![DUNE Deep Underground Neutrino Experiment]	PROCEDURE

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REVISION HISTORY			
Version	**Description of Change**	**Author**	**Effective Date**
0	Initial release	Kevin Fahey	19Feb2019
REFERENCE DOCUMENTS			
Document ID Number	**Document Title**		
ISO 2589-1	Sampling procedures for inspection by attributes		

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Documents referenced in this procedure are applicable to the extent specified herein.

1   Purpose

The purpose of using sampling plans is determine the acceptable quality of an entire population without inspecting or testing the entire population. The sample size selected will be based on industry recognized standards.

Ad hoc sampling should not be used because it will lead to unknown risks that may be too high. Furthermore, there is no formal basis for either the acceptance or non-acceptance of the lot. Examples of ad hoc sampling include the sampling of a fixed percentage of a lot or a convenience sample taken at haphazard times.

2   Scope

This guideline will be used when it has been determined that the population is too large to inspect/test each item, some of the items are inaccessible, if the inspection/test is destructive, or a sample may be more accurate than inspecting/testing the entire population.

3   Definitions

Acceptance Quality Limit (AQL) – Quality level that is the worst tolerable process average when a continuing series of lots is submitted for acceptance sampling.

Lot – Definite amount of some product, material or service, collected together.
Note: An inspection lot may consist of several batches or parts of batches.

Lot Size – Number of items in a lot.

Sample – Set of one or more items taken from a lot and intended to provide information on the lot.

Sample Size – Number of items in the sample.

Sampling Plan – Combination of sample size(s) to be used and associated lot acceptability criteria. A sampling plan is a detailed outline of which measurements will be taken at what times, on which material, in what manner, and by whom. Sampling plans should be designed in such a way that the resulting data will contain a representative sample of the parameters of interest and allow for all questions, as stated in the goals, to be answered.

Normal Inspection – Use of a sampling plan with an acceptance criterion that has been devised to secure the producer a high probability of acceptance when the process average of the lot is better than the acceptance quality limit.
Note: Normal inspection is used when there is no reason to suspect that the process average differs from an acceptable level.

Tightened Inspection – Use of a sampling plan with an acceptance criterion that is tighter than that for the corresponding plan for normal inspection.
Note: Tightened inspection is invoked when the inspection results of a predetermined number of consecutive lots indicate that the process average might be poorer than the AQL.

Reduced Inspection - Use of a sampling plan with a sample size that is smaller than that for the corresponding plan for normal inspection and with an acceptance criterion that is comparable to that for the corresponding plan for normal inspection.

NOTE 1: The discriminatory ability under reduced inspection is less than under normal inspection.

NOTE 2: Reduced inspection may be invoked when the inspection results of a predetermined number of consecutive lots indicate that the process average is better than the AQL.

4   Sampling Plans

4.1   Steps involved in developing a sampling plan are:
    4.1.1   Identify the parameters to be measured, the range of possible values, and the required resolution.
    4.1.2   Design a sampling scheme that details how and when the samples will be taken.
    4.1.3   Select sample sizes.
- What population parameters we want to estimate
- Cost of sampling (importance of information)
- How much is already known
- Spread (variability) of the population
- Practicality: how hard is it to collect data
- How precise we want the final estimates to be

    4.1.4   Design data storage formats.
    4.1.5   Assign roles and responsibilities.
4.2   Inspection Level
The inspection level designates the relative amount of inspection. Three inspection levels, I, II and III, are given in Table 1 for general use. **Unless otherwise specified, level II shall be used.** Level I may be used when less discrimination is needed or level III when greater discrimination is required. Four additional special levels, S-1, S-2, S-3 and S-4 are also given in Table 1 and may

be used where relatively small sample sizes are necessary and larger sampling risks can be tolerated.

The inspection level required for any particular application shall be specified by the responsible authority. This allows the authority to require greater discrimination for some purposes and less for others.

