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APPENDICES

APPENDIX A

The detail bus data, line data, active power, reactive power and bus voltage data of five-bus sample system

| Busdata | | | | | | | | | |
|---------|----------|---------|--------|-------|------|-----------|------|------|------|
| Bus No | Bus code | Voltage | Angle | Load | | Generator | | | |
| | | Mag | Degree | MW | Mvar | MW | Mvar | Qmin | Qmax |
| 1 | 1 | 1.01 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 2 | 1.00 | 0 | 0.00 | 0.00 | 20.00 | 0.00 | 0.00 | 0.00 |
| 3 | 0 | 0 | 0 | 8.00 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 4 | 0 | 0 | 0 | 11.00 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0 | 0 | 0 | 20.00 | 3.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Bus code

1 reference bus

2 PV bus

0 Load bus



| Line data | | | | |
|-----------|--------|-------|-------|-------|
| From bus | To bus | R | x | B |
| | | pu | pu | pu |
| 1 | 2 | 0.050 | 0.250 | 0.000 |
| 1 | 3 | 0.090 | 0.350 | 0.000 |
| 2 | 4 | 0.250 | 0.600 | 0.000 |
| 2 | 5 | 0.060 | 0.250 | 0.000 |
| 3 | 4 | 0.150 | 0.500 | 0.000 |
| 4 | 5 | 0.100 | 0.450 | 0.000 |

Active and reactive power load bus data of five- bus sample system

| Hour | Active power load bus (MW) | | | Reactive load bus (MVAR) | | |
|------|----------------------------|-------|-------|--------------------------|-------|-------|
| | Bus 3 | Bus 4 | Bus 5 | Bus 3 | Bus 4 | Bus 5 |
| 1 | 8.00 | 11.00 | 20.00 | 2.00 | 5.00 | 3.00 |
| 2 | 7.00 | 9.00 | 19.00 | 1.50 | 3.75 | 2.25 |
| 3 | 6.00 | 8.00 | 18.00 | 1.30 | 3.25 | 1.95 |
| 4 | 7.00 | 9.00 | 19.00 | 1.50 | 3.75 | 2.25 |
| 5 | 9.00 | 12.00 | 21.00 | 2.50 | 6.25 | 3.75 |
| 6 | 9.00 | 13.00 | 22.00 | 2.80 | 7.00 | 4.20 |
| 7 | 9.10 | 13.00 | 23.00 | 3.10 | 7.75 | 4.65 |
| 8 | 9.20 | 14.00 | 24.00 | 3.30 | 8.25 | 4.95 |
| 9 | 9.30 | 14.20 | 24.10 | 3.60 | 9.00 | 5.40 |
| 10 | 9.50 | 14.40 | 24.30 | 3.90 | 9.75 | 5.85 |
| 11 | 10.00 | 15.00 | 25.00 | 4.00 | 10.00 | 6.00 |
| 12 | 9.70 | 14.80 | 24.90 | 3.95 | 9.88 | 5.93 |
| 13 | 9.60 | 14.70 | 24.80 | 3.93 | 9.83 | 5.90 |
| 14 | 9.70 | 14.80 | 24.90 | 3.95 | 9.88 | 5.93 |
| 15 | 9.40 | 14.70 | 24.30 | 3.89 | 9.73 | 5.84 |
| 16 | 9.40 | 14.60 | 24.20 | 3.80 | 9.50 | 5.70 |
| 17 | 9.30 | 14.00 | 24.10 | 3.50 | 8.75 | 5.25 |
| 18 | 9.20 | 14.00 | 24.00 | 3.40 | 8.50 | 5.10 |
| 19 | 9.20 | 14.00 | 23.80 | 3.20 | 8.00 | 4.80 |
| 20 | 9.30 | 14.10 | 24.10 | 3.50 | 8.75 | 5.25 |
| 21 | 9.30 | 14.20 | 24.10 | 3.60 | 9.00 | 5.40 |
| 22 | 9.30 | 14.10 | 24.10 | 3.50 | 8.75 | 5.25 |
| 23 | 9.00 | 13.00 | 23.00 | 3.00 | 7.50 | 4.50 |
| 24 | 8.50 | 12.75 | 21.25 | 2.20 | 5.50 | 3.30 |
| 25 | 7.50 | 11.25 | 18.75 | 1.90 | 4.75 | 2.85 |
| 26 | 6.50 | 9.75 | 16.25 | 1.40 | 3.50 | 2.10 |
| 27 | 7.00 | 10.50 | 17.50 | 1.50 | 3.75 | 2.25 |
| 28 | 9.20 | 13.80 | 23.00 | 2.60 | 6.50 | 3.90 |
| 29 | 9.20 | 13.80 | 23.00 | 2.80 | 7.00 | 4.20 |
| 30 | 9.30 | 13.95 | 23.25 | 3.00 | 7.50 | 4.50 |
| 31 | 9.35 | 14.03 | 23.38 | 3.30 | 8.25 | 4.95 |
| 32 | 9.35 | 14.03 | 23.38 | 3.40 | 8.50 | 5.10 |
| 33 | 9.40 | 14.10 | 23.50 | 3.70 | 9.25 | 5.55 |
| 34 | 9.50 | 14.25 | 23.75 | 3.80 | 9.50 | 5.70 |
| 35 | 9.80 | 14.70 | 24.50 | 3.95 | 9.88 | 5.93 |
| 36 | 9.60 | 14.40 | 24.00 | 3.93 | 9.83 | 5.90 |
| 37 | 9.60 | 14.40 | 24.00 | 3.92 | 9.80 | 5.88 |

