

<b>Title: Statistical Rationale for Raw Material Sampling Using <math>\sqrt{N+1}</math> Plan</b>					
<b>Guidance Number: 062</b>					
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**Statistical Rationale for Raw Material Sampling Using  $\sqrt{N+1}$  Plan**

**(The information from this guidance can be used by GMP sites to establish their statistical rationale for the use of this sampling plan.)**

**Introduction**

The practice of using the  $\sqrt{N+1}$  as a rule for sample size is common in the pharmaceutical industry. Saranadasa noted that its use in acceptance sampling is suspect. These “accept on zero defective units” plans often carry higher than expected unacceptable quality levels (UQL) or Lot Tolerance Percent Defective (LTPD). One criticism of the plans is the lack of statistical justification. Is selecting  $\sqrt{N+1}$  units as a sample size ever appropriate? This guidance document will show that  $\sqrt{N+1}$  sampling plans offer similar protection as some ANSI Z1.4 plans. In these cases the  $\sqrt{N+1}$  sampling plans can be used as an alternate approach with the confidence they carry similar risks to lot acceptability decisions.

The Military Standard plans (e.g., ANSI/ASQC Z-1.4, ISO 2859-1, & BS-6001-1 are all one & the same and conform to MIL-STD 105E) are widely accepted as statistically based sampling plans. This guidance document will show that  $\sqrt{N+1}$  sampling plans offer similar protection as Military Standard plans with specified AQL levels between 1.0 and 1.5 (2.5 for the 16 to 25 lot size) percent for small lot sizes up to 150 units. In these cases the two sampling plan approaches can be used interchangeably with similar risks to lot acceptability decisions and outgoing quality.

**Recommendation and Rationale for Recommendation**

Operating characteristic (OC) curves illustrate the probability of accepting a lot over varying percent defective rates (Figure 1). When evaluating sampling plans, two points on the curve are of primary interest: the defective rate when lots will be routinely passed and the defective rate when lots will be routinely failed. It is fairly common to use the 95% probability of accepting a lot as the routinely passing point and the defective rate is called the acceptable quality level or limit (AQL). Lots with a defective rate at or below the AQL would be expected to pass the sampling plan criteria 95% of the time. The 10% probability of accepting a lot is typically used as the failing point and the defective rate is commonly called the unacceptable quality level (UQL) or lot tolerance percent defective (LTPD). Lots with a defective rate at or above the UQL would be expected to pass the sampling plan criteria 10% of the time (fail 90% of the time). The

**$\sqrt{N+1}$  Sampling Plans versus Military Standard  
for Lot Size 16 to 25 (Code C)**

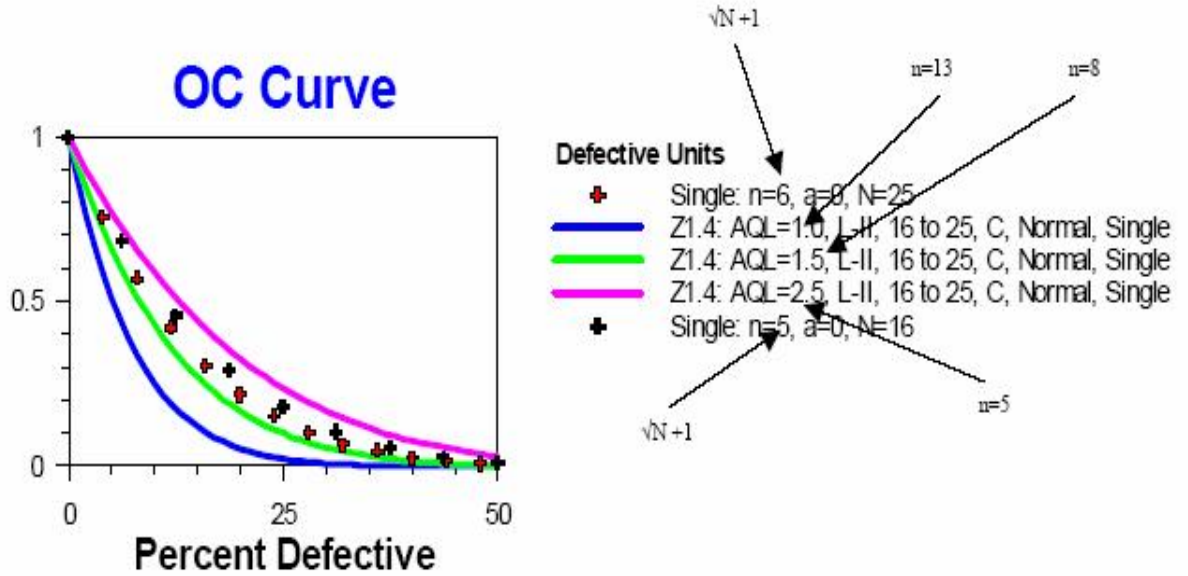


Figure 2

How similar are the  $\sqrt{N+1}$  plans and the Military Standard? For the most part the  $\sqrt{N+1}$  curves are bracketed by Military Standard plans with AQL levels between 1.0 and 1.5. The exception is shown above for the 16 to 25 lot size where the AQL of 2.5 must be used to bracket the  $\sqrt{N+1}$  plans.

