

**APPENDIX 8E. AVERAGE TRANSFORMER DESIGN PROPERTIES
FROM LIFE-CYCLE COST MODEL**

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APPENDIX 8E. AVERAGE TRANSFORMER DESIGN PROPERTIES FROM LIFE-CYCLE COST MODEL

8E.1 INTRODUCTION

In this supplementary technical support document (TSD) appendix, the Department provides additional information regarding the advance notice of proposed rulemaking (ANOPR) life-cycle cost (LCC) calculation results. At the September 28, 2004 public meeting, stakeholders requested the following specific information from the LCC analysis: the average efficiency and average costs and prices for the baseline and each of the five candidate standard levels for the thirteen representative units analyzed. Following that model, the Department is providing the same information on the six candidate standard levels analyzed for the notice of proposed rulemaking (NOPR).

8E.2 TABLES OF AVERAGE TRANSFORMER DESIGN PROPERTIES

Table 8E.2.1 Average LCC Transformer Design Properties for Design Line 1 Representative Unit

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|-------|-------|-------|-------|-------|-------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 1,088 | 1,122 | 1,173 | 1,325 | 1,612 | 1,847 | 2,375 |
| Efficiency at 50% Load (%) | 99.0 | 99.1 | 99.1 | 99.2 | 99.4 | 99.5 | 99.6 |
| Core Loss (W) | 127.9 | 108.2 | 107.0 | 103.9 | 34.1 | 39.9 | 50.3 |
| Coil Loss at 50% Load (W) | 576.5 | 553.3 | 487.5 | 371.0 | 494.4 | 325.6 | 186.5 |

Table 8E.2.2 Average LCC Transformer Design Properties for Design Line 2 Representative Unit

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|-------|-------|-------|-------|-------|-------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 619 | 636 | 640 | 644 | 650 | 720 | 1,530 |
| Efficiency at 50% Load (%) | 98.7 | 98.8 | 98.9 | 98.9 | 98.9 | 99.0 | 99.5 |
| Core Loss (W) | 87.8 | 74.9 | 74.1 | 74.4 | 74.2 | 67.3 | 33.4 |
| Coil Loss at 50% Load (W) | 308.4 | 301.9 | 298.8 | 290.1 | 283.3 | 243.9 | 115.3 |

**Table 8E.2.3 Average LCC Transformer Design Properties for Design Line 3
Representative Unit**

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|--------|--------|--------|--------|--------|--------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 4,252 | 4,321 | 4,441 | 4,753 | 5,646 | 10,649 | 11,458 |
| Efficiency at 50% Load (%) | 99.4 | 99.4 | 99.5 | 99.5 | 99.6 | 99.7 | 99.8 |
| Core Loss (W) | 749.7 | 690.4 | 676.6 | 672.6 | 573.9 | 263.8 | 272.9 |
| Coil Loss at 50% Load (W) | 3698.0 | 3218.3 | 3018.5 | 2648.6 | 2405.0 | 1583.6 | 1433.8 |

**Table 8E.2.4 Average LCC Transformer Design Properties for Design Line 4
Representative Unit**

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|--------|--------|--------|--------|-------|-------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 2,718 | 2,843 | 3,086 | 3,900 | 4,340 | 5,418 | 6,041 |
| Efficiency at 50% Load (%) | 98.9 | 99.1 | 99.2 | 99.3 | 99.5 | 99.6 | 99.6 |
| Core Loss (W) | 420.0 | 366.9 | 349.2 | 198.0 | 132.0 | 150.8 | 154.7 |
| Coil Loss at 50% Load (W) | 1639.9 | 1427.7 | 1238.3 | 1366.0 | 1192.2 | 702.9 | 580.3 |

**Table 8E.2.5 Average LCC Transformer Design Properties for Design Line 5
Representative Unit**

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|--------|--------|--------|--------|--------|--------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 10,808 | 11,151 | 11,600 | 12,203 | 13,613 | 26,916 | 26,917 |
| Efficiency at 50% Load (%) | 99.4 | 99.4 | 99.4 | 99.5 | 99.5 | 99.7 | 99.7 |
| Core Loss (W) | 1958.7 | 1915.6 | 1879.7 | 1867.1 | 1707.9 | 807.4 | 807.4 |
| Coil Loss at 50% Load (W) | 10877.7 | 9528.2 | 8922.3 | 8350.8 | 7929.5 | 5414.2 | 5414.7 |

**Table 8E.2.6 Average LCC Transformer Design Properties for Design Line 9
Representative Unit**

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|--------|--------|--------|--------|--------|--------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 5,379 | 5,423 | 5,522 | 5,830 | 7,038 | 9,620 | 9,619 |
| Efficiency at 50% Load (%) | 98.8 | 98.9 | 99.0 | 99.1 | 99.3 | 99.4 | 99.4 |
| Core Loss (W) | 991.1 | 886.2 | 748.3 | 699.3 | 587.8 | 480.5 | 480.3 |
| Coil Loss at 50% Load (W) | 4334.5 | 4195.6 | 4140.8 | 3344.5 | 2368.7 | 1718.8 | 1719.8 |

**Table 8E.2.7 Average LCC Transformer Design Properties for Design Line 10
Representative Unit**

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|---------|---------|---------|--------|--------|--------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 20,368 | 21,273 | 21,869 | 23,008 | 24,723 | 32,903 | 32,900 |
| Efficiency at 50% Load (%) | 99.2 | 99.3 | 99.3 | 99.4 | 99.4 | 99.5 | 99.5 |
| Core Loss (W) | 3492.7 | 3182.6 | 2937.9 | 2664.3 | 2449.6 | 2303.3 | 2303.5 |
| Coil Loss at 50% Load (W) | 12751.5 | 10920.1 | 10691.9 | 10102.5 | 8979.8 | 5705.3 | 5705.5 |

**Table 8E.2.8 Average LCC Transformer Design Properties for Design Line 11
Representative Unit**

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|--------|--------|--------|--------|--------|--------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 7,812 | 8,127 | 8,379 | 8,907 | 9,824 | 10,679 | 10,679 |
| Efficiency at 50% Load (%) | 98.4 | 98.7 | 98.8 | 98.9 | 99.0 | 99.1 | 99.1 |
| Core Loss (W) | 1195.1 | 935.6 | 894.4 | 819.7 | 738.7 | 672.2 | 672.0 |
| Coil Loss at 50% Load (W) | 6273.4 | 5554.8 | 4803.4 | 4131.5 | 3331.0 | 3099.4 | 3100.2 |

**Table 8E.2.9 Average LCC Transformer Design Properties for Design Line 12
Representative Unit**

| | Candidate Standard Level | | | | | | |
|--|--------------------------|---|---|---|---|---|---|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |

| | | | | | | | |
|---------------------------------|---------|---------|---------|---------|--------|--------|--------|
| Manufacturer Selling Price (\$) | 22,594 | 22,955 | 23,215 | 23,820 | 25,707 | 36,379 | 36,396 |
| Efficiency at 50% Load (%) | 99.2 | 99.2 | 99.3 | 99.3 | 99.4 | 99.5 | 99.5 |
| Core Loss (W) | 3492.8 | 3221.3 | 3084.2 | 2981.6 | 2781.3 | 2387.6 | 2385.9 |
| Coil Loss at 50% Load (W) | 12518.9 | 11938.9 | 11465.3 | 10533.4 | 8850.1 | 5342.1 | 5343.4 |

Table 8E.2.10 Average LCC Transformer Design Properties for Design Line 13 Representative Unit

| | Candidate Standard Level | | | | | | |
|---------------------------------|--------------------------|---------|---------|---------|---------|--------|--------|
| | Base | 1 | 2 | 3 | 4 | 5 | 6 |
| Manufacturer Selling Price (\$) | 28,492 | 28,623 | 29,060 | 30,007 | 34,915 | 48,134 | 48,138 |
| Efficiency at 50% Load (%) | 99.3 | 99.3 | 99.3 | 99.4 | 99.5 | 99.6 | 99.6 |
| Core Loss (W) | 4358.5 | 4315.2 | 3798.7 | 3550.2 | 3147.3 | 2910.1 | 2909.9 |
| Coil Loss at 50% Load (W) | 14280.1 | 13981.9 | 14532.5 | 13365.1 | 10270.0 | 6421.8 | 6421.1 |

8E.3 HISTOGRAMS OF TRANSFORMER DESIGN EFFICIENCIES

8E.3.1 Distribution of Efficiencies for Design Line 1

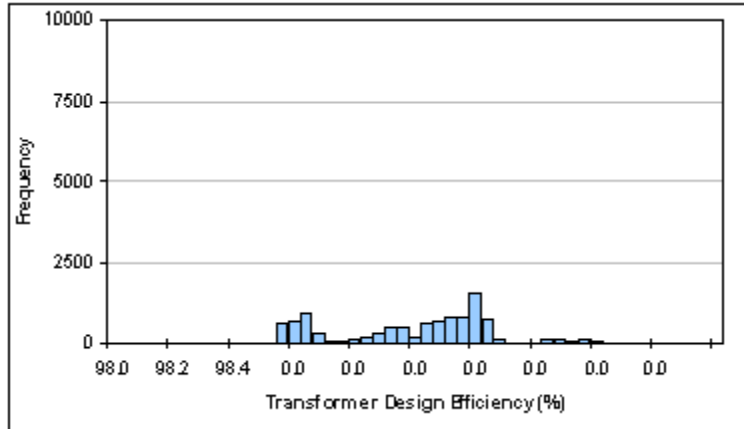


Figure 8E.3.1 Distribution of Efficiencies for Design Line 1 Representative Unit, Baseline

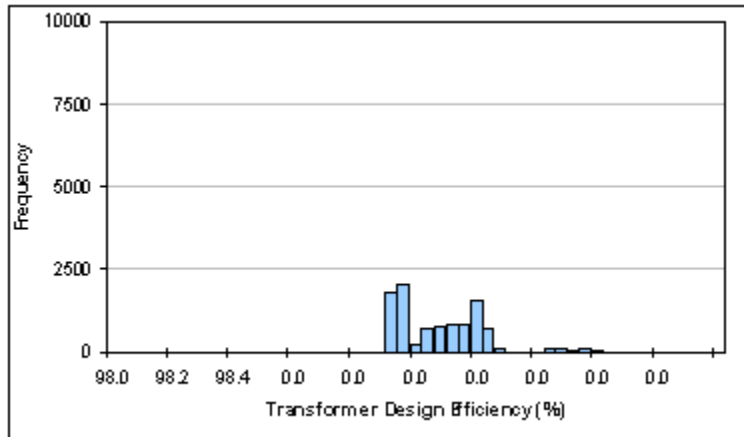


Figure 8E.3.2 Distribution of Efficiencies for Design Line 1 Representative Unit, Candidate Standard Level 1

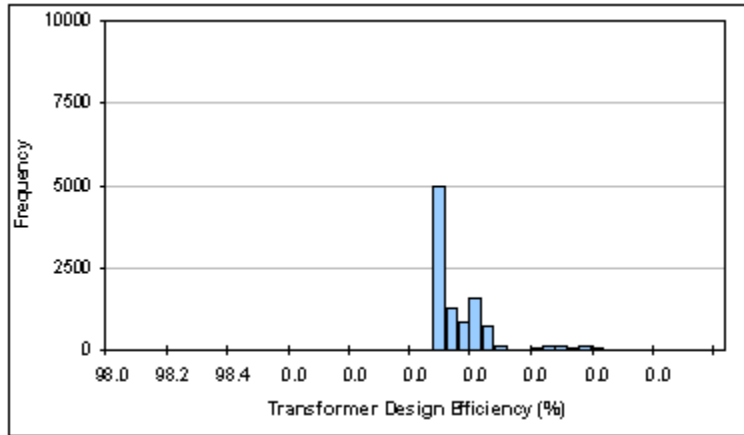


Figure 8E.3.3 Distribution of Efficiencies for Design Line 1 Representative Unit, Candidate Standard Level 2