At each inspection level, the switching rules shall operate to require normal, tightened and reduced inspection. The choice of inspection level is quite separate from these three severities of inspection. Thus, the inspection level that has been specified shall be kept unchanged when switching between normal, tightened and reduced inspection.

In the designation of inspection levels S-1 to S-4, care shall be exercised to avoid AQLs inconsistent with these inspection levels. For instance, the code letters under S-1 go no further than D, equivalent to a single sample size of 8, but it is of no use to specify S-1 if the AQL is 0,1 %, for which the minimum sample size is 125.

The amount of information about the quality of a lot gained from examining samples drawn from the lot depends upon the absolute size of the samples, not upon the relative size of the sample to the lot size, provided the sample is small relative to the lot that is examined. In spite of this, there are three reasons for varying the sample size with the lot size:

a) When the loss due to a wrong decision is high, it is more important to make the correct decision.

b) With a large lot, a sample size can be afforded that would be uneconomic for a small lot.

c) Truly random sampling is relatively more difficult if the sample is too small a proportion of the lot.

4.3 Sample size code letters
Sample sizes are designated by sample size code letters. Table 1 shall be used to find the applicable code letter for the particular lot size and the prescribed inspection level.
Note: For economy of space in the tables or to avoid unnecessary repetition in the text, the abbreviated term "code letter" is sometimes used.

4.4 Obtaining a sampling plan.
The AQL and the sample size code letter shall be used to obtain the sampling plan from Table 2.

For a specified AQL and a given lot size, the same combination of AQL and sample size code letter shall be used to obtain the sampling plan from the table for normal, tightened and reduced inspection.

There are basically two tables. Table 1 tells you which 'code letter' to use. Use this code letter in Table 2 to provide you with the sample size and the maximum numbers of defects that can be accepted and rejected.

How to read Table 1:

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If you follow the example, the 'lot size' is comprised between 3,201 pcs and 10,000 pcs, and the inspection level is 'II'. Consequently, the code letter is "L".

How to read Table 2:

The number of sample items inspected shall be equal to the sample size given by the plan. If the number of nonconforming items found in the sample is equal to or less than the acceptance number, the lot shall be considered acceptable. If the number of nonconforming items is equal to or greater than the rejection number, the lot shall be considered not acceptable.

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Table 1 - Sample size code letters (see 10.1 and 10.2)

Lot size	Special inspection levels				General inspection levels		
	S-1	S-2	S-3	S-4	I	II	III
2 to 8	A	A	A	A	A	A	B
9 to 15	A	A	A	A	A	B	C
16 to 25	A	A	B	B	B	C	D
26 to 50	A	B	B	C	C	D	E
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1 200	C	C	E	F	G	J	K
1 201 to 3 200	C	D	E	G	H	K	L
3 201 to 10 000	C	D	F	G	J	L	M
10 001 to 35 000	C	D	F	H	K	M	N
35 001 to 150 000	D	E	G	J	L	N	P
150 001 to 500 000	D	E	G	J	M	P	Q
500 001 and over	D	E	H	K	N	Q	R

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Table 2-A — Single sampling plans for normal inspection (Master table)

Acceptance quality limit, AQL, in percent nonconforming items and nonconformities per 100 items (normal inspection). Each cell gives Ac Re. ↓ = Use the first sampling plan below the arrow. ↑ = Use the first sampling plan above the arrow. If sample size equals, or exceeds, lot size, carry out 100 % inspection.

Code	Sample size	0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
A	2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31
B	3	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45
C	5	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑
D	8	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑	
E	13	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑		
F	20	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑			
G	32	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑				
H	50	↓	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑					
J	80	↓	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑						
K	125	↓	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑							
L	200	↓	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑								
M	315	↓	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑									
N	500	↓	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑										
P	800	↓	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑											
Q	1250	↓	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑												
R	2000	↓	0 1	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31	44 45	↑													

↓ = Use the first sampling plan below the arrow. If sample size equals, or exceeds, lot size, carry out 100 % inspection.

↑ = Use the first sampling plan above the arrow.

Ac = Acceptance number

Re = Rejection number