UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

PROCUREMENT AND SYSTEMS
ACQUISITION DIVISION

OCT 26 1976

B-175462

The Honorable
The Secretary of the Army

Dear Mr. Secretary:

We reviewed operations at the Lone Star Army Ammunition Plant located in Texarkana, Texas. Lone Star is a Government-owned, contractor-operated industrial activity under the jurisdiction of the Commander, U.S. Army Armament Command (ARMCOM), Rock Island, Illinois. The plant is operated by Day and Zimmermann, Inc., under cost-plus-award-fee contract DAAA09-71-C-0289. The contract is administered by the commanding officer of Lone Star, who acts as the Contracting Officer's Representative.

The Army relies heavily on plants such as Lone Star for production of ammunition items. We reviewed Lone Star operations to see if there were ways to improve the efficiency and economy of ammunition production. We completed our work at the plant in April 1976.

Essentially, we found that efforts to increase productivity through the development and use of a work measurement program were partially successful at Lone Star but did not fully meet the objectives intended by ARMCOM. In addition, better controls are needed over scrap material generated and rework required at Lone Star. We are bringing our findings and suggestions to your attention in order to assist the Army in its efforts to increase productivity not only at Lone Star but at all Army ammunition plants.

OBJECTIVES OF WORK MEASUREMENT PROGRAM ONLY PARTIALLY REALIZED

ARMCOM guidelines require most contractors operating Government-owned plants under its jurisdiction to develop a work measurement program. The purpose of the program is to (1) increase productivity through the use of performance standards and (2) provide current and reliable work measurement data that can be used to plan, schedule, staff, and control operations and to evaluate performance efficiency.

In December 1974 Lone Star's operating contract was modified to emphasize the development and use of engineered standards in all areas of plant operation. From December 1974 to March 1976, about $2.45 million was claimed as savings resulting directly from the work measurement program. Although benefits accrued from the program, its objectives were only partially realized because:

--Method improvement and line balancing studies needed to establish valid engineered standards for direct labor were not done or were not adequate in some instances.

--Some standards were not used to achieve optimum productivity.

--Standard hours were overstated in some instances.

--Production employees were allowed to quit work early.

--Actual staffing of some production operations was not consistent with standards.

Work measurement is the setting of a time standard by a recognized industrial engineering technique, such as time study, standard data, work sampling, or predetermined motion-time systems. Thus, the key to an effective work measurement program is the development and use of valid labor performance standards. Engineered standards indicate the time necessary for a trained operator to complete a specific task of acceptable quality according to a specified method, working at a normal rate in a specified manner, under average conditions, and allowing adequate time for fatigue and personal needs.

ARMCOM regulations require engineered standards to be used whenever economically feasible because they are considered the most reliable; statistical standards and technical estimates are less reliable but require less time and effort to develop. Although all three types of standards are used to measure worker efficiency, the contractor's work measurement program emphasizes the development and use of engineered standards to the maximum extent possible based on economic considerations.

To test the validity of the contractor's engineered standards for direct labor, we reviewed six ammunition

items assembled in four separate production areas during January and February 1976. We analyzed the engineered standards to determine if they (1) were established with proper work measurement techniques, (2) included method improvement and line balancing studies, and (3) were based on the most economical production rate. We observed production of the six items to see if operations were performed as described in the standards. We also determined whether established production rates were being achieved. The items reviewed were the M12 and M13 tracers, an M17 detonator, M80 and M83 primers, and an M578 fuze. During the 2 months reviewed, 50,645 hours, about 39 percent of all production hours at Lone Star, were used to produce these six items. In addition, a limited review was made on two other items, the M67 grenade and the M72A2 rocket, before their production ended in 1975.

Lack of adequate method improvement studies

Method improvement is a technique used to identify and eliminate unneeded elements or work steps, thereby improving the efficiency of performing each necessary operation. Adequate method improvement studies should result in a balanced production line--a line with a constant material flow and efficient use of personnel. It is important that standards be reestablished or revised after method improvements are identified and implemented; otherwise, the standard will perpetuate any inefficiencies in the existing process.

Contractor procedures recognize that standards should be based on a prior, documented method improvement analysis. We found that this was not done for the six items reviewed at Lone Star. Several method improvement proposals affecting three of the six items reviewed were submitted after the standards were established. Further, based on our observations we do not believe the method improvement efforts associated with the development of engineered standards were as productive as they could have been. The following examples are illustrative:

1. In June 1975 subcomponents for the M12 tracer were purchased preassembled; this eliminated assembly operations performed by three workers. Although the standard for the M12 was being developed at the time, this alternative was not identified through simultaneous method improvement efforts. See page 9, example 4, for additional detail.