**$\sqrt{N+1}$  Sampling Plans versus Military Standard  
for Lot Size 51 to 90 (Code E)**

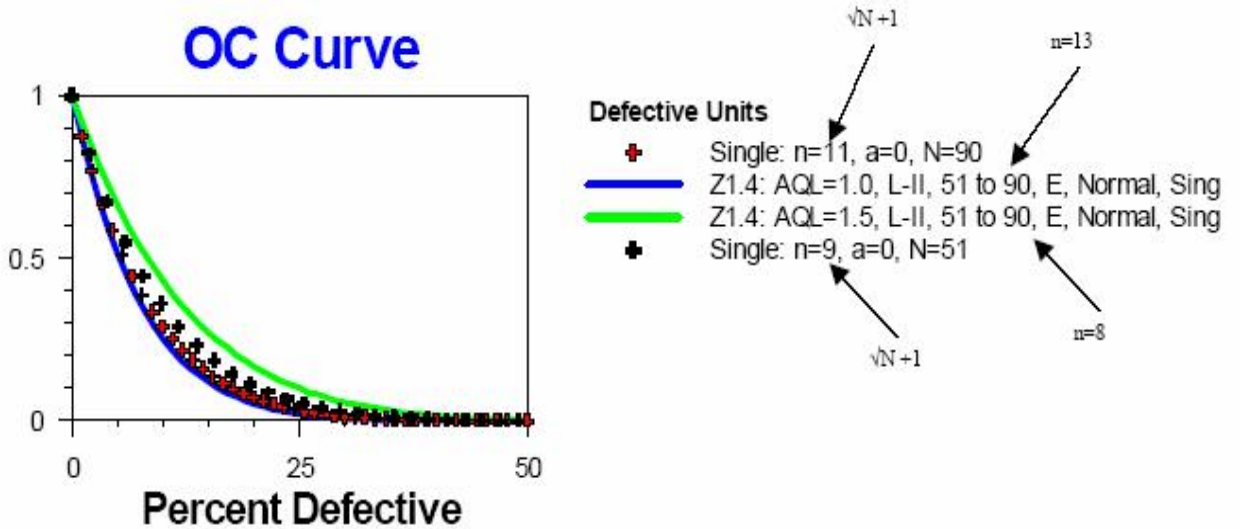


Figure 4

For the next MIL-STD lot size category the OC curves illustrate the same conclusion: the protection and risk of the  $\sqrt{N+1}$  plans are similar to MIL-STD plans with AQL between 1.0 and 1.5.

**Plan Summaries**

Table 2				Table 3			
Sampling Plans	AQL	LTPD	AOQL	Sampling Plans	AQL	LTPD	AOQL
$\sqrt{N+1}$ plan: Single: n=14, a=0, <b>N=150</b>	0.36	14.67	2.54	$\sqrt{N+1}$ plan: Single: n=11, a=0, <b>N=90</b>	0.45	18.89	3.23
Z1.4: <b>AQL=1.0</b> , L-II, <b>91 to 150</b> , F, Normal, Single, n=13, a=0	0.39	16.23	2.73	Z1.4: <b>AQL=1.0</b> , L-II, <b>51 to 90</b> , E, Normal, Single, n=13, a=0	0.39	16.23	2.73
Z1.4: <b>AQL=1.5</b> , L-II, <b>91 to 150</b> , F, Normal, Single, n=32, a=1	1.12	11.62	2.60	Z1.4: <b>AQL=1.5</b> , L-II, <b>51 to 90</b> , E, Normal, Single, n=8, a=0	0.64	25.01	4.33
$\sqrt{N+1}$ plan: Single: n=11, a=0, <b>N=91</b>	0.45	18.68	3.23	$\sqrt{N+1}$ plan: Single: n=9, a=0, <b>N=51</b>	0.56	21.57	3.78
Table 4				Table 5			
Sampling Plans	AQL	LTPD	AOQL	Sampling Plans	AQL	LTPD	AOQL
$\sqrt{N+1}$ plan: Single: n=9, a=0, <b>N=50</b>	0.56	22.00	3.81	$\sqrt{N+1}$ plan: Single: n=6, a=0, <b>N=25</b>	0.83	32.00	5.90
Z1.4: <b>AQL=1.0</b> , L-II, <b>26 to 50</b> , D, Normal, Single, n=13, a=0	0.39	16.23	2.73	Z1.4: <b>AQL=1.0</b> , L-II, <b>16 to 25</b> , C, Normal, Single, n=13, a=0	0.39	16.23	2.73
Z1.4: <b>AQL=1.5</b> , L-II, <b>26 to 50</b> , D, Normal, Single, n=8, a=0	0.64	25.01	4.33	Z1.4: <b>AQL=1.5</b> , L-II, <b>16 to 25</b> , C, Normal, Single, n=8, a=0	0.64	25.01	4.33
$\sqrt{N+1}$ plan: Single: n=7, a=0, <b>N=26</b>	0.71	26.92	4.49	Z1.4: <b>AQL=2.5</b> , L-II, <b>16 to 25</b> , C, Normal, Single, n=5, a=0	1.02	36.90	6.70
				$\sqrt{N+1}$ plan: Single: n=5, a=0, <b>N=16</b>	1.00	37.50	7.16