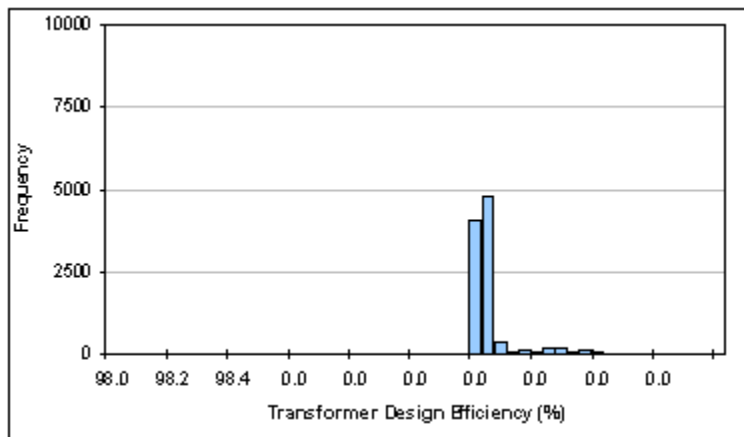


Figure 8E.3.4 Distribution of Efficiencies for Design Line 1 Representative Unit, Candidate Standard Level 3

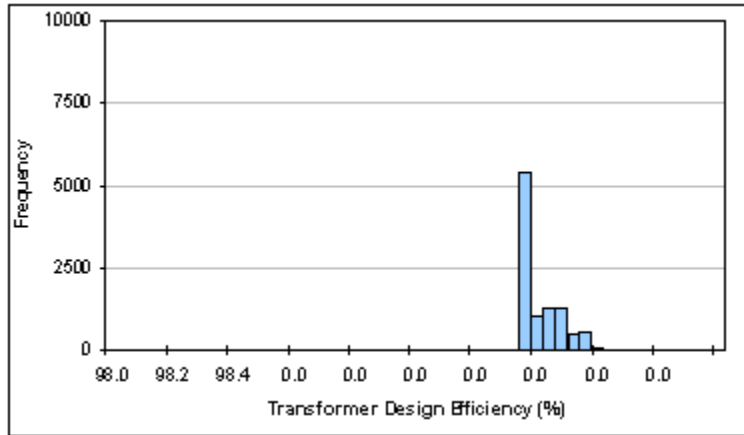


Figure 8E.3.5 Distribution of Efficiencies for Design Line 1 Representative Unit, Candidate Standard Level 4

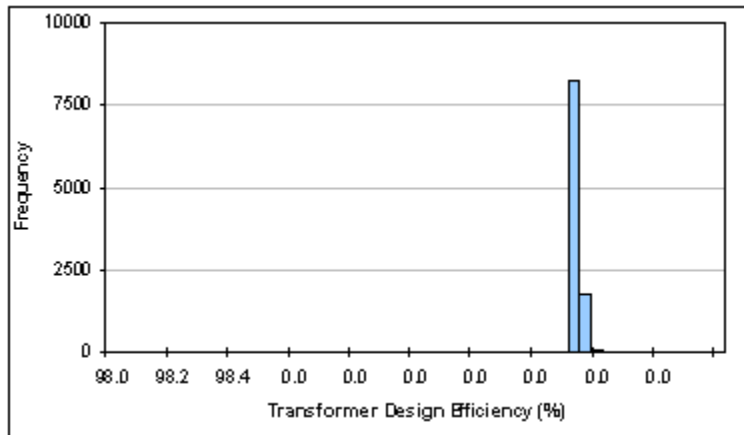


Figure 8E.3.6 Distribution of Efficiencies for Design Line 1 Representative Unit, Candidate Standard Level 5

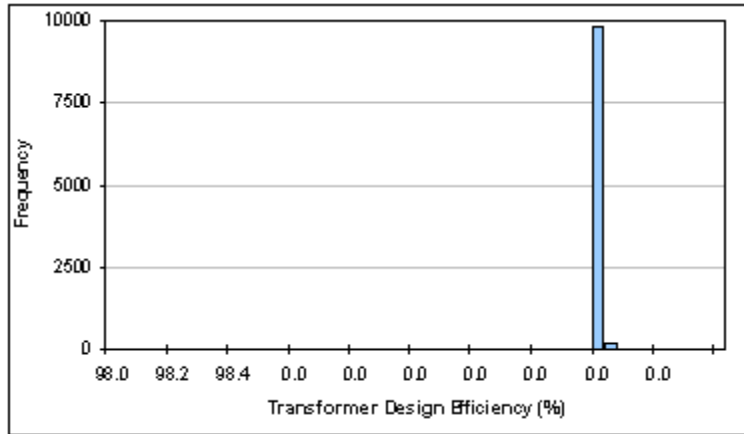


Figure 8E.3.7 Distribution of Efficiencies for Design Line 1 Representative Unit, Candidate Standard Level 6

8E.3.2 Distribution of Efficiencies for Design Line 2

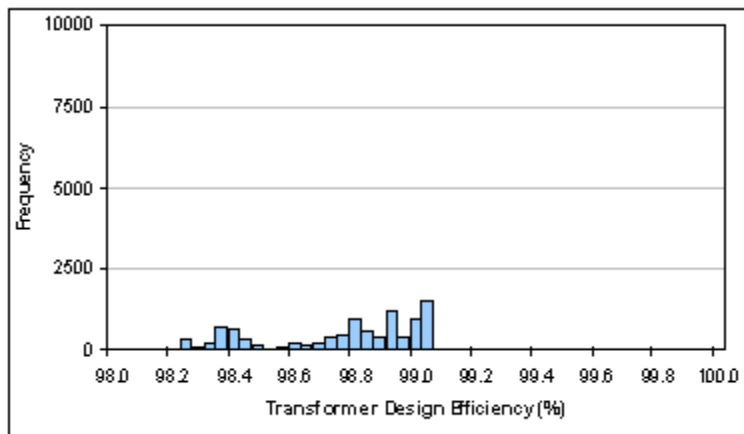


Figure 8E.3.8 Distribution of Efficiencies for Design Line 2 Representative Unit, Baseline

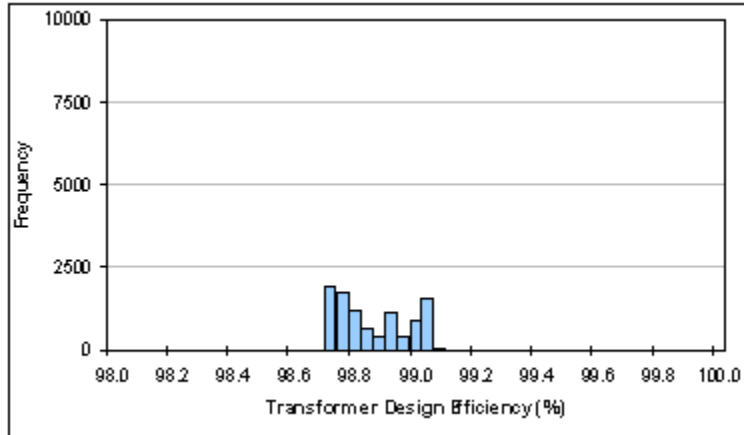


Figure 8E.3.9 Distribution of Efficiencies for Design Line 2 Representative Unit, Candidate Standard Level 1

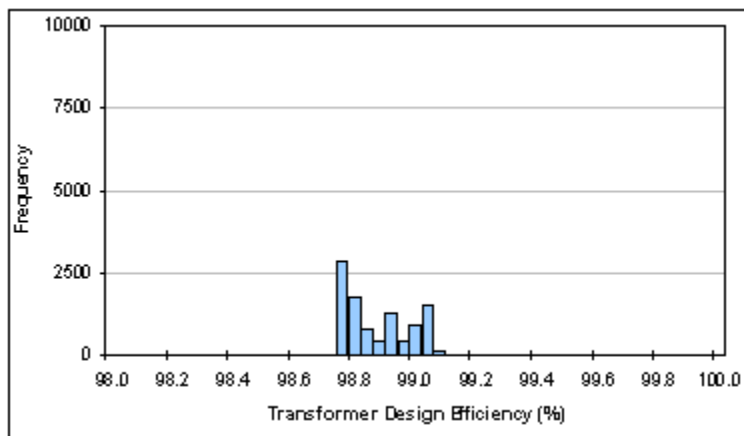


Figure 8E.3.10 Distribution of Efficiencies for Design Line 2 Representative Unit, Candidate Standard Level 2

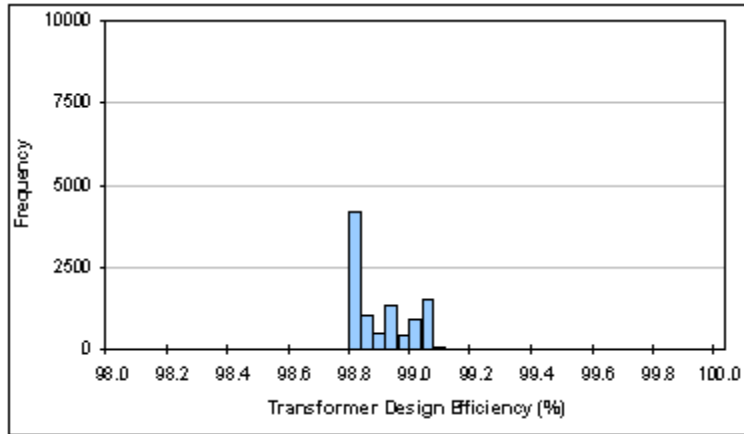


Figure 8E.3.11 **Distribution of Efficiencies for
Design Line 2 Representative Unit,
Candidate Standard Level 3**

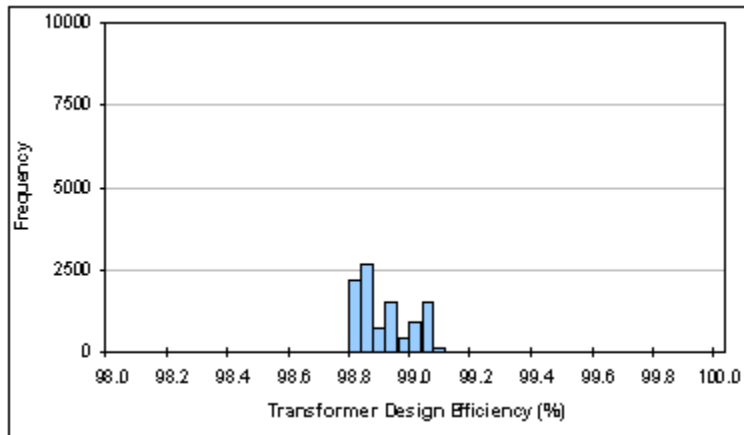


Figure 8E.3.12 **Distribution of Efficiencies for
Design Line 2 Representative Unit,
Candidate Standard Level 4**