Active and reactive power load bus data of five- bus sample system (continued)

| Hour | Active power load bus (MW) | | | Reactive load bus (MVAR) | | |
|------|----------------------------|-------|-------|--------------------------|-------|-------|
| | Bus 3 | Bus 4 | Bus 5 | Bus 3 | Bus 4 | Bus 5 |
| 38 | 9.40 | 14.10 | 23.50 | 3.60 | 9.00 | 5.40 |
| 39 | 9.20 | 13.80 | 23.00 | 3.00 | 7.50 | 4.50 |
| 40 | 9.35 | 14.03 | 23.38 | 3.50 | 8.75 | 5.25 |
| 41 | 9.00 | 13.50 | 22.50 | 3.40 | 8.50 | 5.10 |
| 42 | 9.30 | 13.95 | 23.25 | 3.20 | 8.00 | 4.80 |
| 43 | 9.35 | 14.03 | 23.38 | 3.30 | 8.25 | 4.95 |
| 44 | 9.40 | 14.10 | 23.50 | 3.60 | 9.00 | 5.40 |
| 45 | 9.40 | 14.10 | 23.50 | 3.50 | 8.75 | 5.25 |
| 46 | 9.20 | 13.80 | 23.00 | 3.00 | 7.50 | 4.50 |
| 47 | 9.00 | 13.50 | 22.50 | 2.80 | 7.00 | 4.20 |
| 48 | 8.90 | 13.35 | 22.25 | 2.60 | 6.50 | 3.90 |
| 49 | 8.00 | 12.00 | 20.00 | 2.00 | 5.00 | 3.00 |
| 50 | 7.50 | 11.25 | 18.75 | 1.90 | 4.75 | 2.85 |
| 51 | 8.30 | 12.45 | 20.75 | 2.30 | 5.75 | 3.45 |
| 52 | 8.50 | 12.75 | 21.25 | 2.50 | 6.25 | 3.75 |
| 53 | 8.60 | 12.90 | 21.50 | 2.70 | 6.75 | 4.05 |
| 54 | 9.00 | 13.50 | 22.50 | 2.90 | 7.25 | 4.35 |
| 55 | 9.10 | 13.65 | 22.75 | 3.20 | 8.00 | 4.80 |
| 56 | 9.10 | 13.65 | 22.75 | 3.10 | 7.75 | 4.65 |
| 57 | 9.40 | 14.10 | 23.50 | 3.50 | 8.75 | 5.25 |
| 58 | 9.80 | 14.70 | 24.50 | 3.90 | 9.75 | 5.85 |
| 59 | 9.70 | 14.55 | 24.25 | 3.80 | 9.50 | 5.70 |
| 60 | 9.70 | 14.55 | 24.25 | 3.80 | 9.50 | 5.70 |
| 61 | 9.50 | 14.25 | 23.75 | 3.60 | 9.00 | 5.40 |
| 62 | 9.30 | 13.95 | 23.25 | 3.20 | 8.00 | 4.80 |
| 63 | 9.30 | 13.95 | 23.25 | 3.30 | 8.25 | 4.95 |
| 64 | 9.30 | 13.95 | 23.25 | 3.30 | 8.25 | 4.95 |
| 65 | 9.20 | 13.80 | 23.00 | 3.20 | 8.00 | 4.80 |
| 66 | 9.30 | 13.95 | 23.25 | 3.30 | 8.25 | 4.95 |
| 67 | 9.40 | 14.10 | 23.50 | 3.50 | 8.75 | 5.25 |
| 68 | 9.50 | 14.25 | 23.75 | 3.60 | 9.00 | 5.40 |
| 69 | 9.40 | 14.10 | 23.50 | 3.40 | 8.50 | 5.10 |
| 70 | 9.30 | 13.95 | 23.25 | 3.30 | 8.25 | 4.95 |
| 71 | 8.70 | 13.05 | 21.75 | 2.50 | 6.25 | 3.75 |
| 72 | 8.50 | 12.75 | 21.25 | 2.30 | 5.75 | 3.45 |

