

A Military Encyclopedia

Based on Operations in the Italian Campaigns, 1943-1945.

[p. 293]

Chapter Seven

ENGINEER

Section 1. Topographical Intelligence

Although the Army G-2 was the collecting and dissemination agency for topographic information, the Army General Staff relied on the Army Engineer to evaluate all topographic intelligence required for its planning. This worked very satisfactorily. By the nature of his work and training the engineer was best equipped to advise the staff on terrain and communication routes.

Corps and Division Staffs in general asked less advice from their engineers on terrain than did the Army, because adequate engineer photo interpretation organizations did not exist in Corps and Divisions.

Section 2. Early Provision of Topographic Intelligence

The early provision of such general topographic studies as Inter-Service Topographical reports, was very helpful to the Army staff for orientation purposes. Since the Army planners seldom studied terrain in detail further beyond the front than 100 miles, and since the advance through Italy was relatively difficult and slow, the engineer intelligence organization was able to satisfy the demands of the planning staff, and subsequently the staffs of lower echelons.

Experience showed that if lower units were provided with information too far to their front, they were inclined to "file and forget" or misplace the information. For this reason, the timing of the distribution of engineer intelligence to lower units was given considerable attention, and close liaison between engineer intelligence officers of all echelons was necessary.

[p. 294]

Section 3. Organization of Army Engineer S-2 Sub Section

It was found necessary to augment the S-2 sub-section of the Army Engineer Section by assigning to it an assistant S-2 and a photo intelligence team of two officer interpreters.

The S-2 spent at least half his time on intelligence, supervising the work of the assistants, and in preparing special studies for, and conferring with, members of the Army General Staff. The rest of his time was filled with supervision of mapping.

The assistant S-2 maintained the files on all data concerning terrain, communications, resources, and general intelligence information in enemy territory. He examined and evaluated captured enemy engineer materiel and techniques, disseminating information concerning them. Extensive use of mines and demolitions made this work of considerable importance. He prepared, in conjunction with the S-2, the detailed studies required by the General Staff.

Interpretation of air photos was the principal source of engineer intelligence. In order to even approach the maximum efficiency in securing engineer intelligence from air photos, it was necessary that the photo interpreters be engineers with wide field (and preferably combat) experience. They could easily be trained in specialized photo interpretation because they had had sufficient basic training in this work.

One interpreter operated at Army Group headquarters. He has access to intelligence records from all sources including air photos. He made long-range interpretations across the entire front, reporting on existing routes of communications, possible likely sites for enemy demolitions, bomb damage, etc. He determined and recommended possible requirements for engineer works and materiel far in advance.

The other interpreter, at Army headquarters, made more detailed and extensive studies of the immediate front, and provided all engineer intelligence required by G-3. Working through direct channels with all units concerned, it was possible for him to gather, evaluate, and disseminate intelligence efficiently.

[p. 295]

Section 4. Roads

1. Traffic Problems

a. Operational necessity and the existing roadnets required keeping the main axes constantly in operation and maintained at the highest possible standard. They could never be closed to traffic. This resulted in a large amount of uneconomical work; however, there was no alternative. Patching or half-width repairs had to be utilized where, under other conditions, full-width repairs would have been more economical in time and labor. Engineer resources had to be committed for longer periods than would have been required if traffic could have been stopped. It was rarely possible to allow sufficient time for a newly laid surface to cure properly, with a resultant reduction in its period of life. These factors made long term forecasting of plant, labor, etc. increasingly difficult.

b. The "1-1/2-way" road proved to be highly inefficient when subjected to anything but the lightest traffic. Some vehicles invariably ditched themselves when passing others coming in the opposite direction, imposing serious delays on following convoys. In addition, engineer effort was wasted in repairing damage so caused. The best method of overcoming this was to make the road one way with parking lots at selected points along its length. These were then linked by telephone or radio, and traffic controlled by a system analogous to the block signalling system used on railways.

c. Where roads were in a bad state, engineer control had to be rigidly enforced through the medium of informing Traffic Control of the maximum densities of traffic and the classes which could be accepted.

d. It was found that a small amount of attention paid to the "psychological" aspect of road construction in maintaining a flow of traffic at high density.

[p. 296]

Such items as level approaches to bridges and culverts, and footwalks on bridges to give them a wide appearance materially assisted in keeping up the speed of traffic. Firm road shoulders, and strong side walls or rails to mountain roads encouraged drivers to keep to their side of the road and not toward the center. Similarly drivers were discouraged from driving recklessly by altering the physical appearance of the road where necessary.

2. Construction

Road construction presented distinctly different problems in summer and in winter.

a. In summer, usually only the main supply routes were constructed, or repaired, to more than a minimum standard. Main supply routes required proper drainage facilities and a metalled surface. Laterals and secondary routes were maintained to provide a smooth roadway, but little or no attention was given to surfacing or drainage. The advance was so rapid during summer months that Engineers did not have time to do more than open secondary roads, and the short periods they were used made extensive work unnecessary.

[metalled (Brit.): provided with road metal; macadamized, hard-surfaced; ballasted.]

[road metal: broken stone or cinders used in making and repairing roads or ballasting railroads.]

[macadamize: to construct or finish (a road) by compacting into a solid mass a layer of small broken stone on a convex well-drained roadbed using fine stone dust and water as a cement or now usually cement grout or bituminous material as a binder.]

b. During the winter months, every road that was used had to be put in the best possible condition, and drainage systems opened, enlarged, or rebuilt, if adequate. New construction, or existing roads without good foundations, had to be corduroyed or given a good base of heavy stone. Culverts were a very important part of winter roads. Box culverts in rapidly flowing streams required flooring to prevent scouring under the sills. Lining the inside of a box culvert with corrugated iron greatly increased the flow and prevented eddying around the posts. Small box culverts of wood for passing road drainage under road junctions proved very unsatisfactory because they were easily clogged with ditch mud due to their slow flow. As larger culverts were often impractical, a steel pipe culvert of 12" diameter was needed.

[p. 297]

Culvert beds were rapidly prepared by use of explosives. Curved sheets of corrugated iron made excellent forms for construction of masonry culverts. The biggest mistake in culvert construction was that they were very often built too small. It was found essential that a new culvert have as large a capacity as the original structure.

[corduroy road: a road built of logs laid side by side transversely and usually used in low or swampy places; the material or structure of such a road ribbed transversely.]

c. When small gaps were encountered in rapid advances, full advantage was not taken of the T-2 bridge layer to cross them. Often gaps were filled by advance units using tank dozers, when the T-2 could have been used. Tactical demands often precluded the placing of culverts, and many such fills had to be removed by following engineer units at the cost of a great deal of time and labor. Many small gaps were filled that could have been bypassed.

3. Maintenance

a. Maintenance in summer consisted mostly of smoothing with graders and drags, and filling pot holes. Dust was the greatest traffic hazard on dry roads. One method used to overcome this was by sprinkling with water, but due to limited equipment, only the most important roads could be wet down. Best results in sprinkling roads to overcome the dust hazard was obtained by sprinkling them at night as evaporation was much less at that time. Calcium chloride was used as a dust preventative with questionable results. Road oil was essential for dusty roads under observation.

[road oil: oil, as from asphalt-base petroleum, put on roads to lay the dust and act as a waterproof binder.]

b. Maintenance during the winter months required the supreme effort and maximum employment of all engineers, especially since during winter months the front line was more or less stable, and all roads had to be kept open for long continuous use. The main problem, as usual, was getting the water off and the rock on. All snow had to be removed from an earth road before rock could be deposited and spread.

c. One of the worst problems during wet weather was mud carried on to the main roads from bivouacs. To combat this, units were required to construct entrance roads and were allowed to draw rock from quarries and were furnished with culvert materials if needed.

[p. 298]

At one time, Army was furnished 4000 tons of rock a day for this purpose.

d. Side roads had to be conspicuously marked and barricaded when they had not been opened. Barricades of trees and rocks were necessary to block off demolished bridges. Tracing tape could not always be seen and was easily lost.

e. When sloping the sides of a cut was not practical and sloughing was likely to occur, the drains were kept open by laying along the ditches oil drums whose ends had been cut off. Where possible, bleeder ditches were cut on a slope not less than 1 in 5, at least 18" wide, and at frequent intervals.

f. Rebuilding road shoulders with hand laid rock aided in preventing vehicles from breaking down the earth shoulders and clogging the ditches. At the same time the road crown had to be maintained so surface water would run off.

g. Civilian labour was used to good advantage. It was found that, although a slow workman, the average Italian laborer was a good rock worker. In some cases, a civilian road foreman with civilian crew was given the responsibility of maintaining a definite piece of road.

h. Asphalt Roads.

