SUMMARY

The plastic helmet liner introduced with World War II provided an unusual procurement assignment for the Quartermaster Corps and the Chicago Quartermaster Depot to which the assignment was delegated. At the time it became the Chicago Depot's charge, the liner, necessary auxiliary to the newly conceived steel helmet, M-1, was still in the preliminary design stage, although the new steel helmet already was in production. More than one year's study on the part of the Quartermaster Corps and other branches of the Army had gone into the planning of the organized helmet assembly of steel shell and liner. From this study there were two results: a completed design for a fiber helmet liner and the conclusion that a plastic liner would be more satisfactory and should be designed as soon as possible.

Although the helmet and liner idea had been originally suggested as early as 1932, the first tangible version was derived in large part from a plastic football helmet and suspension invented and patented by John T. Riddell, a Chicago manufacturer of football supplies. The Infantry Board, in early 1941, was first to consider the Riddell football helmet as likely for adaptation in making over the cumbersome and unsafe steel helmet M-1917 of World War I; the Ordnance Department took a hand in the development of sample liners utilizing the football helmet suspension; but before the year was over, the Quartermaster Corps had contributed a great deal of experimentation, and the liner, as a fiber hat worn under a steel shell, had been made a Quartermaster item. The virtue of the M-1

helmet assembly was that it weighed relatively little---three pounds---yet would withstand penetration of a .45 caliber bullet at a 5-foot range. By itself, the liner, weighing only 10 or 11 ounces, was still a safety hat, very useful behind the front lines.

Up to the time the Chicago Quartermaster Depot received its first procurement directive on helmet liners in February 1942, a few hundred thousand of the fiber-type liners had been made on Ordnance Department and Quartermaster Corps order by the Hawley Products Company to fit the steel shells of the new M-1 model helmet being turned out by the McCord Radiator Company. The Chicago Depot continued to contract for the fiber-type liner for more than one year, its manufacture, from mid-1941 to November 1942, totalling 3,900,000. Plans for the plastic liner to replace the fiber item, which from the first had not proved entirely satisfactory, were in the blueprint stage, however, and the Chicago Depot was shortly thrust into the exciting situation of getting firms into production on a new item using a comparatively unfamiliar material, plastic, while meeting immediate demands for the fiber hat.

Although there were those in the Standardization Branch of the Office of The Quartermaster General who expected full-speed production of the plastic liner within six months after its adoption, numerous difficulties stood in the way to prevent this possibility, and in solving them the Chicago Quartermaster Depot played an important role. When full production actually could be acknowledged toward the end of 1942, the Chicago Depot had behind it an experience which included tooling up a new industry, putting its assembly lines in

motion, and meeting a demanding production schedule in the face of many difficulties. Among the problems which were met and solved were the securing of scarce steel to build the helmet liner molds; the training of inspectors who not only could pass on the finished product but could be of aid to plant foremen in solving technical difficulties that arose mainly because of the newness of the item; and accomplishing production at the same time specifications were in process of change.

The plastic helmet liner, approximately 15,000,000 of which were put into production during the first year and a half of procurement, was at first made by two methods. One was a low-pressure molding process which required fairly simple and inexpensive tooling up; this process was adopted, with variations, by two manufacturers, the Hood Rubber Company and the St. Clair Rubber Company. The other process, high-pressure molding, required hard-steel molds which were difficult to obtain because of steel scarcity and the relatively low priority rating on Quartermaster contracts; however, seven manufacturers became equipped for this method, which eventually was decided upon as the process producing the best helmet liner. The high pressure liner manufacturers were the Westinghouse Electric & Manufacturing Company, the Inland Manufacturing Division of the General Motors Corporation, the Mine Safety Appliances Company, the Capac Manufacturing Company, International Molded Plastics, Inc., The Seaman Paper Company and the Firestone Tire & Rubber Company.

Procurement procedure on the helmet liner had several unusual characteristics. Except for the liners bought for the Navy and Marines, by sole directive, Army procurements were made by the Chicago Quartermaster Depot on procurement directives from the Office

of The Quartermaster General, a customary pattern for other items. However, because the most efficient use of the liner demanded a close fit to the wearer's head, it was necessary to buy the liner minus the headband and neckband which made it adjustable to every head size, and to issue the two parts separately to troops. Thus the liner as a complete item became a divided responsibility between the contractors and the Chicago Depot, the former handling the shell and its fixed parts, and the latter, the two detachable components, headband and neckband. Liner contractors were prime contractors, and as such they dealt with suppliers of the hardware and suspension installed in the liner, and were responsible for maintaining all standards of the component items demanded in the specifications. They might manufacture the component items or subcontract, the latter being the plan universally followed. More than 50 manufacturers came to be involved in making the liner and its components as subcontractors or suppliers, while approximately 30 manufacturers made the headbands and neckbands for direct sale to the Chicago Quartermaster Depot. Special attempt was made, in line with War Department policy, to spread contracts among the smaller war plants wherever possible.