Bus voltage data of five-bus sample system

| Hour | Bus voltage (pu) | | | | |
|------|------------------|-------|---------|---------|---------|
| | Bus 1 | Bus 2 | Bus 3 | Bus 4 | Bus 5 |
| 1 | 1 | 1 | 0.9773 | 0.9616 | 0.9745 |
| 2 | 1 | 1 | 0.9817 | 0.9726 | 0.97846 |
| 3 | 1 | 1 | 0.98406 | 0.9758 | 0.98057 |
| 4 | 1 | 1 | 0.9817 | 0.9726 | 0.97846 |
| 5 | 1 | 1 | 0.97314 | 0.9602 | 0.97048 |
| 6 | 1 | 1 | 0.9708 | 0.9564 | 0.96787 |
| 7 | 1 | 1 | 0.9689 | 0.9534 | 0.9656 |
| 8 | 1 | 1 | 0.9671 | 0.9504 | 0.9635 |
| 9 | 1 | 1 | 0.9648 | 0.9465 | 0.9605 |
| 10 | 1 | 1 | 0.9619 | 0.9415 | 0.9561 |
| 11 | 1 | 1 | 0.9601 | 0.9384 | 0.9533 |
| 12 | 1 | 1 | 0.9608 | 0.9396 | 0.9542 |
| 13 | 1 | 1 | 0.9612 | 0.9401 | 0.9547 |
| 14 | 1 | 1 | 0.9608 | 0.9396 | 0.9542 |
| 15 | 1 | 1 | 0.9619 | 0.9413 | 0.9560 |
| 16 | 1 | 1 | 0.9628 | 0.9429 | 0.9574 |
| 17 | 1 | 1 | 0.9657 | 0.9482 | 0.9619 |
| 18 | 1 | 1 | 0.9655 | 0.9494 | 0.9628 |
| 19 | 1 | 1 | 0.9677 | 0.9512 | 0.9641 |
| 20 | 1 | 1 | 0.9657 | 0.9482 | 0.9619 |
| 21 | 1 | 1 | 0.9648 | 0.9465 | 0.9605 |
| 22 | 1 | 1 | 0.9657 | 0.9482 | 0.9619 |
| 23 | 1 | 1 | 0.9695 | 0.9542 | 0.9661 |
| 24 | 1 | 1 | 0.97490 | 0.96220 | 0.97180 |
| 25 | 1 | 1 | 0.9783 | 0.9673 | 0.9756 |
| 26 | 1 | 1 | 0.9828 | 0.9740 | 0.9804 |
| 27 | 1 | 1 | 0.9813 | 0.9718 | 0.9788 |
| 28 | 1 | 1 | 0.9713 | 0.9569 | 0.9680 |
| 29 | 1 | 1 | 0.9702 | 0.9552 | 0.9669 |
| 30 | 1 | 1 | 0.9688 | 0.9532 | 0.9655 |
| 31 | 1 | 1 | 0.9670 | 0.9504 | 0.9637 |
| 32 | 1 | 1 | 0.9664 | 0.9495 | 0.9632 |
| 33 | 1 | 1 | 0.9642 | 0.9456 | 0.9600 |
| 34 | 1 | 1 | 0.9642 | 0.9456 | 0.9600 |
| 35 | 1 | 1 | 0.9610 | 0.9400 | 0.9548 |
| 36 | 1 | 1 | 0.9617 | 0.9412 | 0.9559 |
| 37 | 1 | 1 | 0.9617 | 0.9412 | 0.9559 |

Bus voltage data of five -bus sample system (continued)

| Hour | Bus voltage (pu) | | | | |
|------|------------------|-------|--------|--------|--------|
| | Bus 1 | Bus 2 | Bus 3 | Bus 4 | Bus 5 |
| 38 | 1 | 1 | 0.9650 | 0.9471 | 0.9613 |
| 39 | 1 | 1 | 0.9690 | 0.9534 | 0.9658 |
| 40 | 1 | 1 | 0.9659 | 0.9486 | 0.9626 |
| 41 | 1 | 1 | 0.9667 | 0.9495 | 0.9624 |
| 42 | 1 | 1 | 0.9677 | 0.9514 | 0.9644 |
| 43 | 1 | 1 | 0.9670 | 0.9504 | 0.9637 |
| 44 | 1 | 1 | 0.9650 | 0.9471 | 0.9613 |
| 45 | 1 | 1 | 0.9659 | 0.9487 | 0.9628 |
| 46 | 1 | 1 | 0.9688 | 0.9528 | 0.9655 |
| 47 | 1 | 1 | 0.9705 | 0.9557 | 0.9673 |
| 48 | 1 | 1 | 0.9719 | 0.9577 | 0.9687 |
| 49 | 1 | 1 | 0.9769 | 0.9651 | 0.9390 |
| 50 | 1 | 1 | 0.9782 | 0.9672 | 0.9754 |
| 51 | 1 | 1 | 0.9750 | 0.9627 | 0.9720 |
| 52 | 1 | 1 | 0.9732 | 0.9596 | 0.9701 |
| 53 | 1 | 1 | 0.9718 | 0.9576 | 0.9688 |
| 54 | 1 | 1 | 0.9700 | 0.9548 | 0.9668 |
| 55 | 1 | 1 | 0.9681 | 0.9519 | 0.9648 |
| 56 | 1 | 1 | 0.9686 | 0.9528 | 0.9654 |
| 57 | 1 | 1 | 0.9658 | 0.9485 | 0.9625 |
| 58 | 1 | 1 | 0.9614 | 0.9408 | 0.9555 |
| 59 | 1 | 1 | 0.9625 | 0.9427 | 0.9573 |
| 60 | 1 | 1 | 0.9625 | 0.9427 | 0.9573 |
| 61 | 1 | 1 | 0.9647 | 0.9466 | 0.9608 |
| 62 | 1 | 1 | 0.9677 | 0.9514 | 0.9644 |
| 63 | 1 | 1 | 0.9671 | 0.9505 | 0.9638 |
| 64 | 1 | 1 | 0.9671 | 0.9505 | 0.9638 |
| 65 | 1 | 1 | 0.9677 | 0.9514 | 0.9644 |
| 66 | 1 | 1 | 0.9671 | 0.9505 | 0.9638 |
| 67 | 1 | 1 | 0.9658 | 0.9485 | 0.9625 |
| 68 | 1 | 1 | 0.9647 | 0.9466 | 0.9608 |
| 69 | 1 | 1 | 0.9655 | 0.9494 | 0.9628 |
| 70 | 1 | 1 | 0.9671 | 0.9505 | 0.9638 |
| 71 | 1 | 1 | 0.9732 | 0.9596 | 0.9701 |
| 72 | 1 | 1 | 0.9750 | 0.9627 | 0.9720 |