(1) Washing stones for pre-mix asphalt.

When using river bed gravel for pre-mix, a road construction group found that the normal washing plant was not capable of handling the quantity of stone required. They then discovered that the stone could be washed perfectly in the river bed itself using a bulldozer. With the dozer back-blading, the stone was pulled across a fast current in the river. In this way one D-7 could wash 100 [cubic] yards per day.

(2) Bitumen.

The extremely large amount of oil patching necessary to keep the roads in repair required bulk heating of bitumen. This was done by taking petrol storage tanks from filling stations and using them to heat the bitumen. They were erected with diesel-fed fires beneath them and earthed up to half height for insulation purposes. It was found necessary to insert an adjustable baffle plate between the fire and the bottom of the tank to prevent the latter from being burnt out.

[p. 299]

Flues and chimney were constructed to provide the best possible draught. In this way one company heated 6,000 gallons at one time. Medium-curing bitumen took much too long to cure for operational purposes, since roads had to be used immediately after a surface was laid. In addition, water got into it while it lay in dumps and caused it to froth over and catch fire while in the heater.

Throughout the winter it was necessary to lay pre-mix on the roads either when it was freezing or when the roads were wet. At the same time these roads had to remain in uninterrupted use. To prevent the surface from breaking up under an immediate flow of traffic it was found necessary to increase the normal proportion of bitumen to rock in the mix.

4. Marking Roads

a. All principal roads in Italy north of the Volturno River were numbered, and the widest possible distribution of "Road Numbering Maps" was made. The numbering system was used in conjunction with the British method of giving code names to entire routes, and proved very satisfactory. This aided planning, and simplified road reports, assignment of work, and transportation problems.

b. Standard type signs, in general similar to those used in the United States, were found to be necessary. Prior to the adoption of standard signs, traffic was hampered by the wide variety of Italian and Allied road signs. It was found necessary to keep unauthorized road signs removed from important road junctions to prevent "jamming".

c. Luminous buttons made fine markers, when placed high enough so as not to be splashed with mud, but they were stolen almost as rapidly as they were put up.

d. The Electric Flasher Lamp was often used to mark bypasses or bridges; however the light given off was too small and in most cases could be seen only from a short distance.

[p. 300]

Section 5. Mule Trails

To overcome bogs in mule trails, a track was developed which was simple to lay, and which could be carried on mules. It was produced by cutting Sommerfeld track and Coir matting to half width. The cut end of every fourth or fifth reinforcing bar was bent to form a loop to be held by picket. Prior to laying the track, the trail had to be smoothed and well drained. Where necessary, small culverts, made from ammunition boxes with the ends removed and fastened end to end were used. A brushwood mat laid beneath the Sommerfeld was necessary where the ground was very soft. The track was laid with the Coir matting on top of the Sommerfeld track. By careful maintenance of drainage and by keeping the matting and the Sommerfeld well staked down, the limited life of the track was materially increased.

Section 6. Bridging Lessons

1. General Policy

a. It was found to be of paramount importance to replace divisional crossings rapidly with two-way bridges or culverts. Traffic density was normally greatest in the immediate rear of the forward troops, and the quick replacement of single-way bypasses aided enormously in the build-up of ammunition, etc., in the forward areas.

b. In the replacement of divisional crossings, work was often duplicated by successive groups of engineers dismantling the previous group's work and replacing it with something better. An early decision as to the design of the final crossing saved much engineer effort.

2. Reconnaissance

a. It was emphasized that air photo interpretation was complementary to ground reconnaissance, but could never replace it. Good photo interpretation was of great value to engineers in eliminating as possible bridge sites certain stretches of an obstacle, thus cutting down the number of places to be visited and hence the time spent on reconnaissance.

[p. 301]

b. Except in an approach march or in pursuit, engineer reconnaissance officers should not be attached to any specific forward unit. Such attachment often meant that an officer had to leave his radio behind and accompany the infantry on foot. A better method was to grant the officer a "free lance" role, his instructions merely being to reconnoiter specific points at the first opportunity. At other times, when certain tactical information was necessary for the initiation of his reconnaissance, it was often best for him to remain at forward infantry regimental headquarters until this information was available. It was found that

radio communication was so reliable that a waiting reconnaissance officer could be on his way to any site within a few minutes of its falling into our hands. Moreover, it was thus possible for him to set out with much later and wider information.

c. It was found that only officers of considerable experience were capable of giving reasonably accurate estimates of time required to construct bridge approaches.

d. The use of special engineer codes for transmitting by radio details of equipment, stores, etc., proved invaluable.

3. Use of Mechanical Equipment

Not enough use was made of mechanical equipment for bridge building.

a. When used, cranes proved especially useful for tripling up Bailey bridges when 50 or 60 foot trusses were placed in one lift.

b. Dozers used as counter weights enabled the Bailey bridge to be launched without nose, and with far end posts in position. This method proved especially useful at restricted sites.

4. Technical

a. The timber crib type of abutment proved itself to be the most satisfactory expedient for rapid bridging.

[p. 302]

Where sinkage was a possibility, it was found invaluable to erect, inside the crib, a trestle which took a major part of the bridge load.

b. A quick form of temporary pier erected in water was produced in the following way:

British V-trestling (a heavy trestle equipment with rapidly adjustable "camel's feet") was placed in the water from a light raft and leveled off. Steel girder capsills were placed across the tops of the legs, and a pair of Bailey panels constructed on top of the capsills. This enabled the bridge to be launched and take traffic while a more permanent type pier was being constructed.

c. Another pier quickly constructed in shallow water on gravel bed was made in the following way:

A large grillage was laid down to take the pier which was constructed on steel bridging cribs with steel girder capsills. This proved to be satisfactory as a temporary job. To make in permanent, piles were driven in around the base of the pier and the whole erection concreted in.

d. A ramp constructed of a single span of Bailey panels laid on its side was a useful expedient for raising Bailey panels to the top of a pier.

e. When double truss Bailey bridges had been reinforced by a third truss in the center and not over the full length of the bridge, it was found that, in time, the panels of the third truss tore at the transom seating, starting initially at the outside ends of the truss and working in towards the center, thus nullifying the reinforcing effect intended.

f. It was found that tank transporters and towed trailers often damaged the end posts of Bailey bridges. This was partially overcome by setting heavy steel girders or heavy wood posts in the ground in front of the end posts. This was particularly necessary where the approach to the bridge was on a curve.

g. In the Lombardy plains the rivers flood very rapidly and many floating bridges were lost. This was attributed to two causes.

[p. 303]

The piling up of flotsam on the anchor cables, and the inability of the soft river bottoms to hold the anchors against the increased drag on the bridge. Replacing the normal anchor cables with steel wire ropes and making them fast to features out of the water helped to overcome this difficulty. In addition, it was also found that cutting the bridge at the two half-floating bays and permitting the central floating position to ride out the worst of the flood on its cables, reduced the tendency of the bridge to twist and removed most of the strain on the shore ends. Bridge maintenance personnel had to be trained to carry this out very quickly owing to the speed at which the water rose.

h. It was found that if Floating Bailey equipment was transported with the pontoons on pole trailers (2 bow pontoons or one center pontoon on a trailer) and the normal Bailey components in 2-1/2-ton trucks, there were always sufficient 2-1/2-ton trucks to tow the trailers for any given length of bridge.

i. To replace a fixed Bailey Bridge with a semi-permanent bridge where a bypass was not feasible it was found that the Bailey could be raised and the new bridge built under it. This method stopped traffic for only two short periods first to jack up the Bailey and build new ramps, then when the semi-permanent bridge was completed to remove the Bailey. In some cases where it was planned to build a semi-permanent bridge and a Bailey was built first, the Bailey was initially raised to allow construction of the semi-permanent bridge.

Section 7. Treadway Bridge Construction in Rapid Currents and Flood Water

1. General

Engineers constructing Treadway Bridges under ideal conditions (low water and dry weather) tended to do just enough to insure the crossing. As a result, some bridges were later lost when the river crest was reached.

[p. 304]

On the other hand, bridges built during, and designed for flood waters, usually stayed in place, even after a rapid rise in the river level and current.

2. *Choosing Site*

Sites were frequently chosen too close to the demolished bridge. Due to the debris, the current was swifter and the turbulence greater just below the demolished bridge. It was often better to get farther away, even if it meant more work on the approaches.

3. *Rapid Current*

A fast current decreased the final load capacity of the bridge due to the lack of stability. In the M-1 bridge, the floats tended to take water over the top resulting in a torque which kicked out the pontoons. To solve this problem, the treadway was offset 6" on the downstream side and floats and saddles were lashed to the sections. The M-2 bridge was designed with the load center downstream and provided with a larger float with prows to remedy this defect. Trestle scour, another trouble caused by swift currents, was combated by excavating holes 12" to 18" deep for the shoes and then covering up the shoes with rock. If this was not possible during construction, personnel were kept on hand to "jack down" the columns on the shoes so that the trestles could scout themselves into the river bottom.