2. Eight workers were assigned to assemble a subcomponent of the M578 fuze when only five were needed. As a result, the eight workers could assemble more subcomponents in 3 days than were needed for 5 days of production. They were assigned additional duties on the fuze line during the rest of the week, but this was not recognized in the standard. According to the standard, these workers were not needed for other assembly line operations. Contractor personnel stated that staffing for the assembly of this subcomponent was based on the existing line layout and the assumption that the line would normally be operated each day of the month. Apparently no study was done to determine correct staffing based on actual operating time.

3. Overall, in over one-third of the assembly and packout operations applicable to the six items we reviewed, workers were utilized during less than 70 percent of their available time. Several operations requiring less than 50 percent of a worker's time were staffed with a full-time worker.

Government contract administration personnel generally agreed that adequate method improvement studies had not been made. They also agreed that proper line balancing was lacking on some production items. We noted that they had been critical in past performance evaluations of the contractor's method improvement and line balancing efforts; however, we found that few improvements were made as a result of these evaluations.

Standards not set at optimum production

It is ARMCOM policy to establish, implement, and maintain appropriate standards to achieve optimum productivity of contractor personnel operating Government-owned ammunition plants. ARMCOM defines optimum productivity as the lowest labor rate per unit.

Standards established at the most economical production rate provide a sound basis for (1) measuring production efficiency and (2) determining the impact on production cost of schedule changes or other production options.

Proper work measurement techniques were used at Lone Star in developing engineered standards for individual

operations. However, the standard established for each item was based on a monthly production schedule rather than an evaluation of the standards develcped for the individual operations. These schedules, set by ARMCOM in consultation with Lone Star, were not always set at the most economical production rate. For example, the standards for the M67 grenade and M72A2 rocket were established in December 1974 and February 1975, respectively. The standards were based on the production schedule in effect at that time, which called for 13,500 M67s and 2,000 M72A2s per shift. At the same time, the contractor was reporting to ARMCOM in a quarterly production capacity report that the optimum rates were 28,000 per shift on the M67 and 3,000 per shift on the M72A2. In March 1975, the contractor estimated the processing costs on the M67 and M72A2 could be reduced 19 percent and 20 percent, respectively, based on reported optimum rates of 30,000 and 3,000 per shift. We estimated the cost of the two items could have been reduced by over $600,000 in 1975 if production had been set at the higher rates.

We discussed this with Government contract administration and contractor officials, and they stated that production schedules were not increased because ARMCOM could not provide the additional Government-furnished materials. We then contacted ARMCOM officials, who confirmed that the additional material could not be provided and attributed the material shortage to the recent reduction in ammunition requirements which has led to fewer suppliers for many of the ammunition components and to the extended leadtimes involved in getting new vendors established. Further, the ARMCOM officials did not know why the M67 and M72A2 were not originally scheduled at the higher production rates.

As illustrated above there was potential for a significant increase in productivity and a decrease in cost on these items. However, under the established standard the performance effectiveness rates averaged 100 percent on the M67 grenade and 97 percent on the M72A2 rocket during 1975.

The M578 fuze is another example of this problem. The engineered standard on this item was based on a scheduled production rate of 3,600 units per shift at a time when the contractor was reporting an optimum production rate of 4,500 units per shift. The line superintendent advised us that this line could produce up to 5,500 units per shift with the staffing provided under the standard. We were also advised that this would be the optimum rate, which indicates that

the reported optimum rate was understated. It is apparent that the unit cost of this item could be reduced significantly at the higher production rate; also, productivity would be improved considerably. This fact is not apparent from the performance effectiveness rate derived from the standard. For example, the reported performance effectiveness on this item was 106 percent in January 1976, indicating that little if any improvement could be made in the production process.

Contractor and Government personnel agreed that monthly production schedules are not always set at the most cost-effective rate. They also agreed that standards were based on producing according to a monthly production schedule.

In order for ARMCOM to effectively schedule and coordinate production for all Army ammunition plants, it needs to know each plant's capacity and the most economical production rate. We believe the most economical rate should be established as the standard to which all production should be compared.

Standard hours overstated

Labor standards are designed to allow management to compare actual worker time to a time which represents what can be expected of the average worker under normal conditions. Management needs such information to evaluate worker performance and to determine the reasons for deviations from the standard.

The engineered standards reviewed were developed by establishing standard times for each operation in the production process. The standard times obtained were then used to determine production rates per operation and the total number of operators needed.