APPENDIX B

The detail bus data, line data, active power, reactive power and bus voltage data of EDL 21-bus System

| Busdata | | | | | | | | | |
|---------|----------|---------|--------|-------|-------|-----------|------|------|------|
| Bus No | Bus code | Voltage | Angle | Load | | Generator | | | |
| | | Mag | Degree | MW | Mvar | MW | Mvar | Qmin | Qmax |
| 1 | 1 | 1.01 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 2 | 2 | 1.00 | 0 | 0.00 | 0.00 | 60.00 | 0.00 | 0.00 | 0.00 |
| 3 | 2 | 1.00 | 0 | 0.00 | 0.00 | 40.00 | 0.00 | 0.00 | 0.00 |
| 4 | 2 | 1.00 | 0 | 0.00 | 0.00 | 1.00 | 0.00 | 0.00 | 0.00 |
| 5 | 3 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 6 | 0 | 0.00 | 0 | 33.50 | 19.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 7 | 0 | 0.00 | 0 | 4.50 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 8 | 0 | 0.00 | 0 | 9.70 | 5.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 9 | 0 | 0.00 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 0 | 0.00 | 0 | 7.80 | 4.60 | 0.00 | 0.00 | 0.00 | 0.00 |
| 11 | 0 | 0.00 | 0 | 3.50 | 1.33 | 0.00 | 0.00 | 0.00 | 0.00 |
| 12 | 0 | 0.00 | 0 | 1.00 | 0.59 | 0.00 | 0.00 | 0.00 | 0.00 |
| 13 | 0 | 0.00 | 0 | 2.10 | 1.16 | 0.00 | 0.00 | 0.00 | 0.00 |
| 14 | 0 | 0.00 | 0 | 5.30 | 2.33 | 0.00 | 0.00 | 0.00 | 0.00 |
| 15 | 0 | 0.00 | 0 | 95.00 | 54.97 | 0.00 | 0.00 | 0.00 | 0.00 |
| 16 | 0 | 0.00 | 0 | 4.50 | 1.30 | 0.00 | 0.00 | 0.00 | 0.00 |
| 17 | 0 | 0.00 | 0 | 7.70 | 3.26 | 0.00 | 0.00 | 0.00 | 0.00 |
| 18 | 0 | 0.00 | 0 | 8.00 | 4.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19 | 0 | 0.00 | 0 | 8.30 | 3.96 | 0.00 | 0.00 | 0.00 | 0.00 |
| 20 | 0 | 0.00 | 0 | 30.00 | 10.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| 21 | 0 | 0.00 | 0 | 3.20 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Bus code

1 reference bus

2 PV bus

3 transfer bus

0 Load bus

| Line data | | | | |
|------------------|---------------|-----------|-----------|-----------|
| From bus | To bus | R | x | B |
| | | pu | pu | pu |
| 1 | 2 | 0.01638 | 0.05526 | 0.00666 |
| 1 | 7 | 0.01092 | 0.03684 | 0.00179 |
| 1 | 16 | 0.01638 | 0.05382 | 0.00684 |
| 2 | 5 | 0.02985 | 0.09840 | 0.01246 |
| 2 | 19 | 0.07735 | 0.25500 | 0.03230 |
| 3 | 18 | 0.01747 | 0.05664 | 0.00749 |
| 4 | 10 | 0.10802 | 0.36437 | 0.00011 |
| 5 | 6 | 0.01183 | 0.03900 | 0.02204 |
| 5 | 21 | 0.06916 | 0.22800 | 0.02888 |
| 7 | 8 | 0.02711 | 0.05337 | 0.00601 |
| 7 | 12 | 0.01529 | 0.05158 | 0.00622 |
| 7 | 14 | 0.01638 | 0.05526 | 0.00666 |
| 8 | 9 | 0.06097 | 0.20569 | 0.02479 |
| 9 | 10 | 0.04914 | 0.16578 | 0.01998 |
| 9 | 11 | 0.04914 | 0.16416 | 0.02052 |
| 12 | 13 | 0.00910 | 0.02950 | 0.00390 |
| 14 | 15 | 0.04732 | 0.15600 | 0.01976 |
| 15 | 16 | 0.06598 | 0.06598 | 0.02755 |
| 15 | 20 | 0.06263 | 0.00729 | 0.00607 |
| 16 | 17 | 0.02588 | 0.05672 | 0.00650 |
| 16 | 18 | 0.07098 | 0.24336 | 0.02886 |
| 18 | 20 | 0.05023 | 0.16284 | 0.02153 |