4. *Maintenance*

After a rise in the river, the following rules were constantly observed:

- a. All cables and ropes were kept snug, not tight.
- b. Center line was kept straight by constant adjustment of guy ropes and
bridle lines.
- c. Boats and saddles were lashed to treadway sections.
- d. Transoms were kept snug against treadway.
- e. Drainage was maintained around approaches and abutments.

[p. 305]

Under normal conditions, upstream cables and bridle lines were more efficient than anchors in the gravel bottoms of most Italian streams.

By removing a few floats where the current was stiffest, resistance to the water flow was reduced and the bridge could be continued in use. This lowered the bridge capacity however.

Under flood conditions a treadway bridge could usually be held by anchoring with cables and deadmen at the ends of the bridge. Vehicle winch cables attached to the ends of a bridge in emergency were of great value because if all anchorage failed, the bridge was permitted to swing parallel to the shore by paying out on the winches. When the flood subsided, the bridge was easily returned to its original site.

Section 8. Comparison of River Crossing Equipment

1. **Assault Boats:**

a. *British Canvas Boats.*

- (1) Easily portable (Could be carried open by four men).
- (2) Easily maneuvered in the water when loaded.
- (3) Easily damaged in transit by rough handling.
- (4) Not easily repaired.

b. *U.S. Plywood Boat, M-2.*

- (1) Not so easily portable.
- (2) Easily maneuvered in the water, loaded or empty.
- (3) Not so easily damaged in transit (boats "nest").
- (4) More easily repaired.
- (5) Served dual purpose (i.e. making infantry support rafts and expedient assault boat bridge).
- (6) Much noisier in use with non-rubber shod personnel.

[p. 306]

c. *Conclusions:*

(1) The American pattern assault boat was decidedly more robust and had the great advantage of dual purpose. However, the British boat proved itself perfectly adequate for its primary task which did not require great durability.

2. **Storm Boats:**

a. *British Storm Boat.*

- (1) Heavier to carry across country.
- (2) Would carry heavier load (6 pounder or jeep though latter a top heavy load).
- (3) Carried ten men, but with a lower speed.

b. *American Storm Boat.*

- (1) Carried by 6 men (plus 2 for motor).
- (2) Would carry up to 1500 lbs with very little reduction in speed.
- (3) Carried 7 men (above crew) at maximum speed.
- (4) Was the faster boat; would beach at full speed.

c. *Conclusions:*

(1) For assault crossing of personnel the U.S. boat carried fewer men but got them across the river and in action much faster.

- (2) For cargo carrying, British boat carried a greater load but at a slower speed.

3. **Light Floating Bridges:**

a. *British Folding Boat Equipment (FBE).*

- (1) Class 9.
- (2) Equipment complete with anchoring gear.
- (3) Better performance in fast currents.
- (4) Could be maintained in use indefinitely.
- (5) Would take heavy traffic densities in vehicles per hour.
- (6) Full width roadway.

[p. 307]

b. *Light Treadway.*

- (1) Class 7. (Could be reinforced to Class 9).
- (2) Very quickly constructed.
- (3) Required no special trucks.
- (4) Difficult to anchor and hold in fast moving currents, and to maintain when moving debris was encountered.
- (5) When made up to Class 9 offered more obstruction to water.
- (6) No trestle equipment; therefore sites more limited than with FBE.
- (7) Slow traffic.

moving debris was encountered.

c. *Conclusions:*

- (1) The British FBE was definitely the superior bridge for all round

performance.

- (2) For short periods of use and under good conditions, the light treadway bridge would handle the same loads and was much more quickly constructed.

The last point is important, as in the initial stages of river crossings the speed of construction and the number of personnel exposed are of prime importance. The average floating bridge site is suitable for the construction of the floating treadway.

4. **Heavy Floating Equipment:**

a. *British Bailey Pontoon.*

- (1) Most desirable type of floating bridge.
- (2) Practically no site limitations.
- (3) Large water gap between piers, i.e. less stream obstruction.
- (4) pontoons were stable in high current.
- (5) Side girders gave additional confidence to drivers, but limited width of

[p. 308]

vehicles.

(6) Easy to carry, especially when carried with pontoons on pole trailers behind lorries loaded with normal Bailey components.

(7) Would stand greater change in water level.

(8) Less undulation passing traffic.

b. U.S. 25 ton Pontoon.

(1) Limited as to sites.

(2) More stream obstruction.

(3) Would not stand changes in water level.

(4) Pontoons not usable in high currents, would swamp and sink even when fitted with bow adapters.

(5) Difficult to transport owing to unwieldy trailers.

(6) Had no width limitation for vehicles.

(7) More quickly constructed.

(8) Needed a crane for construction.

c. Conclusions: - (See paragraph 5c).

5. Heavy Assault Equipment:

a. U.S. Armored Treadway, M-1.

(1) Could be reinforced to Class 40.

(2) More quickly constructed than M-2.

(3) Required special trucks or crane to construct. Therefore sites were limited or required preparation.

(4) Has trestle equipment.

(5) Would not carry wider loads, i.e., new Tank Destroyers, 16 ton or larger trailers.

(6) Required fewer vehicles to transport than M-2.

(7) In high currents there was a large torque effect on pontoons. Treadways had to be offset downstream 6" to counteract this.

[p. 309]

b. U.S. Armored Treadway, M-2.

(1) Class 70 without reinforcement.

(2) Required special trucks: These had been designed to take M-1 treadway and would not handle M-2 nearly as quickly.

(3) Same site limitations as M-1.

(4) Would carry all loads.

(5) Required more vehicles to transport.

(6) Saddles were already offset downstream.

c. Conclusions:

(1) The Bailey pontoon bridge was the superior floating bridge of the semi-permanent type but took longest to become operative.

(2) The Armored Treadway bridge could not properly be compared with either the Floating Bailey or the US 25 [ton] Pontoon equipment. It was the most rapidly constructed heavy bridge, either floating or trestle, and was a first rate bridge for tactical use.

Section 9. Snow Clearance

1. A certain amount of preparatory work was found to be necessary prior to the winter season, as follows:

a. The constitution of a link work [network] of snow posts with the responsibility of keeping open the main lines of communication.

b. The erection of snow fences to protect roads from drifts. Drifts nearly always form in the same places from year to year and interrogation of local inhabitants revealed these locations.

c. The erection of tall guide posts alongside the road to indicate at least one edge of the road, and where culverts, etc. existed, both sides.

d. The stationing of mechanical equipment at strategic points.

e. The establishment of adequate reserve dumps of fuel for the mechanical equipment.

[p. 310]

f. The issue of wooden snow ploughs to units living on main routes.

g. The dumping of crushed stone. All units underestimated the amount of fine gravel needed to sand icy roads. On grades, stock piles should be not over 100 feet apart so that the roads could be sanded from the piles.

(1) Fine crushed rock, that will pass a 3/4" screen was best for ice.

(2) During a period of light daily thawing, two inch was used. Sand was no good with a partial thaw during the day. The large stone was not completely covered and upon refreezing protruded to leave a rough surface.

2. Snow posts were so established and organized as to enable them to fulfill the following functions:

a. Assuming responsibility for clearance of a sector of main road or roads linking up with the sector of the next snow post.

b. Organizing manual labor, both civilian and military, to assist in snow clearance. Tools were held for working parties.

c. Reporting frequently state of road in its sector.

d. Rendering medical aid and limited mechanical aid to stranded men and vehicles.

e. Feeding and housing stranded men.

3. Units stationed on or near main routes could materially assist in snow clearance and were instructed to do so as follows:

a. By turning out all available men to work on the main roads.

b. If not required to work on main roads, those living on side roads cleared these to the main ones.

c. By towing wooden snow ploughs up and down the main roads, behind suitable vehicles immediately snow started falling. This method was of little use once any depth of snow had formed.

[p. 311]

4. The most suitable of the readily available pieces of mechanical equipment were found to be:

a. The grader - for snow under one foot deep.

b. The angle dozer - for all snow deeper than one foot.

c. The jeep snow plough did good work in light snow on smooth roads but was not satisfactory for deep snow or rough roads.

d. The snow plow for attachment to 2-1/2 ton trucks proved satisfactory. It could be adapted to a 4 ton truck which, with its additional weight and power, would clear deeper snow.

