-inch map is nearly 6 times that of a 1:25,000. To survey it from 1:25,000 photos will therefore take about 5 times as long with little benefit being obtained from the reduced scale.

The careful revision of a 1-inch sheet will take between 20% and 100% of the time required for the original survey depending on whether it is so good that no correction is found to be necessary or so bad that it has to be wholly redone.

Rapid revision to correct only major changes in river meanders and communications can of course be carried out more quickly.

104. Waterproofing of maps.

- Cloth mounting is impossible in bulk.
- Varnishing is troublesome and not satisfactory.
- No suitable water proof paper has been produced.

It is thought that the only satisfactory solution is a paper waterproofed in its original manufacture. Until that is produced maps must be carefully protected in map cases and freely replaced when damaged.

END