Active power load bus data of EDL 21-bus System

| Hour | Active power load bus (MW) | | | | | | |
|------|----------------------------|-------|-------|--------|--------|--------|--------|
| | Bus 6 | Bus 7 | Bus 8 | Bus 10 | Bus 11 | Bus 12 | Bus 13 |
| 1 | 33.50 | 4.50 | 9.70 | 7.80 | 3.50 | 1.00 | 2.10 |
| 2 | 33.50 | 4.30 | 9.50 | 6.80 | 3.40 | 0.99 | 1.99 |
| 3 | 33.00 | 4.40 | 9.00 | 6.80 | 3.30 | 0.95 | 1.98 |
| 4 | 32.50 | 4.80 | 9.90 | 7.00 | 3.30 | 0.95 | 1.95 |
| 5 | 32.00 | 4.80 | 10.50 | 7.50 | 3.40 | 0.99 | 2.00 |
| 6 | 34.50 | 4.90 | 11.50 | 9.50 | 3.50 | 1.00 | 2.30 |
| 7 | 39.50 | 5.10 | 13.30 | 9.80 | 3.70 | 1.20 | 2.60 |
| 8 | 42.50 | 5.50 | 13.50 | 11.20 | 3.90 | 1.30 | 2.90 |
| 9 | 43.90 | 5.80 | 14.80 | 12.80 | 3.95 | 1.50 | 3.30 |
| 10 | 44.50 | 5.90 | 14.90 | 13.70 | 4.00 | 1.50 | 3.45 |
| 11 | 45.00 | 6.00 | 15.00 | 13.80 | 4.00 | 1.60 | 3.50 |
| 12 | 33.00 | 5.60 | 11.50 | 12.00 | 3.70 | 1.40 | 3.40 |
| 13 | 44.00 | 5.70 | 14.30 | 13.40 | 3.90 | 1.20 | 3.45 |
| 14 | 44.30 | 4.30 | 14.00 | 12.7 | 3.95 | 1.20 | 3.30 |
| 15 | 44.20 | 4.20 | 13.30 | 12.50 | 3.70 | 1.10 | 3.00 |
| 16 | 40.00 | 4.10 | 9.81 | 8.6 | 3.30 | 1.00 | 2.10 |
| 17 | 32.00 | 5.00 | 9.50 | 9.80 | 3.80 | 1.20 | 2.00 |
| 18 | 35.50 | 5.50 | 12.00 | 10.40 | 3.90 | 1.40 | 3.30 |
| 19 | 40.50 | 5.90 | 13.50 | 12.70 | 3.97 | 1.50 | 3.40 |
| 20 | 41.00 | 6.00 | 14.00 | 13.60 | 3.80 | 1.50 | 3.50 |
| 21 | 40.80 | 5.60 | 13.80 | 12.00 | 3.70 | 1.30 | 3.30 |
| 22 | 40.50 | 5.40 | 13.50 | 11.40 | 3.50 | 1.20 | 3.20 |
| 23 | 38.00 | 4.80 | 13.00 | 10.00 | 3.50 | 1.00 | 2.90 |
| 24 | 35.00 | 4.50 | 12.00 | 9.80 | 3.45 | 0.99 | 2.50 |
| 25 | 35.00 | 4.20 | 10.00 | 7.80 | 3.33 | 0.97 | 2.00 |
| 26 | 33.50 | 4.40 | 9.50 | 6.80 | 3.40 | 0.96 | 1.99 |
| 27 | 32.50 | 4.40 | 9.70 | 6.80 | 3.30 | 0.95 | 1.98 |
| 28 | 32.00 | 4.50 | 9.90 | 7.00 | 3.30 | 0.95 | 1.95 |
| 29 | 32.00 | 4.80 | 10.50 | 7.50 | 3.40 | 0.99 | 2.00 |
| 30 | 34.60 | 4.90 | 11.50 | 9.50 | 3.50 | 1.00 | 2.30 |
| 31 | 39.50 | 5.20 | 13.30 | 9.80 | 3.70 | 1.20 | 2.60 |
| 32 | 42.50 | 5.50 | 13.50 | 11.20 | 3.90 | 1.30 | 2.90 |
| 33 | 43.90 | 5.70 | 14.80 | 12.80 | 3.95 | 1.50 | 3.30 |
| 34 | 44.50 | 5.80 | 14.90 | 13.70 | 3.99 | 1.50 | 3.45 |
| 35 | 45.00 | 6.00 | 15.00 | 13.80 | 4.00 | 1.60 | 3.50 |