5. Snow should be cleared off the roads and beyond ditches on either side of the road. If this has not been done, the lane cleared through the snow eventually became a canal for thaw water. If it was not possible to do this, then proper drainage channels were cut through the snow to permit thaw water to escape. Entrances to existing culverts were always kept clear so that thaw water from hillsides would not flow on to the road.

Section 10. Mine Laying Policy

Troops of both the American 5th Army and the British 8th Army suffered numerous casualties as a result of their own AP [Anti-Personnel] mines. In numerous incidents patrols, raiding parties, and advancing troops moved into their own indiscriminate or poorly charted AP mine fields. There were some instances where extreme emergencies justified laying of indiscriminate AP mine fields, but in many other instances indiscriminate or poorly charted mine fields were laid without such justification, and resulted in many needless casualties.

In the Fifth Army AP mines were usually laid by infantry troops under the supervision of division engineers. The engineer personnel were then responsible for the proper charting of the mine field, and distribution of this information to the proper headquarters. At times, when engineer personnel were not available for supervision, AP mine fields were laid by infantry battalion Ammunition and Pioneer platoons or by the mine platoons of infantry regimental Anti-Tank Companies.

[p. 312]

These troops were usually well qualified to lay AP mine fields, but in many instances they were inaccurate in charting the size and location of the mine fields. Also, the headquarters which ordered the laying of these mine fields at times failed to transmit the proper information regarding the mine fields to higher and lower headquarters and to relieving units.

It was the belief of most Engineer Officers in Fifth Army that AP mine fields should be laid only by authority of Division commanders, and then under the supervision of engineer personnel.

It was the opinion of most infantry regimental and battalion commanders that, except in extreme emergencies, AP mine fields should never be laid without the authority of the infantry regimental commander, and that when possible supervision should be exercised by supporting division engineer personnel.

All engineer and infantry officers were agreed that the utmost care should be taken in accurately charting, and in distributing information pertaining to, all mine fields.

The mine experience of the British Eighth Army were similar to those of the American Fifth Army. The British developed a policy which required approval of the Division "G" Staff prior to the laying of any mine fields.

Section 11. Importance and Best Methods of Recording Minefields

1. It was of great importance that all minefields be accurately recorded for two main reasons:
 - a. That units in the area, or that might move into the area, could be notified of their location.
 - b. That engineers required to remove the mines would have a complete and accurate record of type and pattern. Accurate minefield records, when in the hands of the unit concerned, saved lives and simplified the clearing, both in forward and rear areas.

[p. 313]

2. The method laid down by AFHQ [Allied Forces Headquarters] for marking and recording minefields was entirely satisfactory. It was found necessary to have experienced engineer personnel to record minefields, regardless of the type unit laying the mines.

3. Minefield records should be classified lower than SECRET when possible, inasmuch as it was often necessary for the information to be in infantry battalion or lower headquarters.

Section 12. Mine Detection in Forward Areas

No new methods were developed in mine detection during the Italian campaign although numerous devices for mine clearing were developed. No satisfactory substitute was found for visual detection, the SCR-625 mine detector, or the probe. Although these methods were slow and required large numbers of personnel, they were most reliable. The use of war dogs for mine detection was so unsatisfactory that the only war dog company to arrive in this theater was returned to the United States.

Section 13. Mine Clearance

It was frequently found necessary to emphasize the prescribed methods of clearing mines in order to counteract the natural tendency toward carelessness which was bred by familiarity. Among the standard precautions which required repetition were the following:

- a. Only one man should deal with a mine.
- b. Mines are just one of the normal risks of war.
- c. When in doubt, get skilled help.
- d. Observe the ground carefully when moving through a minefield.

[p. 314]

- e. Mark and report an area or lane cleared.

Short cuts were hazardous and often resulted in casualties. Some of the mistakes were:

- a. Bunching together.
- b. Running in a minefield.
- c. Becoming careless or over confident.
- d. Rushing into a minefield to help a man who has been injured.
- e. Forgetting to look for booby traps.
- f. Experimenting with new and unfamiliar mines.

Headquarters planning assaults often did not take into consideration the time necessary to remove mines. As a result, either the assault was delayed, or personnel and equipment were lost unnecessarily.

"Snakes" were occasionally used to clear gaps in heavily mined areas. However, they required relatively flat terrain for assembly and movement in the mine field. The time required for their assembly and employment was usually too long for use in a fast moving situation.

Such specialized vehicles as the SCORPION and the TIE-3 were of little value during most of the Italian campaign because of the ruggedness of the terrain. However, U.S. and British experience with these vehicles under suitable condition of firm, flat terrain and dense minefields, as in the Liri and Po valleys, proved these vehicles to be excellent for mine clearance.

The use of detonating cord cables proved of greater value in clearing gaps through AP minefields, than any other method devised.

Section 14. *General Lessons on Camouflage*

1. *Nets*

a. Experience showed that the pre-garnished fishnets received were of insufficient density. Between 90% and 100% [density] garnished nets were most satisfactory.

b. Flat tops were seldom erected because net drapes blended better with the Italian terrain.

[p 315]

c. Colors of summer and fall nets proved satisfactory but no satisfactory winter net was developed.

d. Shrimp nets were unsatisfactory unless the object to be concealed was in deep shadow, because these nets were not of sufficient density to obscure properly.

e. Regardless of the care given nets, they were not sufficiently durable nor fire resistant.

2. *Pattern Painting*

Continued studies by camouflage officers of enemy methods of pattern painting bore out the general ineffectiveness of such painting to conceal installations. Aerial photos and air observation of large scale painting projects, bore out the contention of field camouflage officers that such painting merely tended to make the structures more conspicuous as military targets. The painting did, however, tone down the structures when dark colors were used.

3. *Screens*

a. For all general screening purposes, double thickness (superimposed) garnished nets, with the garnish thickened around the edges, were used.

b. Where a white surfaced road was to be screened from an elevated viewpoint, the screens were so arranged that each screen covered the next one by half, so that at any given point there were two screens between the object and the viewpoint.

c. Where possible, traffic was made to keep to the far side of the road from the screen so that it would be silhouetted against the darker field than against the lighter road.

d. In some cases where traffic would be silhouetted against a low sun, it was preferable to close the road during those hours than to thicken up the screen more than necessary for normal conditions.

4. Deception

a. When planning an offensive in one sector west of Florence, a policy of rigid concealment was inaugurated to deceive the enemy as to the location of the attack.

[p. 316]

Dumps, hospitals, emplacements, and communication improvements were "played down" to the greatest possible degree. In an adjacent sector, the appearance of great activity was created by the construction of dummy bridges, dumps, field pieces, airfields and other installations as well as the use of gun flash simulators. This program was designed not so much to deceive the enemy as to location of installations, but rather to confuse him about a whole offensive operation.

b. To cover a bridging operation taking place farther upstream the following plan was carried out at a site on which the Germans had accurately registered with artillery fire.

Camouflage screens were erected on frames the night before and several Bailey panels were left protruding, not too obviously, from behind the screens. On the night of the operation a small party well dug in, produced the effects of bridge building by hammering panels, flashing lights and shouting "commands".

The Germans responded with very heavy defensive fire all throughout the night, meanwhile the main bridging operation two or three miles away continued unmolested.

c. A Bailey bridge was shelled periodically until an obviously damaged vehicle was left on it. This was removed each night to allow traffic to pass, and was replaced before dawn. The ridge was not shelled again.

5. Camouflage Discipline

Experience showed that not enough emphasis was placed on concealment from ground observation. In general the camouflage of the infantryman was satisfactory, but that of tents, buildings, vehicles or other installations was not.

[p. 317]

Section 15. Camouflage of Vehicles - Disruptive Painting

The general consensus of opinion among camouflage officers was that pattern painting was of dubious value because:

- a. Varied terrain in Italy made standard patterns and colors impracticable.
- b. When a unit was shifted from one sector to another, as was often necessary, their patterns and colors were revealing rather than concealing. Repainting before a move was nearly always impossible because of insufficient time.
- c. Security was lost and units easily identified when units moved to different sectors.
- d. Camouflage paints and personnel for supervision were often not available.

As a result of extensive study and experiment, all disruptive painting of vehicles in this theater was discontinued, except where specifically directed for a particular operation. The British discarded pattern painting of vehicles in favor of a lusterless olive drab.

Section 16. Engineer Supply System

1. The U.S. system of engineer stores supply proved unsatisfactory. There was no organization designed to, or capable of, handling engineer stores either at division or at Corps, with the result that individual units had to draw direct from the Army depot. There were many disadvantages to this system, of which the following were the most prominent:

- a. The division or corps engineer had no control over supplies. Unit demands often had to be referred back from Army to the Engineer concerned before the unit priority could be established.
- b. The division or corps engineer was not always fully aware of the resources at his disposal when planning an operation, because emergency or unanticipated demands from other Engineers could seriously affect the dump supply.