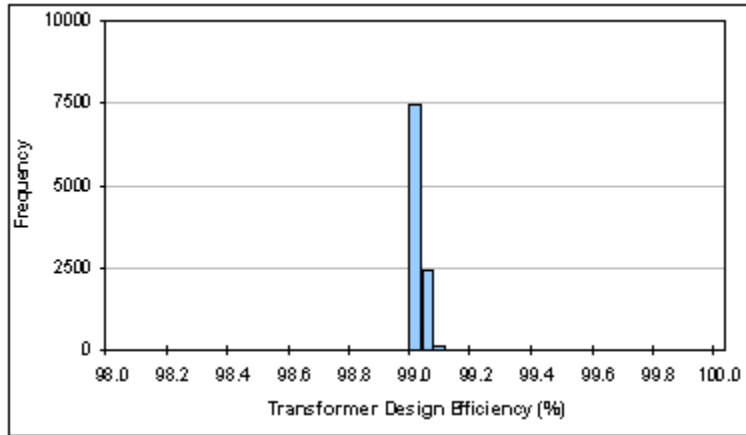


Figure 8E.3.13 **Distribution of Efficiencies for
Design Line 2 Representative Unit,
Candidate Standard Level 5**

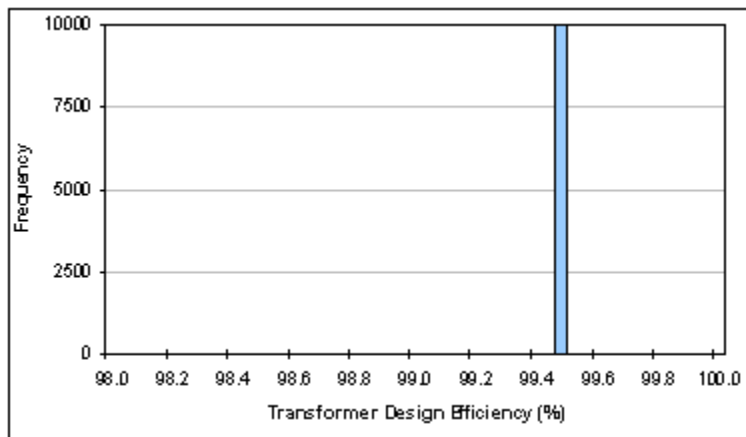


Figure 8E.3.14 **Distribution of Efficiencies for
Design Line 2 Representative Unit,
Candidate Standard Level 6**

8E.3.3 Distribution of Efficiencies for Design Line 3

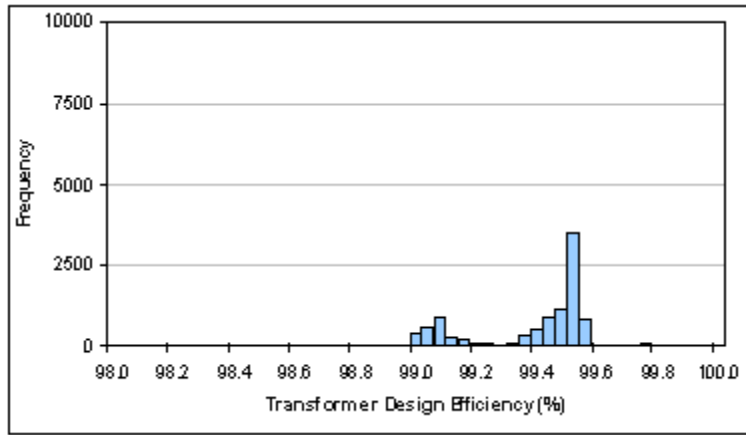


Figure 8E.3.15 **Distribution of Efficiencies for Design Line 3 Representative Unit, Baseline**

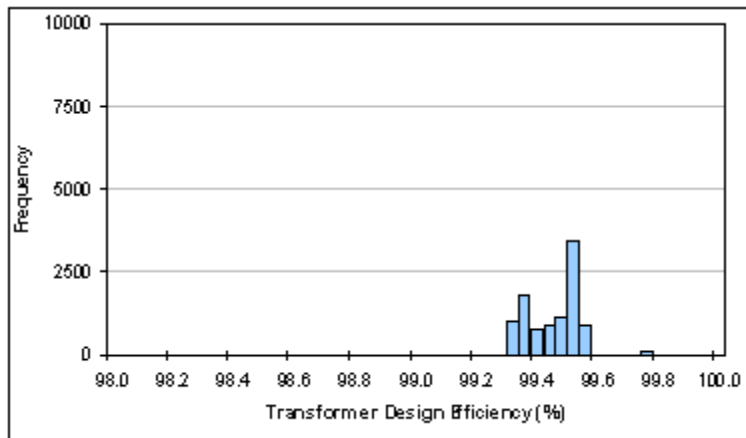


Figure 8E.3.16 **Distribution of Efficiencies for Design Line 3 Representative Unit, Candidate Standard Level 1**

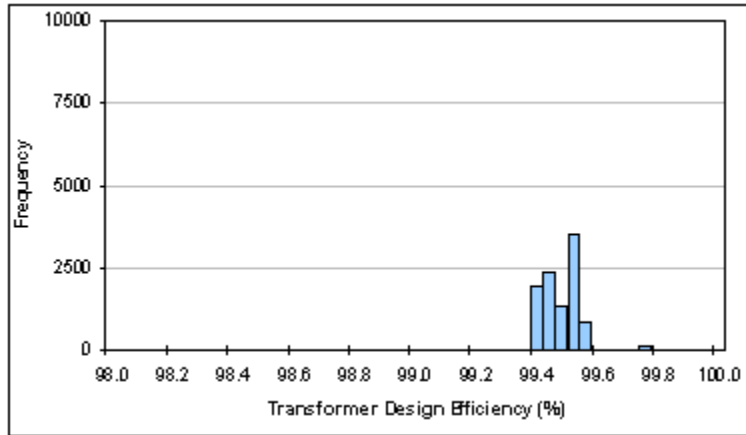


Figure 8E.3.17 **Distribution of Efficiencies for
Design Line 3 Representative Unit,
Candidate Standard Level 2**

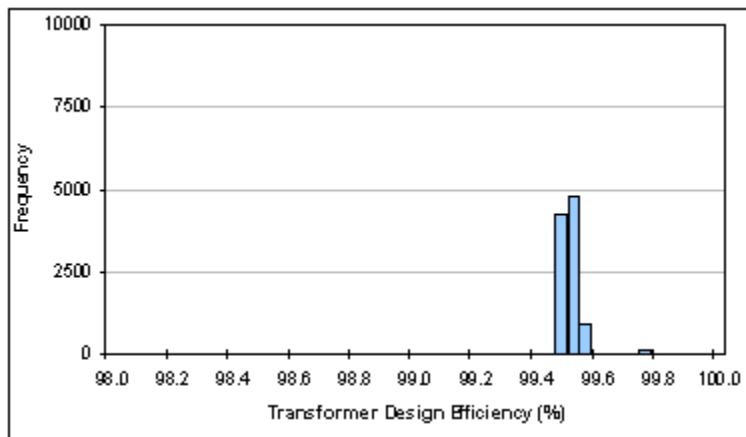


Figure 8E.3.18 **Distribution of Efficiencies for
Design Line 3 Representative Unit,
Candidate Standard Level 3**

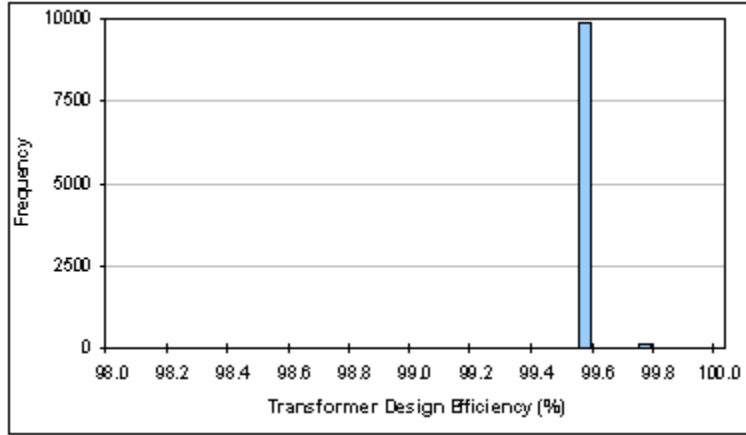


Figure 8E.3.19 **Distribution of Efficiencies for
Design Line 3 Representative Unit,
Candidate Standard Level 4**

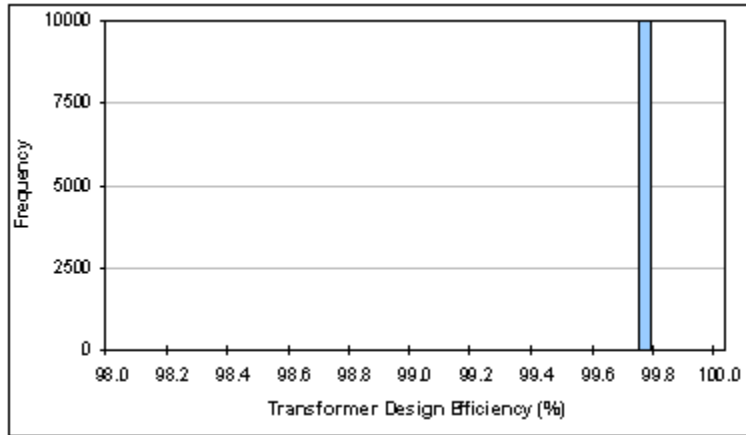


Figure 8E.3.20 **Distribution of Efficiencies for
Design Line 3 Representative Unit,
Candidate Standard Level 5**

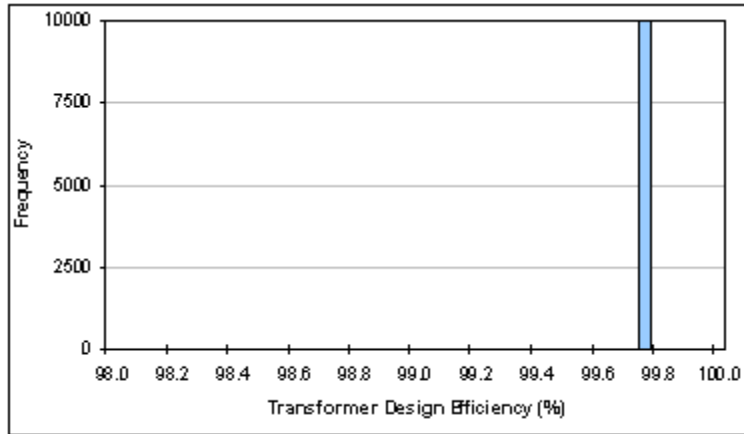


Figure 8E.3.21 **Distribution of Efficiencies for
Design Line 3 Representative Unit,
Candidate Standard Level 6**