In scheduling production of the liner at the plants, two points were foremost in the mind of the procuring depot: one, to meet the master production schedule of the Office of The Quartermaster General which was made up on the basis of needs arrived at in the Army Supply Program; and two, to keep contracts in as close procession as possible, so that the plants would be assured of steady work. By the beginning of 1943, a production of 1,000,000 liners a month could be

depended upon, and production of 1944 could be laid out month by month with fair certainty of delivery.

In the early days of manufacture, production troubles centered largely around delinquencies, which in turn were caused by such factors as technical problems and difficulties in obtaining priorities and in training operators and inspectors. Because specifications were rather broadly written, in order to give freedom on the first contracts, manufacturers tended to experiment, and loss of time in production resulted. Differences in resins and in the duck fabric used as the basis for plasticizing and difficulties in making the paint finish sufficiently dull and sturdy, were technical factors causing delay. Until late 1942, when the AA-rating was given Quartermaster orders, and the Controlled Materials Plan allocating the raw materials steel, copper and aluminum was put into effect, manufacturers could always blame delinquent production on the low priority ratings held by Quartermaster contracts. War Production Board controls on the processing of hides also had an effect on liner production at two distinct periods, in the fall of 1942 and 1943, when manufacturers of leather components of the liner reported they could not complete Quartermaster orders unless tanners were permitted to tan more hides. This difficulty was solved by Quartermaster intervention with the War Production Board. The answer to the shortage problem in some cases was to relax specifications for brief periods. The chief problems in inspection were to train the Government inspectors to observe and correct faults in the finished liners and to make the plant inspectors aware of the numerous parts of the liner, which, individually not meeting specifications, would cause a reject. As time

gave opportunity to observe performance of the liners in the field, the inspection tests of the liner became more stringent. Government inspection on the liner was carried on by a relatively small corps of specialists working out of the Chicago Depot, until the fall of 1943, when the Quartermaster Corps inspection zone plan was set up and inspection duties were divided among three depots. The production of liners got into full swing in the fall of 1943, by which time both the difficulties of production scheduling and control and the distribution snarl of the early days which in part resulted from production delinquency had been overcome.

The history of the helmet liner shows it as an unusual supply item in remaining anything but static in design after the first experimental stages had passed. The biggest change in the liner design was the change from fiber to plastic construction for the shell, resulting in a stronger, longer-wearing item. For this improvement and others which followed, industry and the Research and Development Branch of the Office of The Quartermaster General worked hard and long to examine and perfect any and all suggestions that would make the liner a more comfortable headpiece. The adjustable headband, which eliminated burdensome tariff sizes, was worked out; hardware was redesigned so as to be as comfortable as possible and eliminate many pressure-points on the wearer's head; a chinstrap which could be removed for the delousing operation was developed; and a textured paint coating, less inclined to chip and less reflective, was worked out. Whenever major specification changes occurred, contractors were called upon to alter the items under contract but not yet produced, though care was taken to avoid penalizing manufacturers who had bought up raw materials or supplies they could not use

under the changed specifications. The Chicago Depot had the privilege of permitting completion of any part of an order that was justified before changes according to revised specifications were insisted upon.

By the fall of 1943, when the settling-down period was about over, delivery of 13,000,000 of the liners was scheduled for the end of the year, and contracts had been let for a total production of more than 7,000,000 helmet liners in 1944. At this point, specifications after many revisions were in a more nearly finished state. Cooperation among the helmet liner manufacturers had become noteworthy. Not only were they sending their helmet liners to competitors for criticism, but on occasion they passed on improvements to other firms. The proportion of rejects by the end of 1943 was averaging 1½ percent, compared to approximately 30 percent common in the early days.

As the helmet liner production entered 1944, the number of contractors was reduced from 10 to 6, thereby further improving control by the procuring depot. The cost of the liner, as well as the headband and neckband, had been lowered. While the first plastic liners averaged approximately $1.89 apiece, exclusive of headband and neckband, those for 1944 production were contracted at a top unit price of $1.45 and a low of $1.35; on a procurement of early 1944, the unit prices ranged between $1.34 and $1.43. Not only was the range of prices on the liners growing smaller, but due to some voluntary renegotiation, the actual price on some contracts was as low as $1.24. The adjustable headbands throughout 1942 ranged in price from $0.28 to $0.38½, with an average of approximately $0.31. Contracts of the next year showed unit prices averaging $0.24, with extremes of $0.21 and $0.35; those of 1943 for 1944 production showed a majority of the unit prices at $0.26 and $0.27.

The price of $0.26 is taken as an average at this writing. Neckband prices showed less decline, costing only two and a fraction cents to begin with; by 1944 production they were costing from $0.017 to $0.02. By comparison with the "tin hat" of 1917, which cost the Army at least $2.50 with its "rigging," the helmet and liner of World War II is costing as little, if not less, than its decidedly inferior predecessor.

Helmet liner procurement at this writing may be said to have arrived at an easier stage, with liners coming off the assembly lines at the rate of 800,000 a month, and manufacturers flexible enough to cut back or increase contracts on instruction of the Office of The Quartermaster General. Authority has been delegated as much as possible to the procuring depot, and this "centralization" has made for smoother functioning. The developmental stage of the liner, in which the Chicago Quartermaster Depot participated during its most interesting period, has been completed, and, except for dealing with material shortages, routine procurement is anticipated.