[p. 318]

This was obviously a grave defect especially when the operation was of a mobile and fast moving character.

- c. The time taken to get supplies to the front was much longer than if division dumps had been provided and located well forward. Units had to send their own transport back to collect their supplies, and an average time for the round trip was one day. At the times when the need for engineer supplies was most critical, units usually could ill afford to spare the transport for so long.
- d. To overcome the disadvantages in (c) above many units operated small dumps of their own, which, apart from being an uneconomical distribution of engineer stores, was also a function they were not equipped to carry out.

2. Under the British system, each divisional and Corps engineer group had its own field park company, which in addition to other functions, was a mobile stores handling unit. Dumps were located at Army, and at Corps (by the Corps field park company). The divisional field park company rarely operated dumps during mobile operations. Transport was held at the various levels, at scales consistent with operational demands for ferrying supplies between Army, Corps, and Divisions, the basic principal being that responsibility for delivery to one unit rested with the unit immediately to the rear. However, with the proviso that the stores were invariably delivered to the unit at the site required, this system was varied to provide the most economical use of transport.

3. A supply organization operating on the British principle was desirable to facilitate planning, control, and distribution of Engineer stores. This would necessitate changes in organization similar to the following:

a. At Division, the addition of sufficient personnel to maintain engineer supplies for divisional troops.

b. At Corps, an engineer supply section for control, allocation and statistics only.

[p. 319]

This section would control stocks of divisional dumps and check and amend divisional requisitions as required, forwarding them to Army. No stores would be handled at Corps level.

c. At Army, the addition of sufficient personnel and transport to supply, on requisition through Corps, direct to divisional and corps engineer units.

Section 17. Carriage of Bridging Equipment

There was a definite need for Bridge Companies designed to carry special bridge equipment.

In the campaign in Sicily, Corps Engineers organized a provisional Bridge Train utilizing Corps troops, and Corps and captured German transport.

Upon entering the Italian campaign no bridge company was available except the Armored Treadway Company of the Armored Division. A unit of this company landed with Fifth Army to serve as a Bailey Bridge Train. However, Army soon received more Bailey bridge equipment and as the use of bridging material increased this unit proved inadequate. To fulfill this need, two companies of a General Service regiment were assigned additional transport, thirty-one 2-1/2-ton, 6 x 6, trucks and six Brockway trucks to each company, and utilized as bridge trains. One company was attached to each Corps and served in that capacity until Army was authorized to activate two bridge companies.

On one occasion a Division anticipated a heavy demand for Bailey Bridges. By coordination with supporting Corps Engineers transport was taken from all units concerned and formed into three bridge trains.

Fifth Army eventually formed two bridge companies organized from the disbanded bridge train of the armored division. One of these companies was attached to each Corps and handled both Armored Treadway and Bailey bridge. These units proved satisfactory in supplying Corps needs when they were properly supported by Army, but Army lacked a proper organization to handle bridge equipment at Army level.

[p. 320]

This need was met by using the Heavy Pontoon Battalion to handle Bailey bridge equipment for Army and support the Corps Bridge companies. It was found that Army needed one bridge company to support each Corps bridge company.

It was also found that whenever a new type of bridge equipment was adopted it was essential that Bridge Companies be formed to handle it.

Section 18. Small Unit Dumps

All engineer units maintained a dump of engineer materials. As a rule these dumps stocked only construction materials for culvert or bridge building, and for field defenses. They were usually stocked with material which was overage from construction projects. In the case of division engineers however, defense materials were stocked by requisition because of the necessity for immediate supply to the infantry units.

Small unit dumps were necessary because the interval between the assignment of a project to the unit and the required completion time was frequently too small to permit requisition of necessary materials through channels and delivery to the site. By carrying a small amount of materials on hand, any project could be started immediately upon receipt of the work order. Materials for completion usually arrived through normal channels by the time they were required.

The Army depot had considerable difficulty with units moving forward and abandoning small dumps without notifying the depot. In a rapid advance it was the policy of the depot to pick up any small dumps that units had to abandon. To do so it was essential that the depot be notified of the fact that a dump was abandoned and its exact location. A list of dump contents was also of value to the depot.

Section 19. Engineer Equipment

1. Employment

a. The speed with which road nets were opened by engineers often directly determined the rate of advance of the army in attack, or pursuit.

[p. 321]

In most cases the rate of engineer progress was likewise determined by the type and availability of their equipment. This was particularly true in the rugged terrain encountered in Italy.

b. It was impossible to maintain the roads, construct the dumps and railheads, repair and rebuild the bridges, or improve the Army installations required by a mechanized Army, without the maximum use of mechanical equipment. Without mechanical equipment, the manpower required was prohibitive, and besides, hand labor could not have performed the work in the allotted time.

2. Holding

a. The U.S. practice of making larger organic allotments to construction units than the British proved very sound. It was found that engineer construction units, in order to fulfill their varying missions, need a flexible policy in the assignment of equipment to units.

b. In the Italian theater the rough terrain encountered necessitated the continual use by Engineers of more heavy equipment than was authorized, but until the latter part of 1944 no equipment company was available to supplement unit needs.

c. Experience indicated that equipment companies should be used primarily to supplement the equipment of supported units, when needed, and secondly to supply the special equipment that was used only occasionally. It was found that the equipment company was the proper unit to which to assign new types of equipment or additional equipment needed to fulfill work requirements. In equipment companies the need for flexibility was even greater than in construction units, and the equipment company had no work platoons or other men it could divert to use as operators when it was given equipment above that authorized. An equipment company supporting a Corps needed different types and amounts of equipment than an equipment company supporting Army Engineers.

[p. 322]

3. Types and General Use

a. Division Engineers if given close support by Corps Engineers seldom had need for additional equipment from an equipment company. During the winter they did need additional dump trucks and often needed a primary rock crusher and a gas shovel. However, when these last two items were available to Corps troops they were often shared with divisions.

b. Corps troops' needs from the equipment company were light in the summer but very heavy in the winter. The additional equipment required was the same as that required by division engineers.

c. Army troops, because of the big jobs they were continually required to execute, had a continual need for all types of extra equipment. Here again the demand was especially heavy during the winter especially for more dump trucks, crushers, and gas shovels.

4. Maintenance

a. Engineer first and second echelon maintenance was generally poor, and constant emphasis had to be placed upon its performance. Lack of proper maintenance by using units increased the burden on third and fourth echelon maintenance facilities. Maintenance unit records showed many cases of

damaged equipment directly due to lack of first and second echelon maintenance, improper use of equipment, and careless and incapable operators

b. Engineer third and fourth echelon maintenance was very unsatisfactory due to several reasons:

(1) No Heavy Maintenance Company was available to Fifth Army.

(2) For some time only one platoon of a Medium Maintenance Company was available. This platoon was later replaced by a Medium Maintenance Company, less contact platoon. Considering the number of units to be served, three maintenance companies would have been the normal allotment for Fifth Army.

[p. 323]

(3) The maintenance burden was further increased by the fact that all units serviced were using additional equipment. Some units were operating three times the amount of equipment normally authorized. Also, as the engineer work was heavy and much equipment was old, breakdowns were frequent. These factors all combined to give the Maintenance Company several times the amount of work it was equipped to handle.

c. Supply of parts was inadequate, causing many pieces of needed equipment to lie idle for long periods. This was due to several reasons:

(1) Spare parts kits authorized on the basis of one for each piece of equipment were not available. In an effort to distribute equitably the available kits, Theater changed this authorization to one kit per three pieces of equipment, but actually only very few kits were made available.

(2) Lack of trained depot personnel caused excessive inefficiency. Many critical items were stored in depots and "lost". Shipping tags got torn from cases and inexperienced personnel were unable to identify the contents without opening the cases.

(3) A Parts Supply Company was not available to receive and make proper distribution of parts.

5. Conclusions

a. Nearly all engineer problems in Fifth Army were influenced throughout by the lack of sufficient engineers of all types. This especially aggravated the equipment problem, as the insufficient number of construction units made additional equipment per unit necessary in order to accomplish the required work. Also, no equipment companies were available until late in 1944 when one company was assigned to the Army. There were never sufficient maintenance units. Thus all Engineer units were required to do work beyond their intended capacity. No proper conclusions can be drawn on engineer problems without keeping this fact in mind.

[p. 324]

b. In combat areas the necessity for large allotments of equipment was great because the work in these areas in most cases had to be accomplished quickly and completed by a prescribed time in order to secure satisfactory results.

