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R E P O R T
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ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1477.

The Application of Quality Control to the
Inspection of 20-mm. Hispano-Suiza Ammunition.
(First Report).



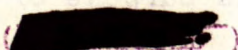
Bureau of Mines
Division of Metallic
Minerals

Ore Dressing
and Metallurgical
Laboratories

CANADA

DEPARTMENT
OF
MINES AND RESOURCES
Mines and Geology Branch

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(CIRCULATION)

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Origin of Request:

Early in July, 1943, a request was made by Lt.-Col. F. W. Huggins, of the Directorate of Small Arms and Small Arms Ammunition, Inspection Board of the United Kingdom and Canada, Ottawa, Ontario, that the possibility of applying Quality Control to the inspection of the 20-mm. Hispano-Suiza ammunition be investigated. Plant visits were made in order

(Origin of Request, cont'd) -

to observe case manufacture and test, as well as fuze filling, shell filling, and assembly of rounds.

At a discussion of the subject, held at Quebec on July 29th, 1943, a committee was set up for the purpose of investigating Quality Control and determining its application to the inspection of this 20-mm. ammunition. This committee is composed of:

Chairman: Group Captain D.W.R. Ryley,
Montreal, Quebec.

Capt. W.L. Sheldon,
Quebec, Quebec.

Capt. M. J. Ward,
Ottawa, Ontario.

Lieut. J. F. Weston,
Montreal, Quebec.

Flight Lieut. S. A. Burns,
Toronto, Ontario.

Consultant: H. H. Fairfield,
Physical Metallurgy Research
Laboratories, Bureau of Mines,
Ottawa, Ontario.

The discussion dealt with the general nature of Quality Control, its application to inspection, and what it might contribute to the inspection of 20-mm. Hispano-Suiza ammunition. It was emphasized that the first step in Quality Control was an analysis of the process from available test data. A meeting of the committee was tentatively scheduled for August 25th.

This first report contains a discussion of the general nature of Quality Control.

DISCUSSION OF QUALITY CONTROL.

What is Quality Control?

Quality Control refers to the analysis of test results by certain statistical procedures. Usually a chart is made of the data. The chart gives a graphic survey of manufacturing conditions.

Does Quality Control Differ from Regular Inspection?

Quality Control is merely an analysis of inspection results. The method of inspection used will depend upon the judgment of the inspection officials. After considering all the information bearing on a product, a method of inspection will be established. The purpose of Quality Control is to provide more information than is ordinarily available, so that the choice of an inspection method can be based on more factual evidence.

What Type of Information Does Quality Control Give?

All measurable properties of material, either manufactured or as found in nature, are subject to variation. In recording a series of tests it is desirable to know whether the variation observed is:

- (1) Normal Variation - that is, one due to a system of causes inherent in a process, each of which continues to exert the same effect on the final product. (This condition is called "under statistical control").
- (2) Erratic Variation - that is, one due to the irregular occurrence of assignable causes for lack of control, or due to one or more of the process variables going 'haywire'. (This condition is called "out of statistical control").
- (3) Cyclical Variation - this type of variation is readily observed by long runs (seven or more) of results on one side of the average. This condition is also out of statistical control, unless it is found that the cycles recur in a definite pattern.

Of What Use is the Information Obtained Through Quality Control?

When Quality Control has been used successfully, it has been found that very slight deviations from normal are detected. These are generally forewarnings of future defectives. Where the first deviation from normal is investigated, usually a cause for the deviation is found and corrected. A gradual improvement in the process takes place until it is under statistical control. When evidence is finally obtained that the process is under statistical control it is often possible to reduce the man hours of inspection per piece.

The value of the information depends upon whether or not it is possible to get the process under control. If no corrective action can be taken after the presence of definite causes for variation has been detected, Quality Control is merely a system of recording data.

Where Does Quality Control Apply to 20-mm. Ammunition?

There are three uses for Quality Control in the inspection of 20-mm. ammunition:

- (1) MANAGEMENT - As a form of record by means of which an overall picture of the product quality may be obtained.
- (2) INSPECTORS - A record of routine inspection of components.
- (3) ENGINEERS - A method of studying the results of special investigations.

Since it has been decided to study the application of Quality Control to 20-mm. ammunition, records of each of the above types should be maintained over a long enough period of time in order to see if they prove to be useful.

(Continued on next page)

(Where Does Quality Control Apply to 20-mm. Ammunition, cont'd) -

(1) Quality Control for Management

Management requires an overall picture of product, and must delegate detail work to specific individuals. The records for management will therefore deal with results on lots. The three most important tests are

- velocity,
- pressure,
- accuracy.