8E.3.4 Distribution of Efficiencies for Design Line 4

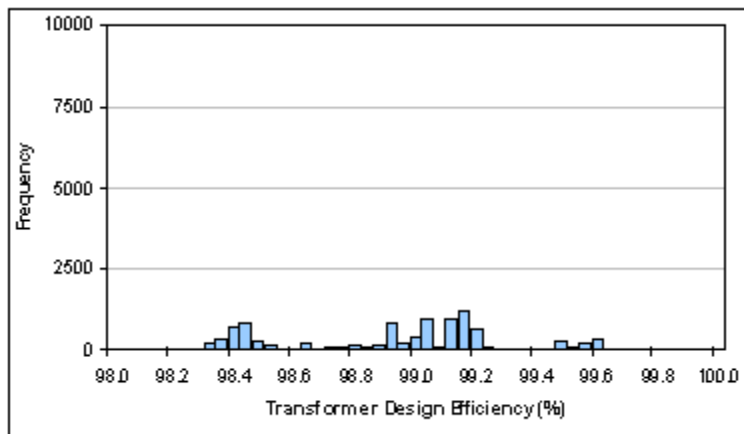


Figure 8E.3.22 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Baseline**

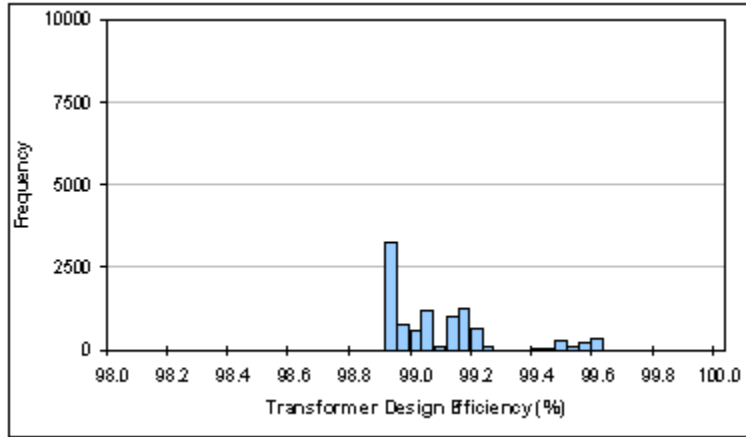


Figure 8E.3.23 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Candidate Standard Level 1**

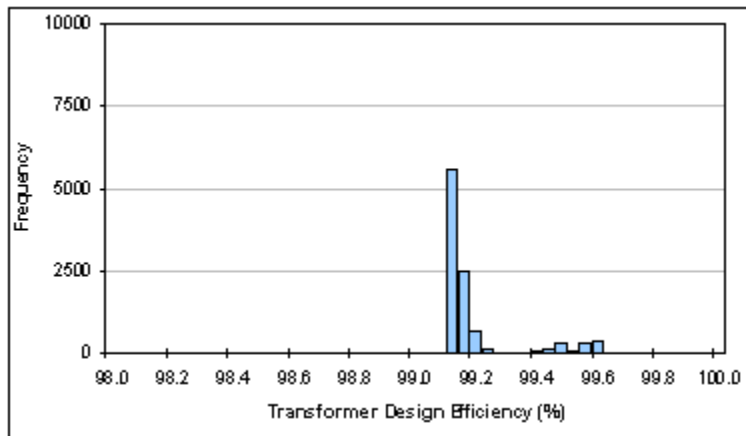


Figure 8E.3.24 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Candidate Standard Level 2**

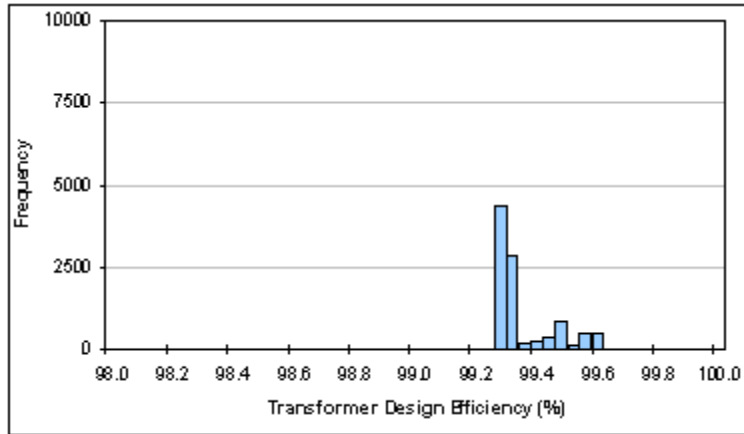


Figure 8E.3.25 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Candidate Standard Level 3**

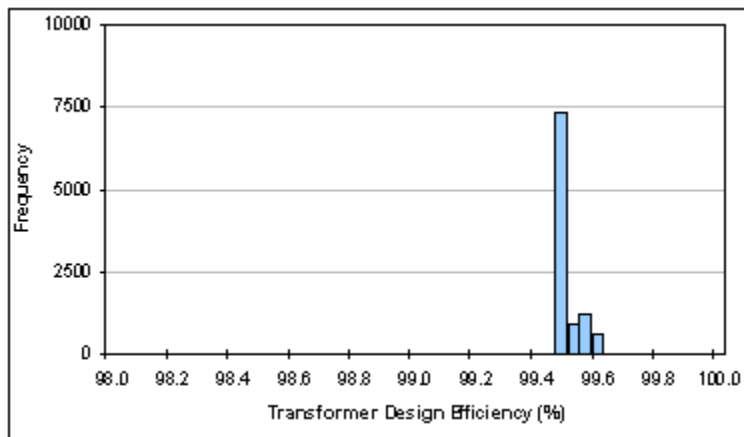


Figure 8E.3.26 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Candidate Standard Level 4**

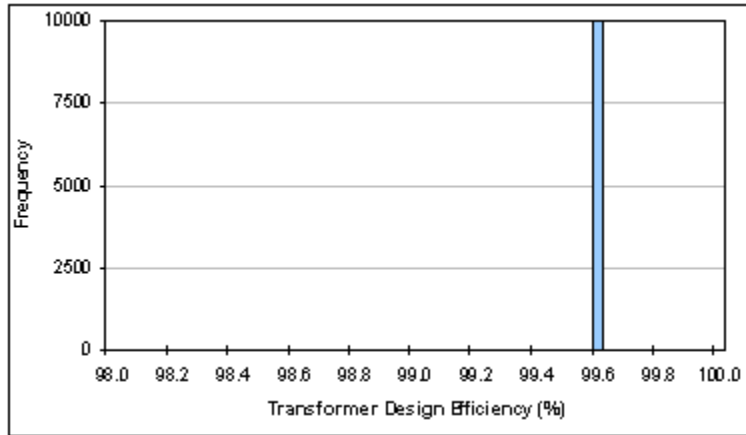


Figure 8E.3.27 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Candidate Standard Level 5**

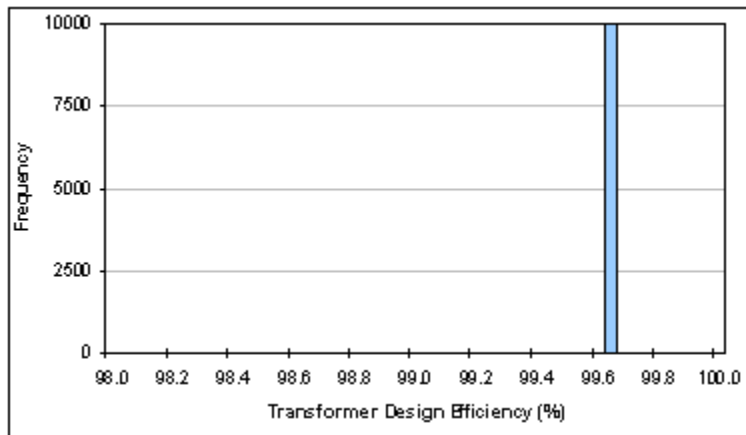


Figure 8E.3.28 **Distribution of Efficiencies for
Design Line 4 Representative Unit,
Candidate Standard Level 6**

8E.3.5 Distribution of Efficiencies for Design Line 5

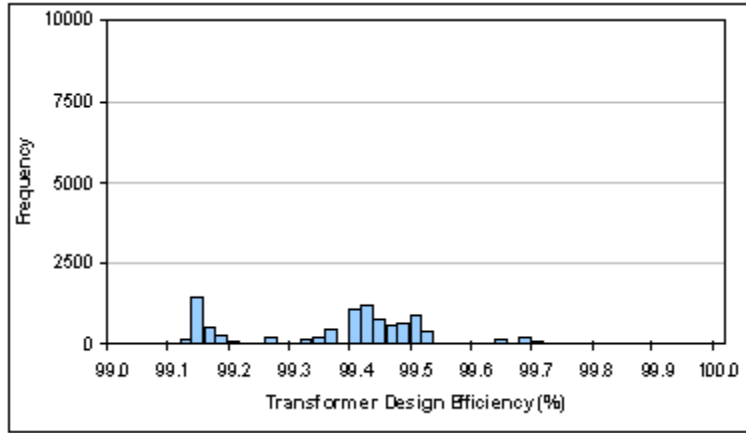


Figure 8E.3.29 Distribution of Efficiencies for Design Line 5 Representative Unit, Baseline

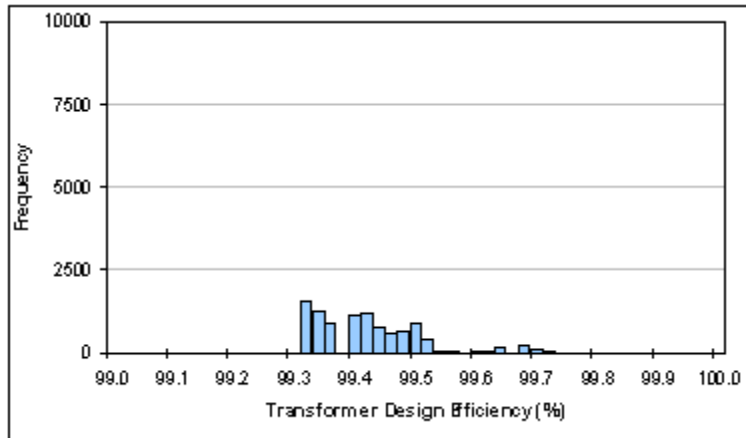


Figure 8E.3.30 Distribution of Efficiencies for Design Line 5 Representative Unit, Candidate Standard Level 1

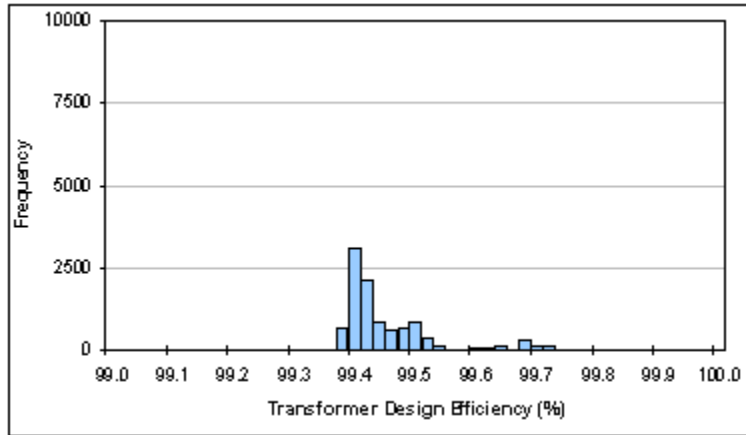


Figure 8E.3.31 **Distribution of Efficiencies for
Design Line 5 Representative Unit,
Candidate Standard Level 2**