Section 20. Special Vehicles vs. Normal 2 1/2 Ton 6 x 6 Trucks for Carrying Bailey pontoons

When loading or unloading the British Pontoon Lorry, all handling was done by hand. When using a normal 2-1/2-ton truck for handling pontoons a crane was necessary to load and unload. Under normal conditions pontoons were loaded on, or unloaded from, the special Pontoon Lorry faster and with less damage than when hauled on standard trucks and handled by cranes. The standard truck will carry the same load (two sections) as the pontoon lorry without damage to the pontoons in transit; however, the cranes used in loading and unloading the standard trucks often caused pontoon damage.

Pontoons and superstructure should not be carried on the same vehicle. Pontoon loads and bridge loads should be kept separate.

A Brockway truck would be ideal for handling and hauling pontoon sections.

Most bridge sites were too restricted for the use of trailers or even semi-trailers.

Section 21. Armored or Assault Engineers

It was considered that there was a definite need for specialized armored vehicles, capable of overcoming obstacles and defenses, and affording protection to the crews and operators. Such vehicles proved to be invaluable in the British Army, having materially assisted mobile operation in the difficult plains of Lombardy, with their frequently recurring irrigation ditches. It was felt that armored vehicles such as the ARK, the AVRE, the CROCODILE, and the CRAB would have been of equal value in the U.S. Army.

[p. 315]

Although both British and Americans were agreed upon the necessity for the armored assault vehicles, there was some difference of opinion on the method of holding and operating this type of equipment.

One line of thought considered it wasteful to form special units to operate these vehicles, which could only be used on special occasions. Those supporting this viewpoint felt that, just as prior to a river crossing where engineers and infantry train together with special river crossing equipment, so should engineers, crews of special assault vehicles, and infantry train together before an operation involving the use of armored assault vehicles. The necessary units (companies or battalions) of combat engineers should be trained and used for assault operations as required, reverting to their normal role when no longer needed. Under such a method of operation, the assault vehicles would be held in engineer depots, kept normally in an Army pool, and operated, when issued, by tank personnel. Although the above represented their basic conception as to the general method of holding and operating this equipment, it was agreed, however, that a unit of armored assault engineers should form an integral part of the armored division.

The opposite line of thought favored the organization of assault units similar to the British system under which armoured or assault engineers were formed into assault brigades, consisting of one armoured regiment, RAC [Royal Armoured Corps], and two armoured regiments, RE [Royal Engineers]. The armoured regiment RAC was equipped with flame throwing and flail tanks while the armoured regiment RE has ARKs, AVREs and tank dozers. This system had the great advantage of producing technically and tactically trained, self administered and controlled units, working under their own commanders, and capable of being put in support of a formation at very short notice. It was considered that in mobile operations these units would be continually employed, this being borne out by experience gained during their short spell in action in the Lombardy plains before operations became static. Experience of the Eighth Army showed that one Armoured Engineer regiment in an Army was insufficient.

[p. 326]

At least two regiments were considered necessary. The strength of each regiment was 36 officers and 507 men operating 18 ARKs, 18 AVREs, 18 tank dozers, and 3 Armoured Recovery units. Armoured engineers had to be employed in squadrons or at least half squadrons. They worked as mixed teams of ARKs, AVREs and dozers. Tactical training and tactical command were still necessary. Furthermore the armoured engineers were never employed equally distributed throughout the formations of the Army. They were always wanted where a main effort was made, and subsequently, in the event of a breakthrough, with the Armoured Division.

Experience in Italy was insufficient to provide the basis for a final conclusion as to whether armored engineers should form part of ordinary combat battalions or should be grouped in special battalions. Experience in their employment in all theaters should provide the basis for any decision as to the form of their final organization.

Section 22. Comparison of U.S. and British Water Supply Equipment

1. Purification

The American coagulant sand filter process could operate with higher turbidities than could the British diatomaceous earth process. As a result, much greater production could be attained by the American process.

2. Tankers

The American allocated the 250 gallon 2-wheel tank trailer to organizations and reserved the tank trucks (700 gallons) and semi-trailers (1500 gallons) for hospitals and water hauling companies. Small unit water hauling was accomplished by the use of five gallon cans carried in any vehicle.

The British assigned their tank trucks (250 and 420 gallons) and 150 gallon trailers to organizations. These trucks and trailers were fitted with small filters and were independent of water points.

[p. 327]

Because of their smaller capacity less efficiency per man-truck-trip resulted. The British had no provision for large capacity long hauls and did not operate dry distribution points.

3. *Booster Pumps*

The American direct drive 55 GPM [gallons per minute] pump was a reliable, sturdy pump.

The British variable length, flexible drive 40 GPM pump was excellent for it allowed pumps to be immersed in a source below the suction lift (25 ft) of the standard pump. In addition, two or three pumps could be connected on one drive shaft in series to furnish double or triple the head, or in parallel to provide increased flow.

4. *Storage Tanks*

The 3,000 gallon American canvas tank with staves was very satisfactory because of its large capacity, small leakage, and the flange outlet in which to couple discharge hose.

The British 1,500 gallon canvas storage tank leaked badly and had no provision for coupling discharge hose.

5. *Hoses*

The American 1-1/2", 2", and 2-1/2" rubber hose wore well, but occasionally developed blisters inside. The canvas 1-1/2" discharge hose was of good quality but had high friction loss.

The British armored 2" hose was superior in performance and durability. The canvas 2" hose was inferior in weave and wear.

6. *Chlorinators*

The Americans chlorinated at the water points either with gaseous chlorine or hypochlorite. For clear waters, they used automatic line hypochlorinators, gas "wall" chlorinators, or improved drip chlorinators.

The British chlorinated purified water by hand, the tank truck driver adding hypochlorite powder and sodium thiosulphate

[p. 328]

The British starch-iodide test for chlorine residual was more qualitative, while the American disc comparator was more exact.

Section 23. *Division Engineer Battalion*

1. Personnel

a. It was necessary to operation a ballalion engineer supply dump which stocked field fortification materiel for the use of infantry units. As no personnel were authorized [i.e., available] to operate these dumps, additional personnel had to be attached to the S-4 section.

b. Because it was necessary to build and maintain roads in the division area as well as to support the three regimental combat teams, the three companies had to be divided between four missions. This resulted in greatly decreased operating efficiency and overburdened all personnel. The addition of a fourth company to the battalion would have added materially to the operating efficiency. This would have allowed a more permanent assignment of engineer companies to support RCTs and would have resulted in better teamwork. It would also have reduced the amount of help that was continually required of Corps Engineers for strictly division work.

c. There was usually at least one officer of each company either sick or away on SD or TD. As most jobs required the presence of an officer, regardless of the number of men required, the five officers of each company were not sufficient.

2. Equipment

a. It was felt that 2-1/2 ton 6 x 6 dump trucks should be substituted for the authorized cargo trucks as the majority of engineer hauling was for materiels which could more efficiently be dumped than unloaded by hand. A dump truck could always substitute for a cargo truck, but a cargo truck was never a good substitute for a dump track.

[p. 329]

b. Most roads in the Italian theater were of dirt or gravel, and a motorized grader for each battalion would have greatly facilitated maintenance.

Section 24. Organization and Equipment of Treadway Bridge Company

1. Personnel

Assistant drivers were needed for Brockway trucks. When bridge requirements were heavy, trucks were often in continuous operation for 24 to 36 hours.

2. Equipment

a. Two R/4 dozers were authorized. D-7 dozers would have been more efficient. One of the main uses for a dozer in this organization was to pull mired Brockways out of the mud and an R/4 could not do the job.

b. One half-track as authorized was not needed.

c. Company needed two 3/4 Ton Weapons Carriers; one to supply water and rations, and one for use as maintenance vehicle, to haul parts from ordnance and take parts and repair crew to vehicles broken down on the road. Without these it was necessary to use 2-1/2 ton trucks from the bridge train.

d. Brockway trucks were preferred to 2-1/2 trucks for hauling Bailey Bridges. The 2-1/2 ton truck could not be unloaded at the bridge site as quickly, and the men required to unload 2-1/2 ton trucks could be better employed on bridge construction.

e. Allotment of Brockway and 2-1/2 ton 6 x 6 cargo trucks was satisfactory.

f. A bridge train's worst problem was the maintenance and replacement of Brockway trucks, caused by theater shortage of parts and vehicles.

[p. 330]

Section 25. Heavy Pontoon Battalion

1. The greatest problem of the heavy pontoon battalion was the maintenance and replacement of equipment. This was due largely to two causes:

a. There was only one such unit in the theater and supply stocks were critical.

b. There was a lack of standardization in the manufacture of many items such as trailers, prime movers, cranes and bridge parts. As a consequence it became necessary for the battalion to manufacture numerous replacement items.