Active power load bus data of EDL 21-bus System (continued)

| Hour | Active power load bus (MW) | | | | | | |
|------|----------------------------|-------|-------|--------|--------|--------|--------|
| | Bus 6 | Bus 7 | Bus 8 | Bus 10 | Bus 11 | Bus 12 | Bus 13 |
| 36 | 33.00 | 5.80 | 11.50 | 12.50 | 3.70 | 1.40 | 3.40 |
| 37 | 44.00 | 5.60 | 14.30 | 13.40 | 3.90 | 1.20 | 3.45 |
| 38 | 44.30 | 5.70 | 14.00 | 12.7 | 3.95 | 1.20 | 3.30 |
| 39 | 44.20 | 5.20 | 13.30 | 12.50 | 3.70 | 1.10 | 3.00 |
| 40 | 40.00 | 5.00 | 10.00 | 8.00 | 3.30 | 1.00 | 2.10 |
| 41 | 32.00 | 4.80 | 9.50 | 9.80 | 3.80 | 1.20 | 2.00 |
| 42 | 35.50 | 5.20 | 12.00 | 10.40 | 3.90 | 1.40 | 3.30 |
| 43 | 40.50 | 5.70 | 13.50 | 12.70 | 3.97 | 1.50 | 3.40 |
| 44 | 42.00 | 6.00 | 14.20 | 13.50 | 4.00 | 1.60 | 3.50 |
| 45 | 40.80 | 5.80 | 13.80 | 12.00 | 3.70 | 1.30 | 3.30 |
| 46 | 40.50 | 5.40 | 13.50 | 11.40 | 3.50 | 1.20 | 3.20 |
| 47 | 38.00 | 5.00 | 13.00 | 10.00 | 3.50 | 1.00 | 2.60 |
| 48 | 35.00 | 4.70 | 12.00 | 9.80 | 3.45 | 0.99 | 2.30 |
| 49 | 33.00 | 4.60 | 9.80 | 9.00 | 3.50 | 0.97 | 2.00 |
| 50 | 32.50 | 4.40 | 9.50 | 7.00 | 3.40 | 0.96 | 1.99 |
| 51 | 33.00 | 4.10 | 9.70 | 6.80 | 3.30 | 0.95 | 1.98 |
| 52 | 32.50 | 4.10 | 9.90 | 7.50 | 3.30 | 0.95 | 1.95 |
| 53 | 32.00 | 4.60 | 10.50 | 7.50 | 3.40 | 0.99 | 2.00 |
| 54 | 34.50 | 5.00 | 11.50 | 9.50 | 3.50 | 1.00 | 2.30 |
| 55 | 39.50 | 5.50 | 13.00 | 9.80 | 3.70 | 1.20 | 2.60 |
| 56 | 43.90 | 5.70 | 13.50 | 11.20 | 3.90 | 1.30 | 2.90 |
| 57 | 43.90 | 5.90 | 14.60 | 12.80 | 3.95 | 1.50 | 3.30 |
| 58 | 44.50 | 5.90 | 14.90 | 13.70 | 4.00 | 1.50 | 3.45 |
| 59 | 45.00 | 6.00 | 15.00 | 13.80 | 4.00 | 1.60 | 3.50 |
| 60 | 33.00 | 5.90 | 11.50 | 12.50 | 3.70 | 1.40 | 3.40 |
| 61 | 44.00 | 5.70 | 14.30 | 13.40 | 3.90 | 1.20 | 3.45 |
| 62 | 44.30 | 5.60 | 14.00 | 13.00 | 3.95 | 1.20 | 3.30 |
| 63 | 44.20 | 5.20 | 13.30 | 12.50 | 3.70 | 1.10 | 3.00 |
| 64 | 40.00 | 4.60 | 11.00 | 10.00 | 3.30 | 1.00 | 2.10 |
| 65 | 32.00 | 4.90 | 9.50 | 9.80 | 3.80 | 1.20 | 2.00 |
| 66 | 35.50 | 5.40 | 12.00 | 11.00 | 3.90 | 1.40 | 3.30 |
| 67 | 40.50 | 5.60 | 13.00 | 12.70 | 3.97 | 1.50 | 3.40 |
| 68 | 43.00 | 6.00 | 14.50 | 13.40 | 4.00 | 1.60 | 3.50 |
| 69 | 40.80 | 5.70 | 13.60 | 12.00 | 3.70 | 1.30 | 3.30 |
| 70 | 40.50 | 5.30 | 13.50 | 11.40 | 3.50 | 1.20 | 3.20 |
| 71 | 38.00 | 4.80 | 13.00 | 10.00 | 3.50 | 1.00 | 2.90 |
| 72 | 35.00 | 4.30 | 11.80 | 9.80 | 3.45 | 0.99 | 2.50 |

Active power load bus data of EDL 21-bus System (continued)