We found that some standards overstated the time necessary to produce an item. Actual shift production rates consistently exceeded the standard production rate for five of the six items reviewed. The following schedule shows actual and standard shift production rates for the months of January and February 1976.

Item	Standard production rate	Actual production (note a) January	Actual production (note a) February
M12 tracer	5,000	5,100	5,100
M13 tracer	6,000	6,400	6,400
M17 detonator	10,750	13,000	13,000
M80 primer	5,000	4,465	5,151
M83 primer	6,000	6,255	5,300
M578 fuze	3,600	3,750	3,810

a/M80 primer figures are averages; all others are modes.

Additionally, we found that the M578 fuze was produced at the rates shown above with an average staffing of 83 workers. For 38 production shifts reviewed, the staffing met or exceeded the standard staffing of 99 workers only five times. This appears to support the line superintendent's statement that with 99 workers 5,500 fuzes could be produced per shift. Similar staffing fluctuations were noted for other items although they were not as pronounced. When standard production rates can be met or exceeded consistently with fewer than the standard hours, the accuracy of the standard becomes questionable. Overstating the hours necessary to produce an item distorts performance effectiveness and can result in a loss of productivity.

Attainable productivity not realized

Production line employees are paid at an hourly rate and are therefore expected to be productive until normal shift quitting time. We observed some production line operations shutting down when a predetermined production rate was achieved, and employees were allowed to leave the line before completion of the shift.

We discussed our findings with Lone Star officials and were informed by the plant manager that he authorized the line superintendents to allow production employees to quit work early as a reward for outstanding performance. The plant manager said he initiated the program to change "anti-standard" attitudes and to increase productivity. Management personnel of the Contracting Officer's Representative were unaware of the employees quitting work early.

Production employees are allowed break periods and cleanup time under union agreement. In addition, the standards contain allowance times for such contingencies as fatigue, delay, and personal needs. Therefore, we believe

the additional time allowed was inappropriate and resulted in an unwarranted loss of productivity.

For example, on one occasion we observed workers leaving the M12 tracer production line approximately 45 minutes early. Based on the standard production rate of 12.5 items per minute, an additional 563 items could have been produced had the workers not quit before the end of their shift. This additional number of items would have represented an 11-percent increase in productivity for that day.

As a result of our discussions, the plant manager discontinued the practice of allowing employees to quit work before the end of their shift.

Standards not consistent with actual operations

Direct labor standards must be consistent with actual operations if they are to provide meaningful and reliable information on production effectiveness. In our random observations during the 2-month period of January and February 1976, we observed several instances in which actual operations relating to the six items reviewed were different from those on which the standard was based.

The following examples are illustrative of the differences we found:

1. A worker on the M578 fuze performed an operation which required 44 percent of his time according to the standard. The standard did not identify any additional operations performed by this worker. We observed that the worker was assigned additional tasks once the shift production rate was achieved. This would distort the performance effectiveness reported on this item.

2. The standard on the M578 fuze reflected a continuous production operation with many workers performing only one task and with many utilized less than 70 percent. To reduce idle time, actual operations on the M578 fuze were performed in steps; part or all workers were used to perform a particular portion of the operations on one day and were used on succeeding days to complete the production. This change in the production process invalidated the standard and distorted performance effectiveness ratings.

3. Actual staffing on the M12 tracer varied from 38 percent below to 16 percent above the standard during January 1976.

4. Four operation on the M12 tracer requiring three workers were eliminated by purchasing components preassembled instead of separately, as was previous practice. The three workers no longer needed for this assembly operation remained on the line performing other operations. This change in the process should have been reflected in the standard, and the three workers should have been dropped from the line. Contractor personnel stated that these workers were needed to perform inspection of the tracer bodies. A review of inspection records disclosed only 56 hours, about 2 percent of available hours, charged to inspection of the tracer bodies. Failure to remove the operators not only distorted performance effectiveness but resulted in an unnecessary cost of about $42,000 for this item.

We believe the discrepancies noted could have been avoided or corrected had the auditing functions been performed in a timely manner. Contractor officials agreed that some of the discrepancies noted were not corrected in a timely manner. Government contract administration personnel indicated their evaluation of the contractor's performance was accomplished by randomly auditing the standard studies. Their goal of one in-depth audit per month had not been accomplished due to other higher priority work. As can be seen from the examples given, the failure to identify and correct these discrepancies led to inefficient practices and excessive costs.