2. An important expedient developed to prevent the uneven and excessive settlement of trestle shoes in soft bottoms was a 4' x 20' rigid mat of timber and steel members on which the trestle shoes were placed. This mat provided sufficient bearing on the soft soil for the loads carried over the bridge.

3. As the heavy pontoon bridge was seldom used operationally in this theater, the heavy pontoon battalion was used as an adjunct to the Bailey Bridge depots. It was possible to carry two standard Bailey Bridges on the vehicles of one company of the battalion.

Section 26. Engineer Light Equipment Company

Although the organization of the company was entirely satisfactory to operate its authorized equipment, great difficulties were experienced trying to provide operators for additional necessary equipment assigned by special authorization. It was found that an authorization for additional equipment should be balanced by an appropriate increase in personnel, when this equipment was to be permanently retained by the organization.

It was found the number of dump trucks assigned the company was too small to be of any real benefit, and it was generally felt that an equipment company did not require dump trucks.

[p. 331]

In Fifth Army, the Equipment Company dump trucks were assigned to other units, while the truck drivers were retained to operate extra equipment assigned the company.

To obtain better and more efficient maintenance of equipment, the following additional items of maintenance equipment were required:

a. A heavy engineer shop truck. With a borrowed shop truck the company was able to repair nearly 100% of its own equipment, thus reducing the burden on the medium maintenance company. The equipment company had men capable of making such repairs but were not authorized the tools and equipment. Many small parts not available were made in the heavy shop truck.

b. A charger, battery, portable, 12 volt, 2,000 watt, gas engine drive. Because of the large number of batteries, both six and twelve volt, in the company, the authorized battery charger could not service the batteries as rapidly as was needed.

c. A valve grinding and refacing machine. The lost time required by evacuation of company equipment to engineer maintenance companies for this work would have been eliminated.

d. A compressor, air, portable, gasoline drive, 3/4 HP, six cu. ft., complete with hose. The 4 CFPM air compressor was not sufficient to service the large number of vehicles in the company.

Section 27. Engineer Medium Maintenance Company

Serious difficulties were experienced in the maintenance of engineer equipment within the Fifth Army as only one maintenance company was available to do all the work that should be done by three maintenance companies. Because of this, and the fact that much of the equipment in the hands were old and the operational demands on that equipment were heavy, breakdowns were frequent and the company was greatly overburdened.

[p. 332]

As a result, during the last half of 1944, an average of fifty pieces of equipment were on the "waiting line". In addition, the supply of spare parts was insufficient. This caused unnecessary delay in returning the equipment to units and resulted in overcrowding of shop space because of partially dismantled equipment awaiting parts. If left in the open such equipment was exposed to dust in summer and rain in winter.

To increase the work output the following additional equipment was needed:

a. For main shop.

(1) Press, hydraulic, track, gasoline driven for rebuilding tracks.

(2) Milling machine for rebuilding gears.

(3) Power hacksaw.

(4) Cleaning unit, steam, oil burning for cleaning equipment and assemblies.

(5) Quickway crane. The 10 ton wreckers were limited in the height of lift, it was difficult to maneuver the boom, and they often were not available because it was necessary to use them as prime movers.

(6) Three ordnance parts vans, semi-trailer. It was necessary to store and transport large quantities of parts.

b. For contact platoon.

(1) Lubricator, trailer mounted. Because of the large quantities of equipment to be serviced in the field, hand lubrication methods were impractical.

(2) Gasoline tank trailer, 500 gallons. Large quantities of gasoline were required, and the transport and hauling of 5 gallon cans was inefficient.

(3) Water trailer, 250 gallons. Refilling radiators required a large volume of water which the allotment of 5 gallon cans did not provide.

(4) Valve grinding set. Time and labor were saved by grinding valves on the job and eliminating the necessity of returning equipment to the shop.

[p. 333]

(5) Typewriter. Records and requisitions were required to be typed although the platoon was operating in the field.

Section 28. Engineer Camouflage Battalion

Although a camouflage battalion was authorized for each Army, there were never more than two companies in the theater at one time and only one company after the middle of 1944. Camouflage units with Fifth Army did excellent work. They were often given jobs that required a great deal of imagination and proved to be very good at improvising. They were often required to do more labor than organized for and it was felt that operation would have been more efficient if camouflage companies had been enlarged to approximately the strength of a combat company and made separate units under Army control.

Camouflage units were organized for the supervision, inspection, planning and supply of camouflage projects executed by the troops of the activity or area being camouflaged. However, within this

theater approximately 80% of the camouflage work required was operational. It was necessary for the camouflage company to perform nearly all of the labor on projects. As a result, the company as organized had insufficient men to perform adequately the necessary camouflage work, and was required to procure assistance either from other branches or civilians.

Camouflage units were considered non-combatant and organized from older and limited-service men. Inasmuch as the great majority of camouflage requirements were with front line units the operating efficiency of the units was impaired.

It was found that insufficient transportation was authorized for the camouflage company. It was not practicable to rely on other units for transport of supplies and equipment to job sites. The 3/4 ton weapons carrier authorized could not transport the large amounts of materials and equipment required.

[p. 334]

Section 29. *Engineer Dump Truck Company*

1. *Personnel*

a. Assistant drivers were needed for the company trucks. Using units generally desired the trucks to operate two shifts a day. This could not be done without deadlining some of the trucks to provide the additional drivers. The records of one company indicated that one-third of its truck-days was night work.

b. Because the company is an independent unit it was necessary to divert one man from his normal duties to act as assistant supply sergeant.

2. *Equipment*

a. Dump Trucks.

(1) Short-wheelbase trucks would have been more efficient as they are easier to turn around, load is better distributed, and fewer front springs would be broken than with long-wheelbase trucks.

(2) Inasmuch as winches were seldom needed, it was felt that economy could be effected by providing sixteen winch-trucks (two per squad) rather than have all trucks in the company equipped with winches.

(3) The slope board over the cab was found to be too light to be effective. It broke off too easily, and should be left off or made stronger. Most units found little need for it.

b. Organizational Equipment.

The following additional equipment was found highly desirable:

- (1) One portable air compressor.

There were fifty-three vehicles which had to be greased and painted, and whose tires had to be repaired. During peak operations, the company repaired an average of thirty tires daily, and it was often necessary to repair as many as fifty per day. With only one air compressor, this meant that vehicles had to wait in the motor pool while tires were being repaired when these vehicles were vitally needed on the job.

[p. 335]

Quite often the company was divided into two groups with platoons operating for different organizations. This left one platoon without a compressor which aggravated the difficulties.

- (2) One 3 KW Generator.

The generator was needed for illuminating the motor pool in order that mechanical work could be carried on at night. During pressing operations, the company operated two shifts per day. This required that mechanical work and tire repair also be operated in two shifts to provide proper maintenance.

Section 30. Engineer Depot Company

There was no engineer depot company in the theater during the Italian campaign. Depots which were established, were organized by detachments organized in the theater. As a result of not having available properly organized and trained personnel, there was constantly an overburdening of the detachment. Until early in 1945, Army engineer depots were operated by a platoon which was augmented by attached labor, either soldier or civilian. Trained personnel familiar with all items of engineer supplies were not available. This fact made engineer operations more difficult and often made supply distribution inefficient.

Maintenance of depot operating equipment was difficult because no repair personnel [were] authorized. It was necessary to divert additional men from other duties to maintain this equipment.

Although the depot detachment was organized specifically only to operate one Army engineer Class II & IV depot, it was occasionally found necessary to operate more than one. When more than one depot (four at one period) was operated, the difficulties of administration and operation were correspondingly multiplied.

[p. 336]

Section 31. Engineer Topographic Company

There was only one topographic company to service the entire Fifth Army, although the normal contemplated allotment of topographic units was one company for each Corps and one battalion for each

Army. As a result, this company was constantly overburdened. Because of the abnormal requirements made of this company, the following difficulties were encountered:

a. It was impossible to produce the required amount of work with the equipment authorized. The normal company equipment was augmented so that it was operating nearly the amount authorized for a battalion.

b. Although additional men were not available to operate efficiently on a two shift basis, this was partially overcome by training men in two or three different jobs so that they could be substituted where necessary. However, this practice greatly overburdened the men because of the specialized work they were required to do. As a result, the jobs were done much less efficiently.

c. All supply stocks were always critical.

It was felt that if each Corps had its own topographic company, an enlarged company of approximately 200 personnel could adequately handle the requirements of the Army.

The survey platoon, because of its type of work, always operated away from the company. Many problems of administration and supply were encountered. Since little work of the survey platoon concerned the other two platoons of the company, it was felt that more efficient operation would have been achieved had all ground survey platoons been organized under a central controlling unit.