Other tests may become of interest, such as velocity required for detonation of fuze, dry velocity minus wet velocity, etc. Management is also interested in an overall picture of the per cent of rejects, for case defects, fuze defects, shell defects, and final round defects. The purpose of these records is:

- (a) To make the interpretation of large quantities of observations easier.
- (b) To obtain assurance that a consistent product is being made.
- (c) To point out the need for corrective action on certain phases of the process.

(2) Quality Control for Inspectors

The policy of inspection has been stated as:

"Not one defective round shall pass into the hands of the forces". Inspectors should therefore concern themselves not only with weeding out defectives after they have been made, but also with detecting bad manufacturing conditions and trying to eliminate the causes of defectives. The purpose of Quality Control in the hands of inspectors is to enable them to be more alert to dangerous variations in the process.

(Continued on next page)

(Where Does Quality Control Apply to 20-mm. Ammunition,
cont'd) -

Some test values which could be plotted at regular intervals are:

- depth of cap chamber,
- height of anvil,
- height of cap in case,
- weight of scoop load for detonator,
- weight height and specific gravity of pressed pellets,
- height of explosive in shell,
- powder load in case,
- load to pull shell from case,
- hardness tests,
- number of split shells,
- explosive force (pressure bar test).

Such tests as are at present recorded in quantitative form can be plotted in control charts quite readily. They should be maintained up to the minute by the inspector performing the test with the aid of engineering supervision. A trial period of about two months should show whether or not they would serve a useful purpose.

Where 100 per cent visual or gauge inspection is used, a record is usually kept of the defects per lot. It is recommended that fraction defective charts be kept for each regular type of defect. This will give a graphic indication of variation in the process, and may prove of value in correcting irregularities in the process. The data available on fraction defective concerns cases, fuzes, shells, and final rounds.

(5) Quality Control for Engineers -

Engineers in charge of inspection after surveying the information contained in inspectors records may wish to change the inspection practice. Before making any change it may be advisable to collect special information. An example of this is shell loading. At present

(Where Does Quality Control Apply to 20-mm. Ammunition, cont'd) -

there is some doubt as to the density of the compacted charge. Since density may affect prematures, control of this property is very important. Therefore, it may be necessary to devise a density test which will be carried out until it is certain that the pressing operation is under control. Pressure readings on the press may also be required, as well as the regular dimensional measure of pellets and height of final charge.

Quality Control charts give the most scientific analysis of the performance of different machines. Since the quality of the product rests mainly on the type of machine used, it will be necessary to evaluate the performance of different production machinery from time to time.

Another special test might be a roughness measurement on the inside of the shell. Rough surfaces may affect prematures. Brush Surface Analyzer readings may be necessary for a certain period in order to ensure that surface finish is controlled.

Why Attempt to Improve the Process; Does Not 100 Per Cent Inspection Eliminate The Possibility of Defective Ammunition?

The Northern Electric Company, the Westinghouse Electric Company, and the United States Ordnance have investigated the ability of skilled inspectors over a period of time. The results indicate that inspectors will pick out about 85 per cent of the defective material.

This observation is borne out by the fact that after 20-mm. cartridge cases are thoroughly inspected at the St. Malo Arsenal, defectives are found on reinspection by the Inspection Board of United Kingdom and Canada. Assuming that one inspection operation picks out 90 per cent of the

(Why Attempt to Improve the Process, cont'd) -

defectives, and the manufactured product is 2 per cent defective, then two 100 per cent manual inspection operations will still leave $0.02(0.10)^2 = 0.000200$ defectives, or 200 defectives per million.

The greater the number of defectives manufactured, the greater is the possibility that defective ammunition will be released.

Therefore, it is more desirable to correct the condition at the source than to try and weed out defectives after they are produced.

CONCLUSIONS:

Quality Control is a method of analyzing observations.

The information obtained through Quality Control might possibly result in an improved product, lowered cost, less defectives, less work in inspection. If the causes for variation in product detected by Quality Control technique cannot be eliminated, then the system will prove useful only as a form of recording data.

After a superficial observation of 20-mm. production and inspection, it was proposed that available records be analyzed in order to get a scientific survey of the history of the product. It will then be necessary to submit the control chart records to those in charge of inspection in order to see if the information they contain can serve a useful purpose.

A trial period of about two months should prove whether or not a control chart for a certain variable is assisting inspection.

In order to correct the impression that Quality

(Conclusions, cont'd) -

Control reduces inspection it is necessary to state that the reverse is equally possible. Quality Control requires that the process be studied very thoroughly. Therefore, at the start of the program an increase in the work done on inspection is necessary. If the causes for variation in the product can be brought under control, then inspection practice may be changed.

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