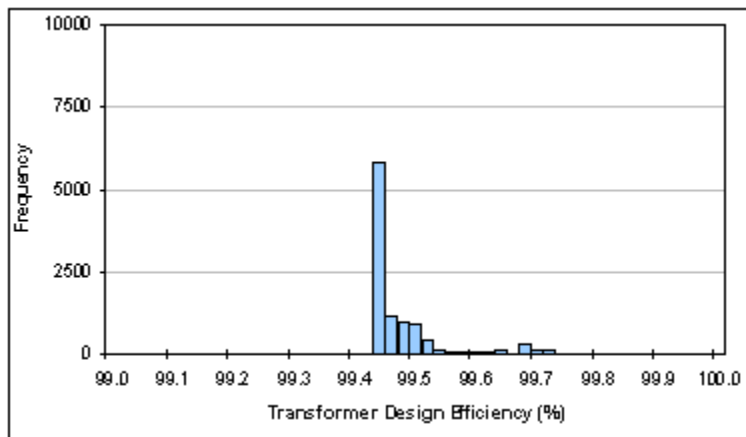


Figure 8E.3.32 **Distribution of Efficiencies for
Design Line 5 Representative Unit,
Candidate Standard Level 3**

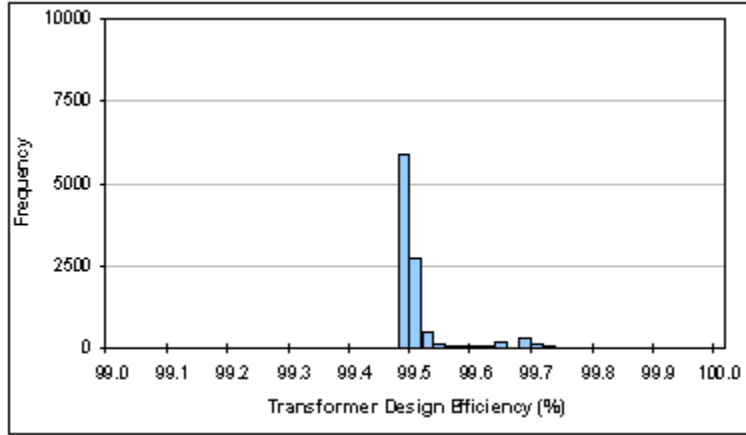


Figure 8E.3.33 **Distribution of Efficiencies for
Design Line 5 Representative Unit,
Candidate Standard Level 4**

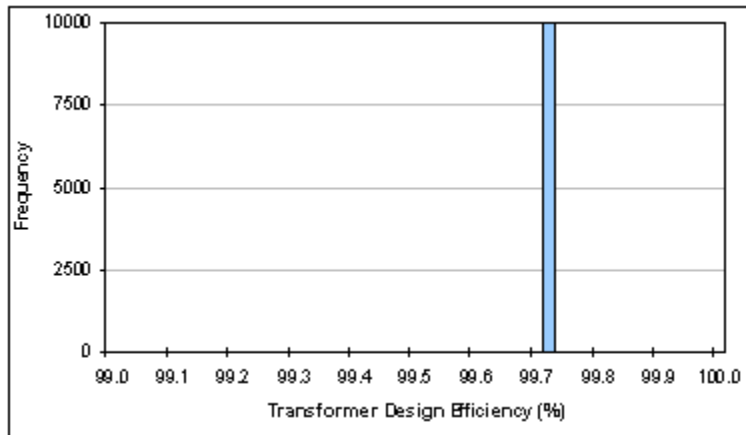


Figure 8E.3.34 **Distribution of Efficiencies for
Design Line 5 Representative Unit,
Candidate Standard Level 5**

8E.3.6 Distribution of Efficiencies for Design Line 9

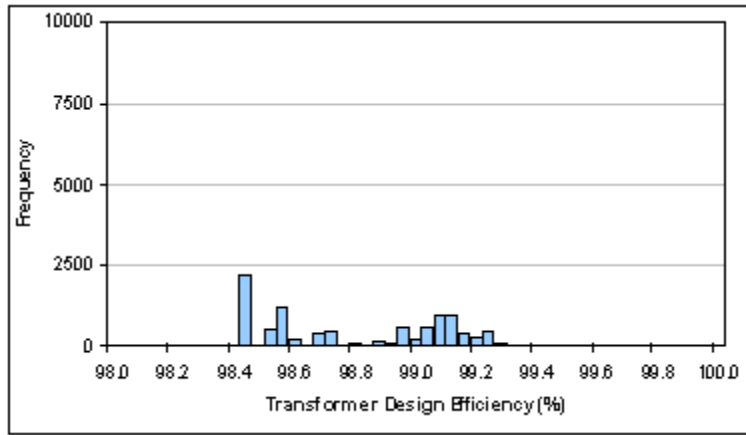


Figure 8E.3.35 Distribution of Efficiencies for Design Line 9 Representative Unit, Baseline

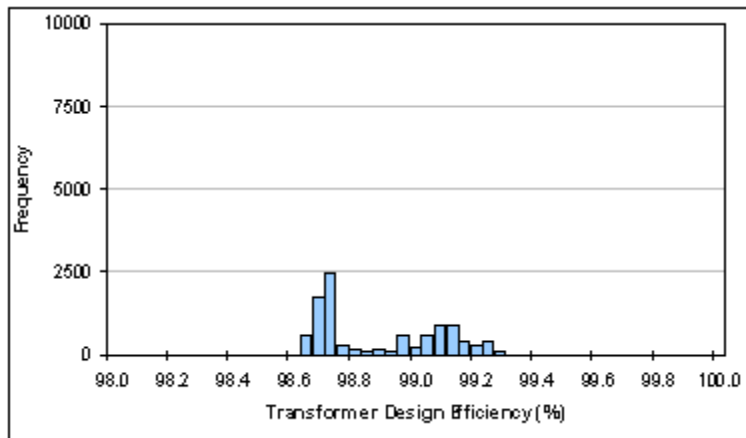


Figure 8E.3.36 Distribution of Efficiencies for Design Line 9 Representative Unit, Candidate Standard Level 1

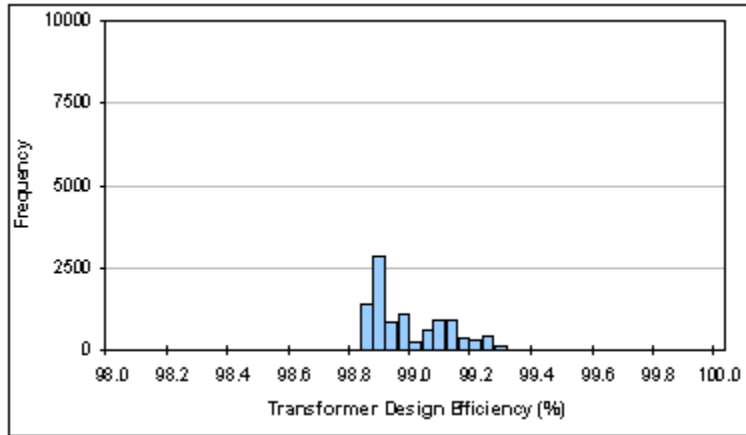


Figure 8E.3.37 **Distribution of Efficiencies for
Design Line 9 Representative Unit,
Candidate Standard Level 2**

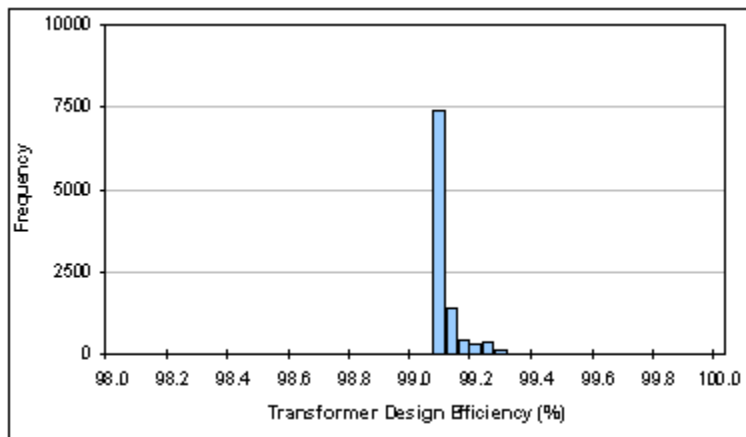


Figure 8E.3.38 **Distribution of Efficiencies for
Design Line 9 Representative Unit,
Candidate Standard Level 3**

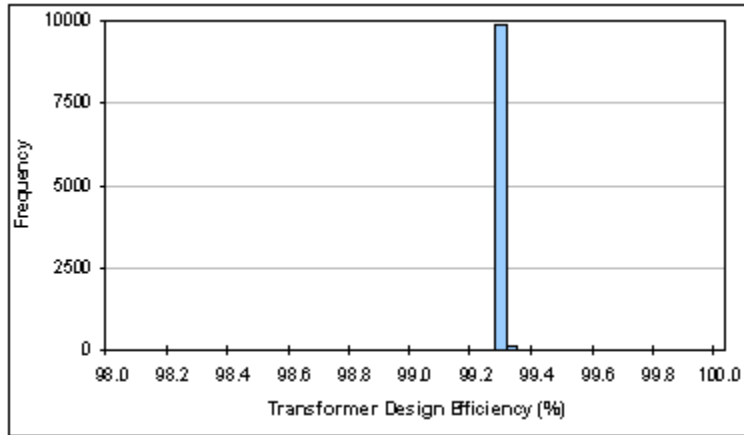


Figure 8E.3.39 **Distribution of Efficiencies for
Design Line 9 Representative Unit,
Candidate Standard Level 4**

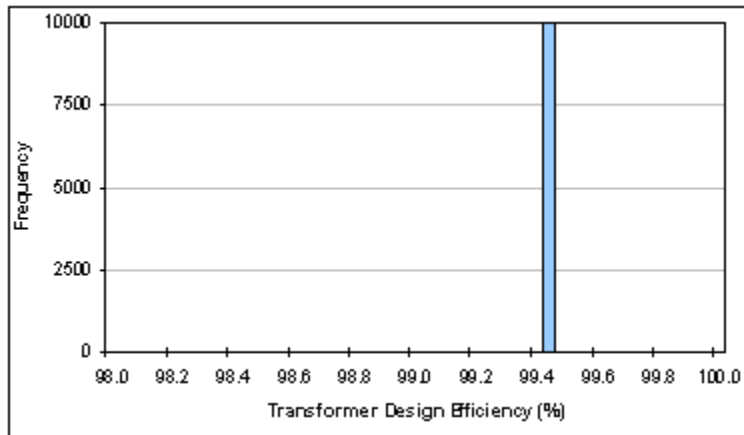


Figure 8E.3.40 **Distribution of Efficiencies for
Design Line 9 Representative Unit,
Candidate Standard Level 5**

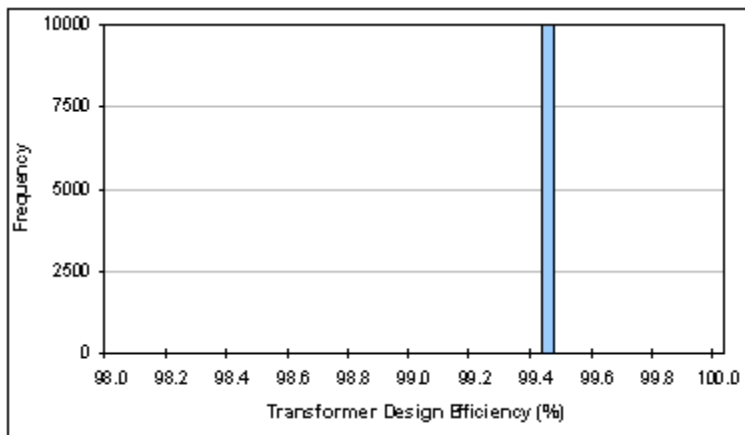


Figure 8E.3.41 **Distribution of Efficiencies for Design Line 9 Representative Unit, Candidate Standard Level 6**