| Hour | Active power load bus (MW) | | | | | | | |
|------|----------------------------|--------|--------|--------|--------|--------|--------|--------|
| | Bus 14 | Bus 15 | Bus 16 | Bus 17 | Bus 18 | Bus 19 | Bus 20 | Bus 21 |
| 1 | 5.30 | 95.00 | 4.50 | 7.70 | 8.00 | 8.30 | 30.00 | 3.20 |
| 2 | 5.20 | 80.84 | 4.20 | 7.60 | 7.50 | 8.10 | 29.50 | 3.00 |
| 3 | 5.00 | 75.80 | 4.10 | 7.50 | 6.80 | 7.90 | 29.30 | 2.70 |
| 4 | 5.00 | 70.84 | 3.90 | 7.40 | 6.70 | 7.80 | 29.00 | 2.60 |
| 5 | 5.70 | 96.00 | 4.00 | 7.70 | 7.80 | 8.90 | 30.00 | 3.40 |
| 6 | 5.90 | 111.50 | 5.40 | 7.90 | 8.50 | 9.10 | 31.20 | 3.90 |
| 7 | 6.00 | 120.50 | 5.80 | 8.00 | 9.50 | 9.50 | 32.50 | 4.50 |
| 8 | 6.50 | 163.00 | 6.00 | 8.60 | 11.50 | 10.30 | 32.80 | 5.40 |
| 9 | 6.70 | 164.50 | 6.20 | 9.50 | 12.80 | 10.60 | 33.00 | 5.80 |
| 10 | 6.90 | 164.90 | 6.30 | 9.70 | 13.00 | 10.80 | 33.00 | 5.90 |
| 11 | 7.00 | 165.00 | 6.30 | 9.80 | 13.10 | 11.90 | 33.10 | 6.00 |
| 12 | 6.20 | 112.00 | 5.80 | 8.30 | 9.50 | 9.50 | 31.20 | 5.30 |
| 13 | 6.70 | 164.00 | 6.10 | 9.40 | 12.30 | 10.40 | 32.80 | 5.80 |
| 14 | 6.90 | 164.70 | 6.20 | 9.60 | 12.60 | 10.90 | 33.00 | 5.90 |
| 15 | 6.50 | 130.00 | 5.90 | 9.40 | 11.90 | 10.60 | 32.70 | 5.20 |
| 16 | 5.50 | 125.00 | 5.50 | 8.50 | 10.00 | 9.80 | 31.10 | 5.00 |
| 17 | 5.20 | 95.90 | 4.70 | 7.90 | 9.50 | 8.60 | 30.00 | 4.20 |
| 18 | 5.80 | 134.00 | 5.90 | 8.90 | 10.60 | 10.70 | 31.40 | 5.30 |
| 19 | 6.70 | 162.00 | 6.20 | 9.50 | 12.80 | 10.90 | 32.60 | 5.70 |
| 20 | 6.90 | 163.00 | 6.20 | 9.60 | 12.90 | 11.00 | 32.90 | 5.80 |
| 21 | 6.50 | 161.00 | 6.00 | 9.30 | 12.70 | 10.80 | 31.80 | 5.50 |
| 22 | 6.00 | 145.00 | 5.60 | 9.00 | 12.00 | 10.50 | 31.50 | 5.30 |
| 23 | 5.60 | 132.00 | 5.10 | 8.50 | 11.30 | 9.80 | 31.00 | 5.00 |
| 24 | 5.50 | 115.00 | 5.00 | 8.00 | 10.00 | 9.00 | 30.00 | 4.50 |
| 25 | 5.20 | 98.00 | 4.70 | 7.70 | 9.50 | 8.60 | 29.80 | 3.50 |
| 26 | 5.10 | 93.00 | 4.20 | 7.60 | 8.00 | 8.10 | 29.50 | 3.20 |
| 27 | 5.00 | 75.80 | 4.10 | 7.50 | 7.50 | 8.00 | 29.30 | 2.80 |
| 28 | 5.00 | 75.00 | 3.90 | 7.40 | 6.80 | 7.80 | 29.00 | 2.70 |
| 29 | 5.60 | 99.00 | 4.00 | 7.70 | 6.70 | 8.90 | 30.00 | 3.40 |
| 30 | 5.70 | 130.00 | 5.40 | 7.90 | 7.80 | 9.10 | 31.20 | 3.90 |
| 31 | 6.20 | 146.00 | 5.80 | 8.00 | 8.50 | 9.80 | 32.50 | 4.30 |
| 32 | 6.50 | 163.00 | 6.00 | 8.60 | 9.50 | 10.50 | 32.80 | 5.60 |
| 33 | 6.80 | 164.50 | 6.20 | 9.50 | 11.50 | 10.70 | 32.90 | 5.90 |
| 34 | 6.95 | 164.90 | 6.30 | 9.70 | 12.80 | 11.70 | 33.00 | 5.95 |
| 35 | 7.00 | 165.00 | 6.30 | 9.80 | 13.00 | 11.90 | 33.10 | 6.00 |

Active power load bus data of EDL 21-bus System (continued)