No provisions had been made for reproduction of non-topographical materials such as posters, charts, holiday greetings, pamphlets, etc. However, the topographic company was frequently required to reproduce these miscellaneous items.

[p. 337]

Section 32. Water Supply Battalion Operations

A. PRODUCTION

1. Mobile Unit

a. Engine exhaust was initially piped through the roof resulting in illness and inefficiency of the operator as well as the danger of the hot gases burning the camouflage net. This condition was remedied by altering the exhaust pipe so that the hot gases and fumes were piped down through the floor.

b. Water pressure gauges, mounted on the pump discharge pipe over the engine, failed frequently due to excessive vibration. These breakdowns were remedied and the gauge made more accessible to the operator by mounting it on the control panel and connecting it to its original fitting with a length of copper tubing.

c. By removal of a stop-lug inside the 5-way valve cover, the simultaneous use of the chemical feed and filter in pre-settling and pre-flock processes was accomplished. This change resulted in the more rapid processing of water.

d. The entire water purification unit was removed from its truck and mounted on a trailer improvised from the salvaged portion of a GMC 2-1/2 ton 6 x 6 truck. This trailer-mounted unit was entirely satisfactory both in mobility and efficiency of operation.

2. *Booster Pumps*

a. There were often instances where the water requirements were greater than the capacity of the standard 55 GPM booster pump. It was necessary to improvise combinations of two or more pumps to do the same job that a single larger pump could have accomplished much more efficiently. A variety of larger pumps could well be included as organic equipment

b. There were many operations requiring the filtering of water from sources inaccessible to the standard pump. As a result these sources either could not be utilized or an unsatisfactory improvisation was made by combinations of pumps.

[p. 338]

If a variable length flexible shaft which could operate around corners, or allow the pump to be immersed in a source below the suction lift of the standard pump had been available, such sources could have been utilized.

B. *DISTRIBUTION.*

(1) Frames of the GMC 6 x 6 tank truck had about 30% breakage at the hole through which the gasoline line passes. The frames were strengthened by the using unit by welding reinforcing plates on the frame at the breakage point.

(2) Vibration of the radiator of the truck-tractor caused leaks to develop. This was partially corrected by insertion of a strip of salvage rubber hose between the radiator and its mounting.

(3) Inadequate support for the rear fenders of GMC 6x6 tank truck resulted in much breakage of fenders and supports. This was corrected by welding the ends of a long strap iron, passed over the tank to the fenders.

(4) Racks of iron bars and angles were installed on the walkway of tank trucks to permit the hauling of miscellaneous equipment.

(5) The use of 2-1/2 ton dump trucks in place of the cargo trucks authorized would have facilitated operations because of the necessity for the construction and maintenance of water point access roads.

C. WELL DRILLING.

(1) Due to the mobility required of the well drilling rig, the skid mounting was unsatisfactory. This was overcome to a certain extent by mounting the rig on a standard 8 ton trailer. More mobility could be achieved by mounting the rig on a truck.

(2) No provision for a supply of water for lubrication of drilling tools was made with the rig as issued. Inasmuch as water was seldom available at the drilling site, a 500 gallon water tank was procured and mounted on the drilling rig.

[p. 339]

(3) Operations would have been expedited had a greater variety of hand tools been furnished with the drilling rig.

(4) Construction of a large tool box on the trailer "kick-up" permitted convenient storage of parts, tools, and miscellaneous equipment.

(5) Operations of the well drilling section would have been more efficient if they had as organic equipment a rear winch truck similar to that issued petroleum engineers.

D. SUPPLY.

(1) Excess equipment and a large reserve of supplies were necessary because the water supply requirements proved to be much greater than the battalion was originally intended to furnish.

(2) Items which were particularly inadequately stocked in depots were 2-1/2" rubber discharge hose, chlorinator parts, pressure gauges, well-screen, well-drilling 2nd and 3rd echelon parts, deep well pump, and spare parts for Waukeshaw and Wisconsin engines. This often caused serious curtailment of operations until requisitions could be filled.

(3) Lumber for construction of water towers, especially platform materiel, was often not available to the water supply battalion because the use of such lumber for bridges was given higher priority.

E. NEW DEVELOPMENTS.

1. Suction Chlorinator

Where the water source was clear, chlorine was accomplished by the installation in a booster pump suction line of a reverse pitot tube connected to a tank of chlorine solution by a hose and valve.

2. Winterized Water Tank

The canvas tank on a water tower was protected against freezing by constructing a shelter of lumber and roofing paper. Two standard immersion heaters were used to keep the water above freezing temperature.

[p. 340]

3. *Portable Water Tower*

Using standard 2" pipe and fittings, a portable water tower was constructed using the same basic design as for the timber tower.

4. *Water Tank Cover Support*

To prevent snow and rainwater from weighing down the canvas water tank cover a support was devised of two lengths of steel tubing forming a cross over the tank, and bent so that the center was 18" higher than the ends which rested on the perimeter of the tank.

Section 33. *Fire Fighting*

1. Fire prevention was considered to be the most important aspect of fire fighting; and, where sites for installations and dumps of inflammable materiel were selected without the advice of fire service personnel, the hazards of fire were considerably increased. The importance of burning over projected sites for gasoline and ammunition dumps, in order to destroy all inflammable materiel such as dried grass and brushwood was strongly emphasized

2. Frequent inspection of installations were made by personnel of the fire service. These proved valuable in making members of the installations more conscious of fire hazards. Recommendations made after each inspection resulted in a further reduction of fire risks.

3. With regard to the siting of chemical extinguishers and the numbers required at dumps and installations, it was found impossible to lay down rigid rules. Such sites had to be visited by fire service personnel and such elements as proximity of water supply, proximity of fire fighting units, and distances between stacks of materiel [were] carefully assessed before an accurate estimate could be formed of the amount of fire fighting equipment required.

[p. 341]

4. The American fire fighting units were equipped to enable them to commence work very quickly but lacked sufficient mobile water tanks to combat large fires. It was found that a minimum of two trucks (total 600 gallons) should be dispatched to every fire, and when more water was necessary the water supply battalions had to be called upon to provide tankers. This later became SOP so that the nearest water supply unit received a fire call at the same time as the nearest fire fighting unit.

The British units were without mobile water tanks and depended upon the availability of local water or static water tanks, which were always erected at installations which had no local water and

where considerable fire risk existed. Their pumping equipment was more powerful than the American, but due to the necessity of using static water took longer to get into action. The British foam producing plant also depended on the use of static water, but was capable of producing larger quantities of foam than the Americans. It was found therefore that the American equipment with its speed of getting into action, and the British equipment with its more powerful pumps and its capability of longer sustained action, formed an excellent combination at any fire. Both types of equipment were dispatched to all large fires when practicable.

5. Gasoline dumps presented no special difficulties. Here again the carrying out of adequate fire precautions beforehand, including the rejection of all leaking cans, the cutting of grass between stacks, and the prevention of all means of ignition were all important. In the actual fighting of gasoline fires it was found that a foam cover of 4-8 inches over the whole area of the fire was necessary to extinguish it.

6. Certain characteristics were discovered about burning ammunition.

a. When water was put on a slag of burning ammunition an explosion resulted. Although this had not the intensity of a normal shell explosion, it was still dangerous.

[p. 342]

b. It took about ten to fifteen minutes after a fire had started for the temperature to become sufficiently high to explode the shells in that stack.

7. Tank dozers were of great value in fighting ammunition fires. They were used initially to shield firemen from flying splinters, but it was found that they could be used to greater advantage in smothering the fire with earth. Firemen played water on the idler wheels of the tank to prevent them from burning, and on the tank itself to keep it cool.

8. When tank dozers were not available ordinary tanks or half-tracks were used successfully to enable firemen to approach the fire close enough to make water streams effective.

9. Bulldozers were invaluable in moving large quantities of materiel, where this was necessary to get at the heart of the fire. This was especially true of fires involving coal or straw.

10. The original two wheel drive trucks issued to American units were found to be incapable of negotiating muddy and icy roads, and had to be exchanged for four wheel drive trucks.

11. Precautions had to be taken in cold weather to prevent the freezing of the lines and pumps. On the return journey from a fire they often froze and had to be thawed out immediately on return. Trucks were kept in heated garages during cold weather.

[end of chapter]

[The document as presented here is - within the limits of the my vision, alertness, and stamina - an accurate rendering of the original; but it is not a "true copy". Occasional misspellings and typographic errors in the

original have been corrected. Further annotations - primarily abbreviation and acronym expansions - and insertions of clearly dropped words appear in 'square brackets'.
- Patrick Skelly, for milhist.net]

[Transcribed 2002-05-29]