8E.3.7 Distribution of Efficiencies for Design Line10

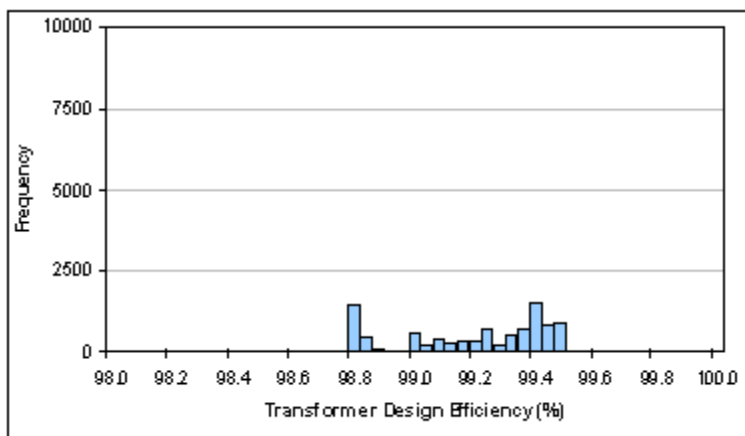


Figure 8E.3.42 **Distribution of Efficiencies for Design Line 10 Representative Unit, Baseline**

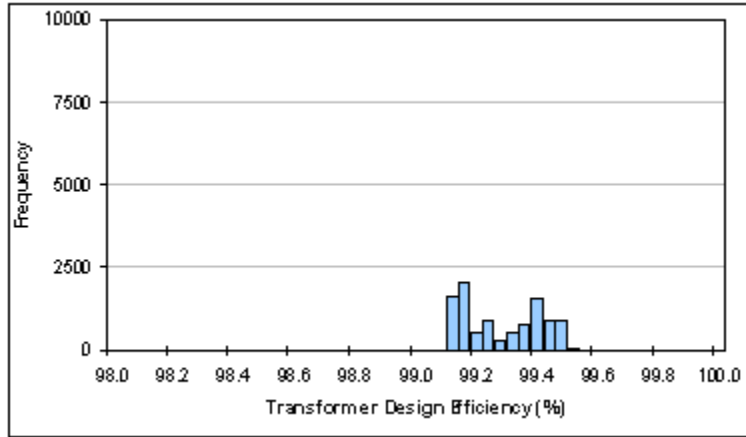


Figure 8E.3.43 **Distribution of Efficiencies for Design Line 10 Representative Unit, Candidate Standard Level 1**

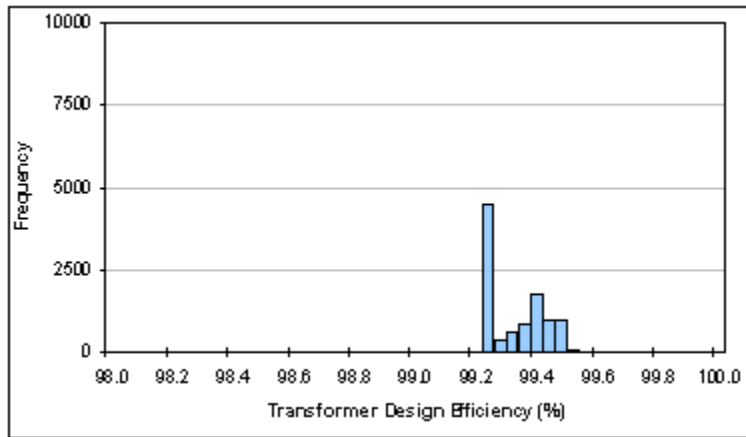


Figure 8E.3.44 **Distribution of Efficiencies for Design Line 10 Representative Unit, Candidate Standard Level 2**

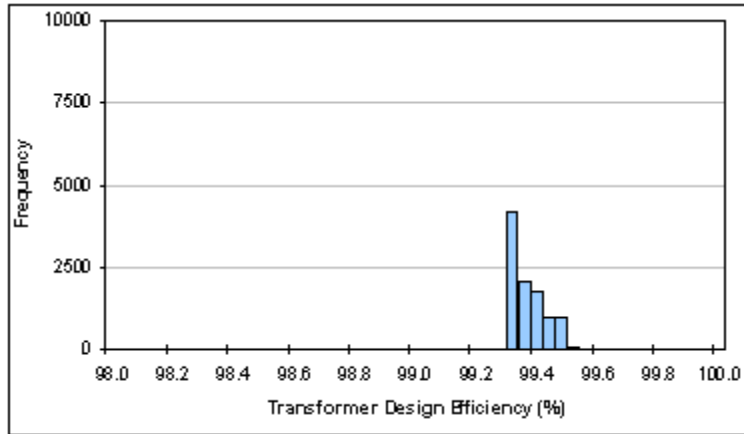


Figure 8E.3.45 **Distribution of Efficiencies for
Design Line 10 Representative
Unit, Candidate Standard Level 3**

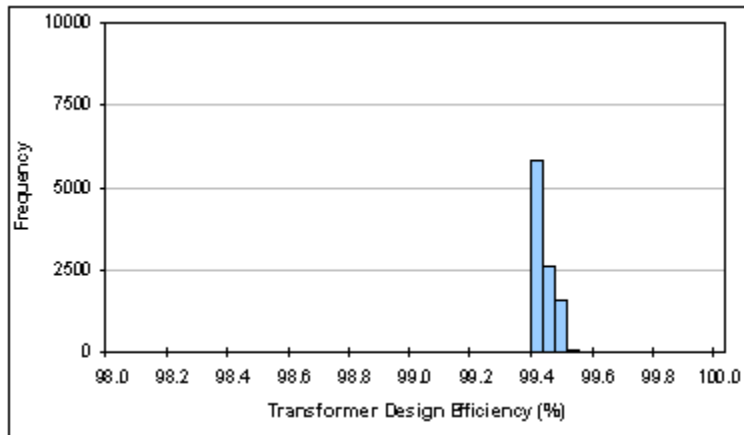


Figure 8E.3.46 **Distribution of Efficiencies for
Design Line 10 Representative
Unit, Candidate Standard Level 4**

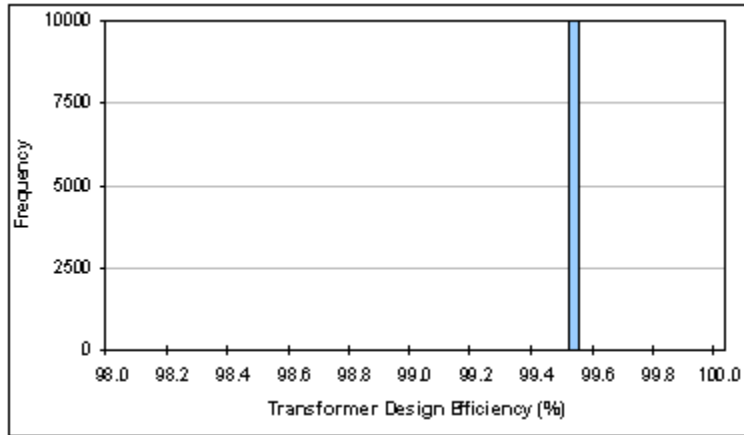


Figure 8E.3.47 **Distribution of Efficiencies for
Design Line 10 Representative
Unit, Candidate Standard Level 5**

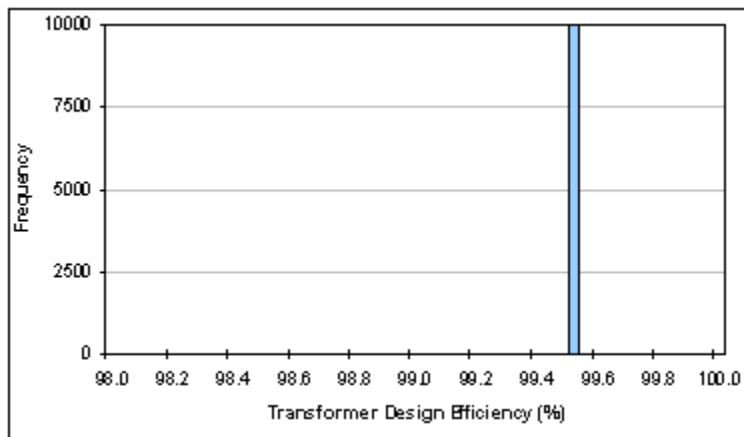


Figure 8E.3.48 **Distribution of Efficiencies for
Design Line 10 Representative
Unit, Candidate Standard Level 6**

8E.3.8 Distribution of Efficiencies for Design Line 11

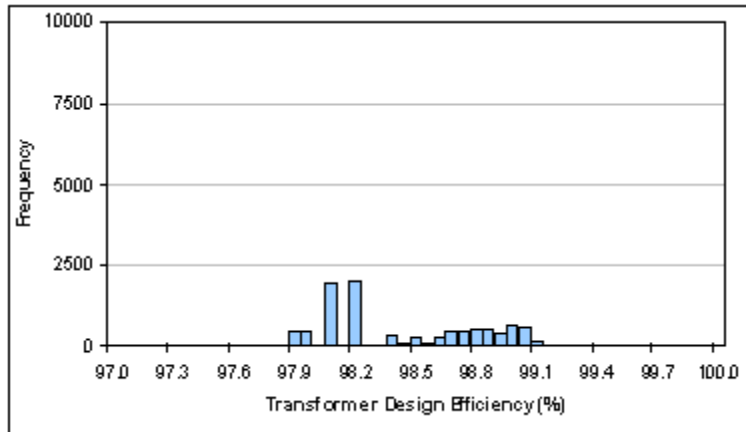


Figure 8E.3.49 Distribution of Efficiencies for Design Line 11 Representative Unit, Baseline

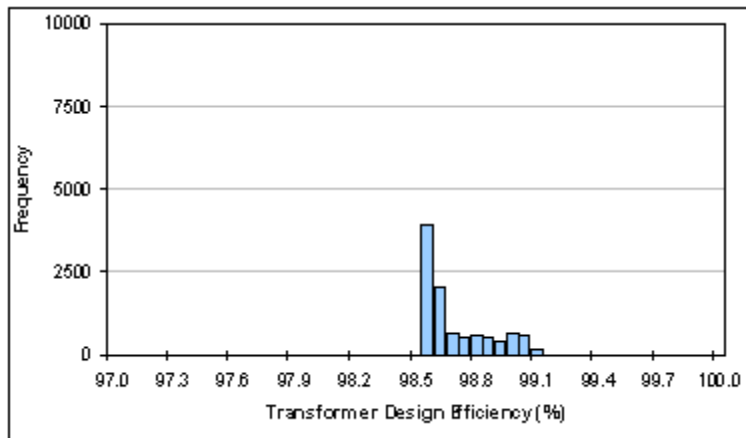


Figure 8E.3.50 Distribution of Efficiencies for Design Line 11 Representative Unit, Candidate Standard Level 1

