

January 4, 1981

TO: B. W. CULPEPPER, M.D. *RUC*
FROM: S. PELL *SP*

SAMPLING OF X-RAYS TO ESTIMATE
PERCENT DEFECTIVE

The purpose of the procedure described here is to determine, on the basis of a random sample of x-rays, whether the proportion of defective x-rays taken at a given Company site exceeds an acceptable limit, or standard.

After a random sample of x-rays is drawn, the films are examined to determine how many in the sample do not meet certain technical standards. Those that do not will be counted as defective. If the percent defective in the sample is significantly greater than the percent that is specified as the acceptable limit, it will be concluded that the x-rays at the plant do not meet the required standards.

The data presented here are based on the following conditions and procedures.

- The acceptable limit of the proportion of defective x-rays is 10 percent.
- A test of significance will be done to test the null hypothesis that the percent defective at the site does not exceed 10 percent.
- The level of significance that will be used to decide whether the percent defective in the sample is significantly greater than 10 percent will be 0.05 (one-tailed).
- If the percent defective in the sample is not significantly greater than 10 percent, the x-rays at the site will be rated as "acceptable." If not, they will be rated, "not acceptable."

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- Because of sampling error, there will be instances when the percent defective in the sample will not be significantly greater than 10 percent, even though the true percent defective at the site is, in fact, greater than 10 percent. Therefore, allowance will have to be made for a certain deviation from the standard; that is, the difference between 10 percent and a greater percentage that may actually be the true percent defective at the site. The amount of this deviation is designated, E. Thus, if the true percent defective is 15, the value of E is 5 (15 minus 10).

- The sample size will be large enough to insure, with a probability of 0.80, that the x-rays will not be rated as acceptable when, in fact, the value of E exceeds a specified amount. The probability, 0.80, is called the "power of the test." It is the probability of correctly concluding that the percent defective at the site is greater than 10 percent. The sample size required to attain this level of probability depends upon the value of E. The smaller the value of E, the greater is the required sample size. Thus, to determine the required sample size, it is necessary to decide first how much of a deviation from the standard one is willing to accept and then balance this decision against the feasibility of utilizing the required sample size.

The attached table and chart show the required sample size for various values of E. If a sample of 69 is selected and the true percent defective is 20 percent, the probability is 0.80 that one will correctly conclude from the sample that the percent defective at the site is greater than 10 percent, ie, classify the quality of the x-rays as "not acceptable." If, however, a sample of 69 is selected and the true percent defective is 15 percent (rather than 20 percent), the probability is only 0.41 that one will correctly conclude that the quality of the x-rays is "acceptable."

Thus, if a deviation of 10 percent (20-10) is tolerable, a sample size of 69 is adequate, but if one does not want the deviation to be greater than 5 percent (15-10), it would be necessary to select a sample size of 252, as indicated in the table.

Selection of a Sample Size

In summary, the choice of a sample size to make an assessment of the quality of x-rays at a given site must be based on the following considerations.

- The selection of an acceptable proportion of defective x-rays that will serve as a standard.

- The selection of a certain degree of deviation from the standard that is considered tolerable (the value, E).

- The selection of a level of significance for determining whether the sample percent defective is significantly greater than the percent defective selected as the standard.

- The selection of a probability value (power of the test) to provide reasonable assurance that the sample percent defective will be found to be significantly greater than the standard when the fact the true deviation from the standard exceeds the value, E.

- The selection of a sample size that would not require an undue expenditure of time and money to assess each x-ray in the sample:

On the basis of these considerations, a sample size between 65 and 80 would probably be optimum.

SP:msd
Attach.