BETTER CONTROLS NEEDED OVER SCRAP AND REWORK

In manufacturing processes which require the input of large quantities of materials and labor, the quantity of scrap material generated and the amount of rework required to achieve an acceptable product can be the difference between an efficient and inefficient process. It is important, therefore, to have adequate control over scrap and rework. If practicable, normal or acceptable scrap and rework rates (standards) should be developed and routinely compared with actual rates. When large deviations occur, management should determine the cause and take corrective action. In addition, there should be a criterion for determining when an item should be scrapped or reworked.

Lone Star had not developed normal or acceptable scrap or rework rates for any of the ammunition items it produces. Also, considerable in-process rework occurs without an analysis of whether it is cost effective.

Scrap

The contractor prepares two daily in-process scrap reports. One is prepared by production supervisors and is used by quality control personnel to prepare monthly scrap reports. The other is prepared by quality control inspectors and is used to update inventory records. Neither report is routinely used by higher level management personnel to monitor scrap.

The two reports varied widely in scrap reported during 1975. We could not reconcile these differences, but contractor officials said they felt the report prepared by quality control inspectors more nearly reflected actual experience with scrap.

For the purpose of award fee evaluation, the contractor was asked to conduct an in-depth analysis of in-process scrap and to determine the appropriate scrap rate on about one-third of the items produced during the period March-August 1975. In-process scrap was determined from the production supervisor's report because this report contained a more complete explanation of the causes for the scrap. Scrap rates varied from .34 to 10.26 percent of production costs on the items studied.

We believe this study was a step in the right direction but was of limited value because it was based on inaccurate data contained in the production supervisor's report and established no standards as benchmarks for management concern and action.

The contractor is developing an automated management information system which will include in-process and end-item scrap reports. If properly implemented, this system should provide accurate and reliable data on scrap and a basis for establishing standards. The part of the system providing these reports is not expected to be implemented until 1979 because of the low priority assigned to it. Government contract administration officials indicated that in the meantime they will monitor the contractor's efforts to reduce scrap.

Rework

Decisions to rework or replace parts should be based on economic considerations. We believe management should have a clearly stated, economical rework criterion, such as the maximum acceptable ratio of the cost to rework a part to the cost of other alternatives--for example, purchasing a replacement part.

ARMCOM requires the contractor to submit cost estimates on rework of finished production. However, this is not required for in-process rework. In-process rework costs are normally included in regular production cost and are not separately identified. Therefore, the cost of in-process rework and whether it was cost effective cannot be readily determined.

For example, we were informed that certain subcomponents of the M578 fuze had been reworked as many as five times. There was no analysis to determine if this in-process rework was cost effective. We believe management needs such information to preclude the possibility of doing in-process rework which is not cost effective if other alternatives are available. We also believe information should be obtained on the total cost of in-process rework and used by management to identify and eliminate possible problem areas.

Lone Star officials agreed that there is considerable in-process rework. They also agreed that rework criteria were needed and indicated rework operations at Lone Star will be reviewed by examining individual items and establishing a break-even point to determine whether rework is cost effective. In determining this break-even point, we believe consideration should be given to the possibility that an item may have to be reworked several times, as in the example of the M578 fuze above.

CONCLUSIONS AND RECOMMENDATIONS

Although Lone Star had made notable progress in its work measurement program, it was not achieving the results intended by ARMCOM because of deficiencies in the direct labor standards program. In addition, Lone Star was not achieving attainable productivity of production personnel.

Lone Star had not developed normal or acceptable scrap and rework rates for the ammunition items produced. Without reliable rates to use as standards, excessive costs could result. Also, criteria had not been developed for

in-process rework. Such criteria are needed to preclude uneconomical in-process rework.

Although we limited our review to Lone Star, we believe our findings could apply to other Army ammunition plants. Therefore, we recommend that you take appropriate action to have ARMCOM

--review the work measurement programs established at the Army ammunition plants to insure that objectives are being accomplished,

--review the optimum production rates reported by the Army ammunition plants to determine if they are the most economical rates and when economically feasible schedule production at these rates, and

--require contractors operating Government-owned ammunition plants to establish normal or acceptable scrap and rework rates and rework criteria.

In regard to these recommendations, as you know, section 236 of the Legislative Reorganization Act of 1970 requires the head of a Federal agency to submit a written statement on actions taken on our recommendations to the House and Senate Committees on Government Operations not later than 60 days after the date of the report and to the House and Senate Committees on Appropriations with the agency's first request for appropriations made more than 60 days after the date of the report.

We are sending copies of this report to the Director, Office of Management and Budget, the Secretary of Defense, and interested congressional committees.

Sincerely yours,

R. W. Gutmann
Director