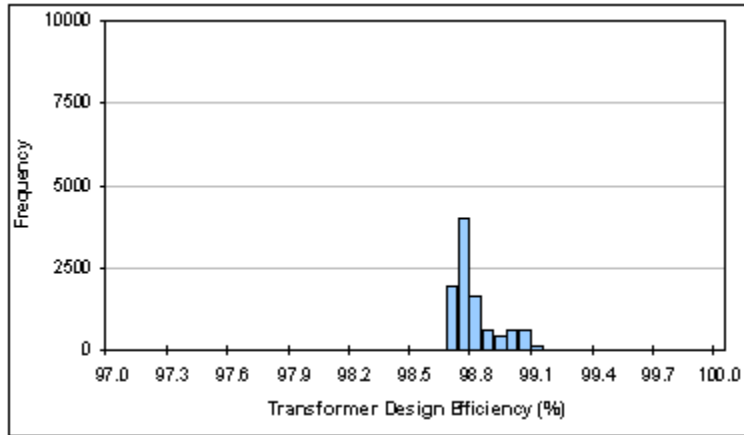


Figure 8E.3.51 **Distribution of Efficiencies for Design Line 11 Representative Unit, Candidate Standard Level 2**

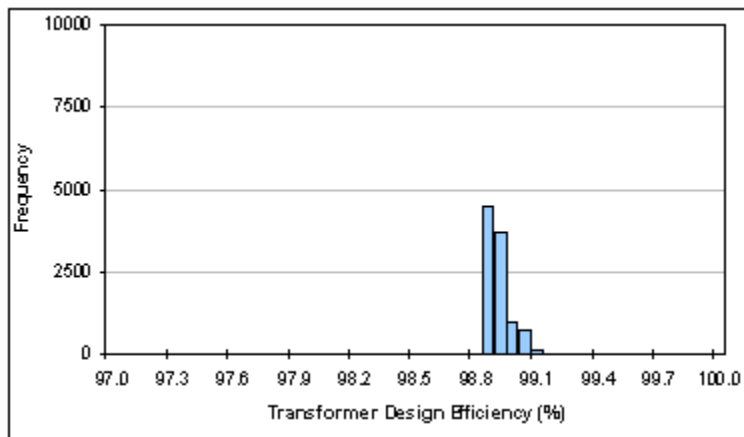


Figure 8E.3.52 **Distribution of Efficiencies for Design Line 11 Representative Unit, Candidate Standard Level 3**

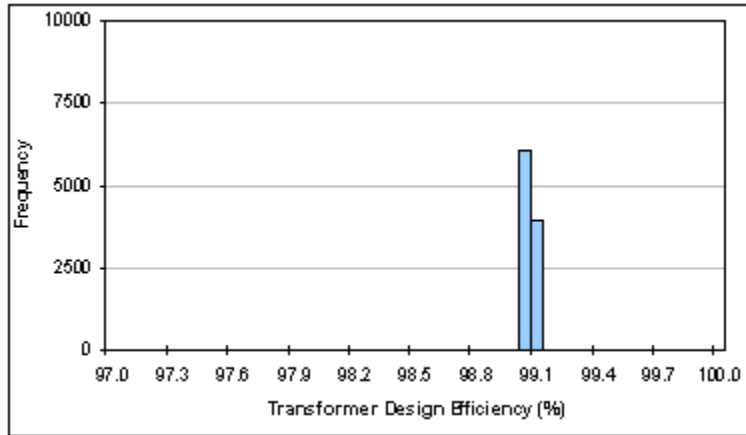


Figure 8E.3.53 **Distribution of Efficiencies for
Design Line 11 Representative
Unit, Candidate Standard Level 4**

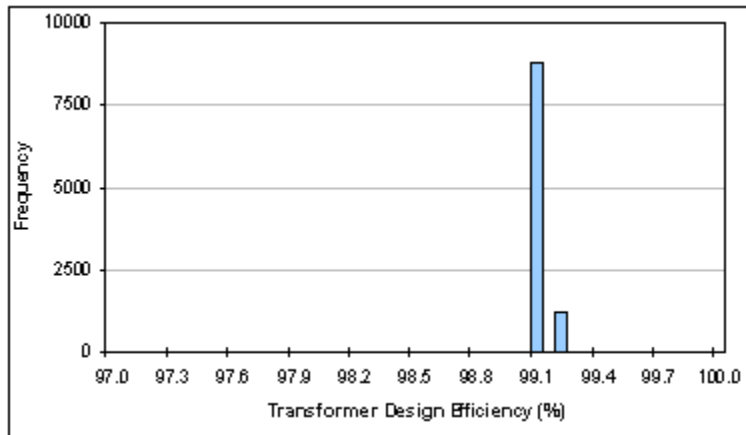


Figure 8E.3.54 **Distribution of Efficiencies for
Design Line 11 Representative
Unit, Candidate Standard Level 5**

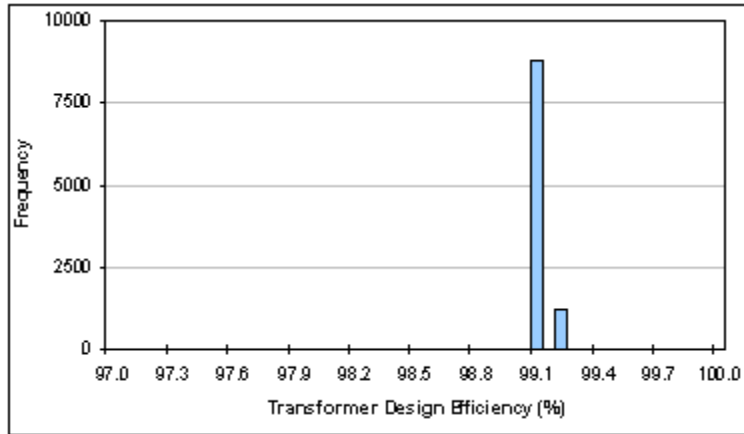


Figure 8E.3.55 **Distribution of Efficiencies for Design Line 11 Representative Unit, Candidate Standard Level 6**

8E.3.9 Distribution of Efficiencies for Design Line 12

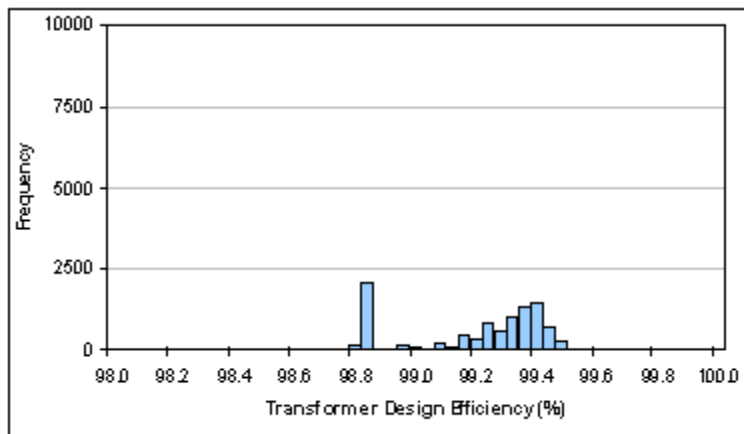


Figure 8E.3.56 **Distribution of Efficiencies for Design Line 12 Representative Unit, Baseline**

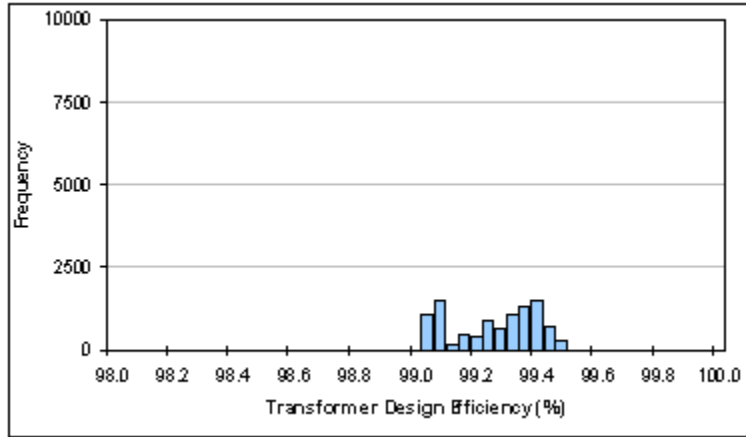


Figure 8E.3.57 **Distribution of Efficiencies for Design Line 12 Representative Unit, Candidate Standard Level 1**

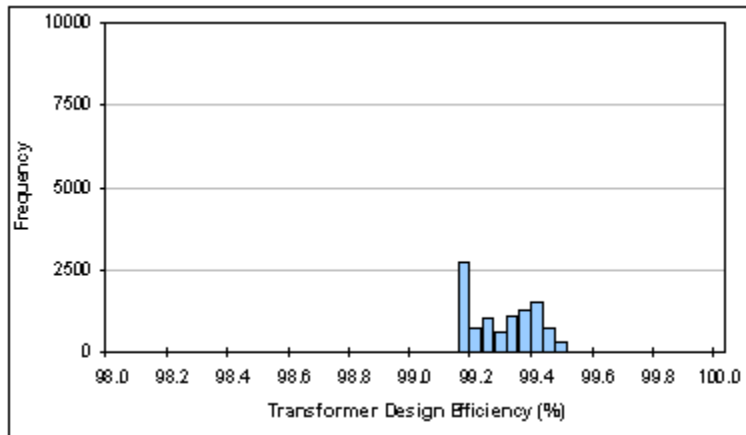


Figure 8E.3.58 **Distribution of Efficiencies for Design Line 12 Representative Unit, Candidate Standard Level 2**

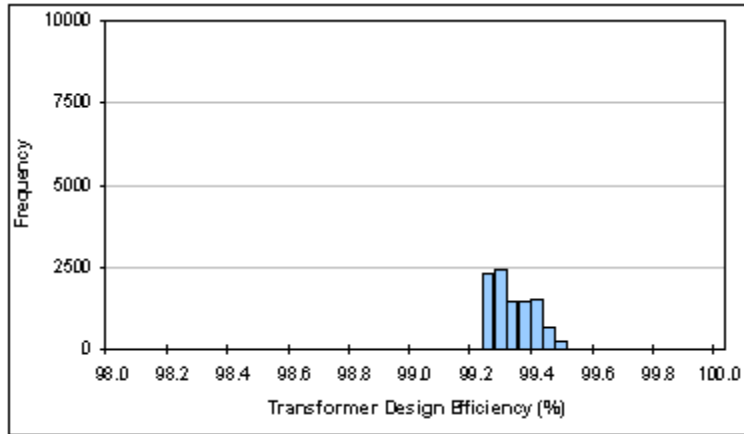


Figure 8E.3.59 **Distribution of Efficiencies for Design Line 12 Representative Unit, Candidate Standard Level 3**

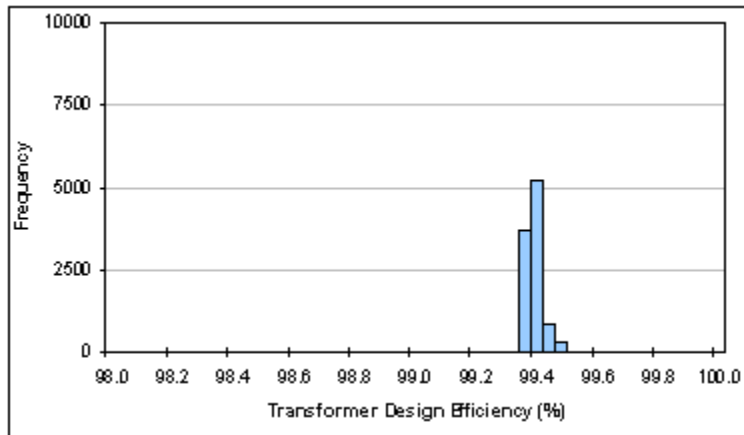


Figure 8E.3.60 **Distribution of Efficiencies for Design Line 12 Representative Unit, Candidate Standard Level 4**