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REQUIRED SAMPLE SIZE TO TEST THE
 HYPOTHESIS THAT THE PERCENT DEFECTIVE IS
 NOT GREATER THAN 10 PERCENT, ACCORDING
TO VARIOUS VALUES OF THE TRUE PERCENT DEFECTIVE*

True Percent Defective	Deviation E+	Required Sample Size
15	5	252
17	7	134
20	10	69
22	12	49
25	15	33
27	17	26
30	20	19

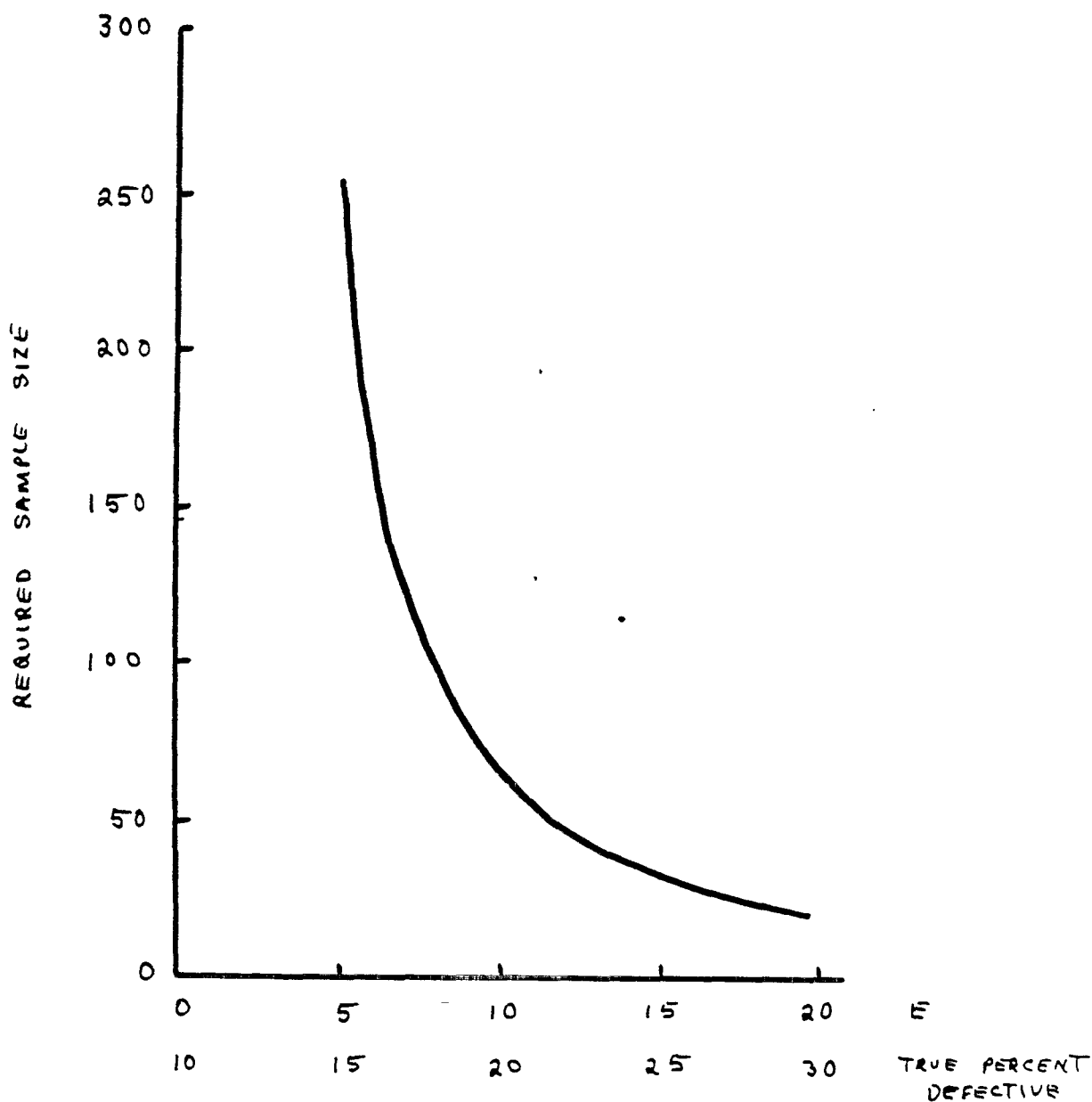
*Level of significance = 0.05
 Power = 0.80

+Difference between true percent
 defective and 10 percent.

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REQUIRED SAMPLE SIZE TO TEST THE
HYPOTHESIS THAT THE PERCENT DEFECTIVE IS
NOT GREATER THAN 10 PERCENT, ACCORDING TO
VARIOUS VALUES OF E AND OF THE TRUE PERCENT DEFECTIVE*



* Level of significance = 0.05
Power = 0.80