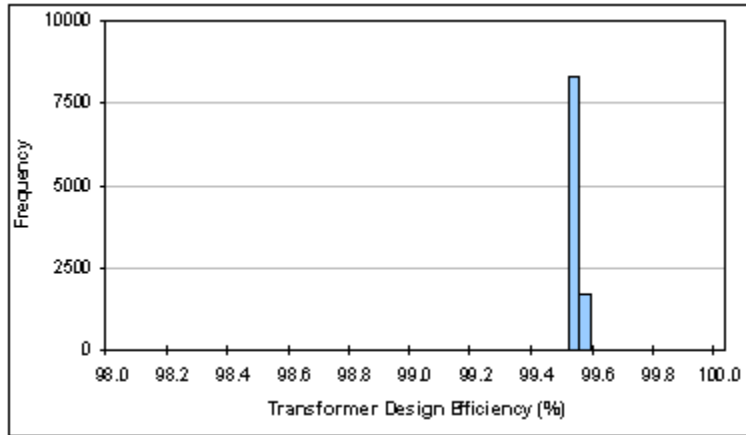


Figure 8E.3.61 **Distribution of Efficiencies for
Design Line 12 Representative
Unit, Candidate Standard Level 5**

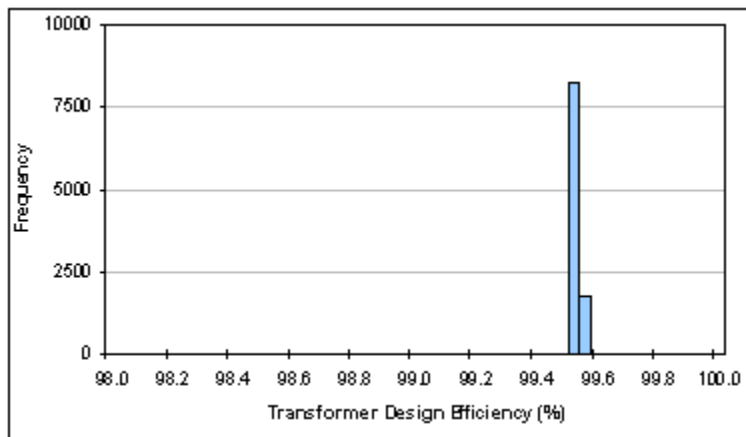


Figure 8E.3.62 **Distribution of Efficiencies for
Design Line 12 Representative
Unit, Candidate Standard Level 6**

8E.3.10

Distribution of Efficiencies for Design Line 13

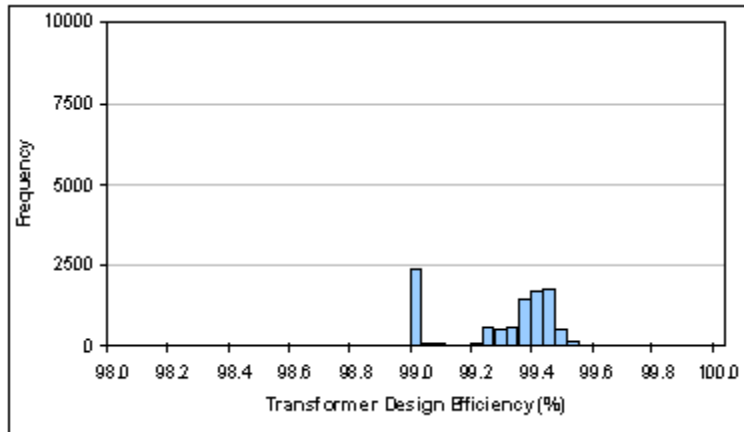


Figure 8E.3.63 Distribution of Efficiencies for Design Line 13 Representative Unit, Baseline

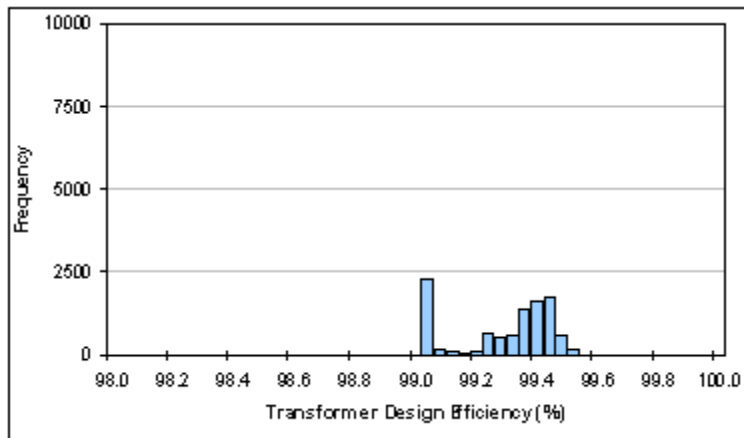


Figure 8E.3.64 Distribution of Efficiencies for Design Line 13 Representative Unit, Candidate Standard Level 1

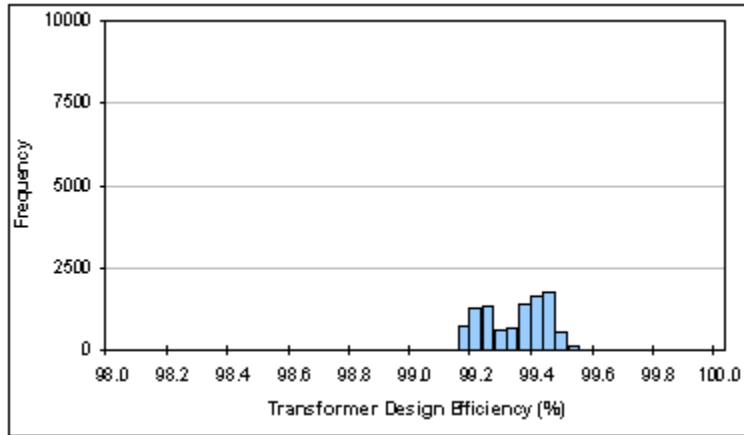


Figure 8E.3.65 **Distribution of Efficiencies for Design Line 13 Representative Unit, Candidate Standard Level 2**

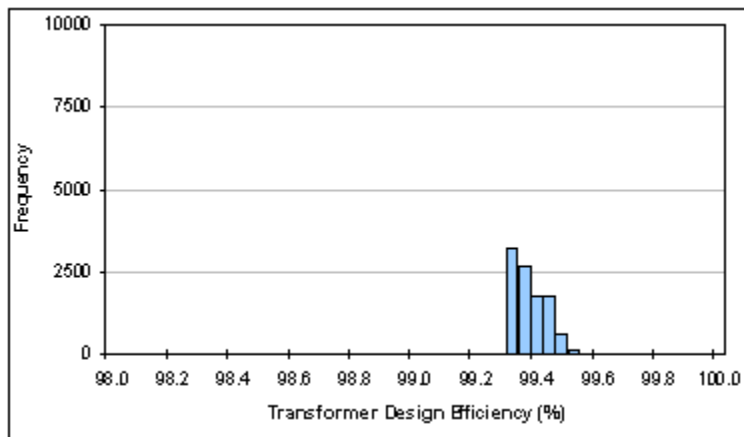


Figure 8E.3.66 **Distribution of Efficiencies for Design Line 13 Representative Unit, Candidate Standard Level 3**

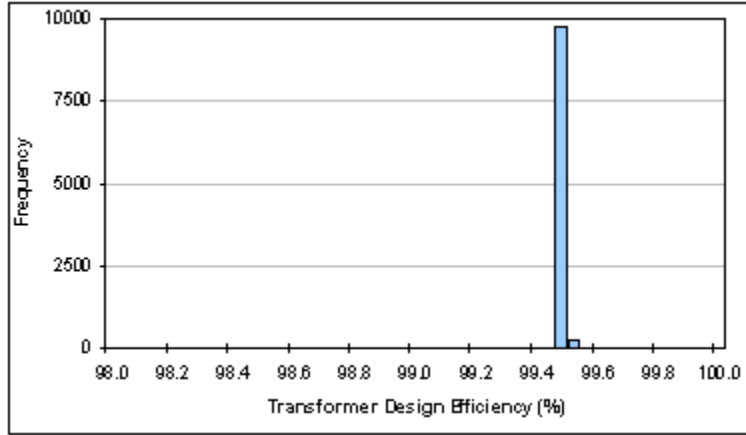


Figure 8E.3.67 **Distribution of Efficiencies for Design Line 13 Representative Unit, Candidate Standard Level 4**

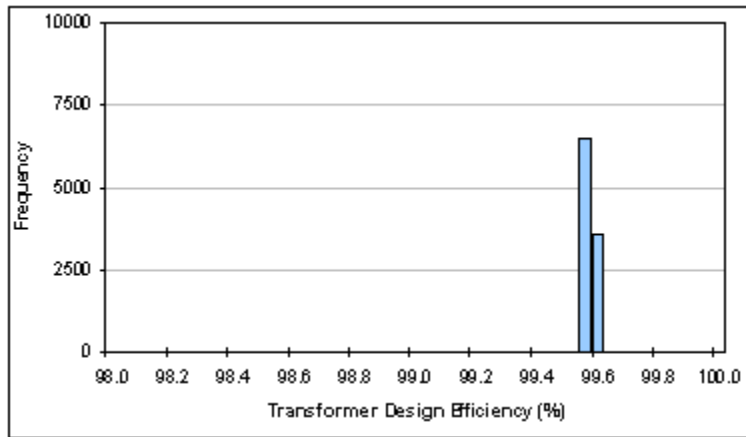


Figure 8E.3.68 **Distribution of Efficiencies for Design Line 13 Representative Unit, Candidate Standard Level 5**

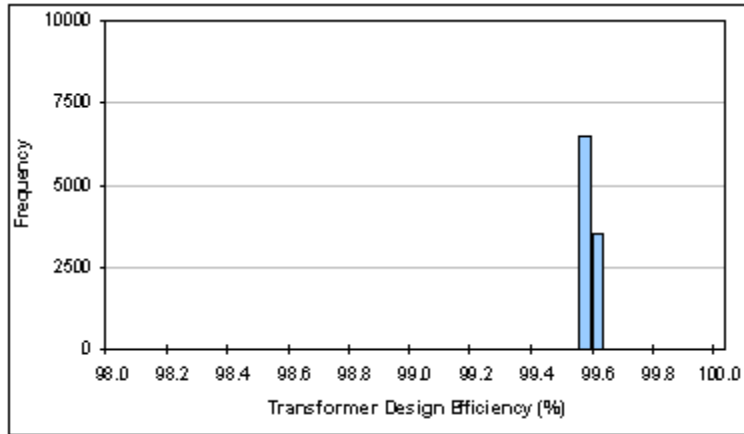


Figure 8E.3.69 **Distribution of Efficiencies for
Design Line 13 Representative
Unit, Candidate Standard Level 6**