| Hour | Active power load bus (MW) | | | | | | | |
|------|----------------------------|--------|--------|--------|--------|--------|--------|--------|
| | Bus 14 | Bus 15 | Bus 16 | Bus 17 | Bus 18 | Bus 19 | Bus 20 | Bus 21 |
| 36 | 6.20 | 112.00 | 5.80 | 8.30 | 9.50 | 9.50 | 31.20 | 5.40 |
| 37 | 6.70 | 158.00 | 6.10 | 9.40 | 12.30 | 10.40 | 32.80 | 5.80 |
| 38 | 6.90 | 163.00 | 6.20 | 9.60 | 12.60 | 10.90 | 33.00 | 5.70 |
| 39 | 6.80 | 150.00 | 5.90 | 9.40 | 11.90 | 10.60 | 32.70 | 5.20 |
| 40 | 6.00 | 125.00 | 5.50 | 8.50 | 10.00 | 9.80 | 30.00 | 5.10 |
| 41 | 5.20 | 114.00 | 4.70 | 7.90 | 9.50 | 8.60 | 29.80 | 4.50 |
| 42 | 6.50 | 134.00 | 5.90 | 8.90 | 10.60 | 10.70 | 31.40 | 5.40 |
| 43 | 6.70 | 162.00 | 6.20 | 9.50 | 12.80 | 10.90 | 32.60 | 5.80 |
| 44 | 7.00 | 165.00 | 6.30 | 9.80 | 12.90 | 11.50 | 33.10 | 6.00 |
| 45 | 6.50 | 161.00 | 6.00 | 9.30 | 12.70 | 10.30 | 31.80 | 5.80 |
| 46 | 6.00 | 145.00 | 5.60 | 9.00 | 12.00 | 10.10 | 31.50 | 5.60 |
| 47 | 5.60 | 132.00 | 5.10 | 8.50 | 11.30 | 9.80 | 31.40 | 5.30 |
| 48 | 5.50 | 115.00 | 5.00 | 8.00 | 10.00 | 9.50 | 31.30 | 5.00 |
| 49 | 5.30 | 96.00 | 4.70 | 7.70 | 9.50 | 9.00 | 29.80 | 4.60 |
| 50 | 5.20 | 93.00 | 4.20 | 7.60 | 8.00 | 8.10 | 29.50 | 3.00 |
| 51 | 5.00 | 75.80 | 4.10 | 7.50 | 7.50 | 7.90 | 29.30 | 2.70 |
| 52 | 5.00 | 75.00 | 3.90 | 7.40 | 6.80 | 7.80 | 29.00 | 2.60 |
| 53 | 5.70 | 99.00 | 4.00 | 7.70 | 6.70 | 8.90 | 30.00 | 3.40 |
| 54 | 5.90 | 130.00 | 5.40 | 7.90 | 7.80 | 9.10 | 31.20 | 3.90 |
| 55 | 6.00 | 146.00 | 5.80 | 8.00 | 8.50 | 9.50 | 32.50 | 4.50 |
| 56 | 6.50 | 163.00 | 6.00 | 8.60 | 9.50 | 10.30 | 32.80 | 5.40 |
| 57 | 6.70 | 164.50 | 6.20 | 9.50 | 11.50 | 10.60 | 33.00 | 5.80 |
| 58 | 6.90 | 164.90 | 6.30 | 9.70 | 12.80 | 10.80 | 33.00 | 5.90 |
| 59 | 7.00 | 165.00 | 6.30 | 9.80 | 13.10 | 11.90 | 33.10 | 6.00 |
| 60 | 6.20 | 112.00 | 5.80 | 8.30 | 9.50 | 9.50 | 31.20 | 5.30 |
| 61 | 6.70 | 164.00 | 6.10 | 9.40 | 12.30 | 10.40 | 32.80 | 5.80 |
| 62 | 6.90 | 164.70 | 6.20 | 9.60 | 12.60 | 10.90 | 33.00 | 5.90 |
| 63 | 6.50 | 130.00 | 5.90 | 9.40 | 11.90 | 10.60 | 32.70 | 5.20 |
| 64 | 5.50 | 125.00 | 5.50 | 8.50 | 10.00 | 9.80 | 30.00 | 5.00 |
| 65 | 5.20 | 95.90 | 4.70 | 7.90 | 9.50 | 8.60 | 29.80 | 4.20 |
| 66 | 5.80 | 134.00 | 5.90 | 8.90 | 10.60 | 10.70 | 31.40 | 5.30 |
| 67 | 6.70 | 162.00 | 6.20 | 9.50 | 12.80 | 10.90 | 32.60 | 5.70 |
| 68 | 7.00 | 163.50 | 6.30 | 9.80 | 13.10 | 11.90 | 33.10 | 5.90 |
| 69 | 6.50 | 161.00 | 6.00 | 9.30 | 12.70 | 10.80 | 31.80 | 5.50 |
| 70 | 6.00 | 145.00 | 5.60 | 9.00 | 12.00 | 10.50 | 31.50 | 5.30 |
| 71 | 5.60 | 132.00 | 5.10 | 8.50 | 11.30 | 9.80 | 31.00 | 5.00 |
| 72 | 5.50 | 115.00 | 5.00 | 8.00 | 10.00 | 9.00 | 30.00 | 4.50 |



Reactive power load bus data of EDL 21-bus System

| Hour | Reactive power load bus (MVAR) | | | | | | |
|------|--------------------------------|-------|-------|--------|--------|--------|--------|
| | Bus 6 | Bus 7 | Bus 8 | Bus 10 | Bus 11 | Bus 12 | Bus 13 |
| 1 | 19.00 | 2.00 | 5.00 | 4.60 | 1.33 | 0.59 | 1.17 |
| 2 | 18.50 | 1.90 | 4.75 | 4.37 | 1.27 | 0.56 | 1.11 |
| 3 | 17.40 | 1.56 | 3.90 | 3.59 | 1.04 | 0.46 | 0.91 |
| 4 | 15.50 | 2.00 | 5.00 | 4.60 | 1.33 | 0.59 | 1.17 |
| 5 | 16.90 | 2.25 | 5.64 | 5.18 | 1.50 | 0.67 | 1.31 |
| 6 | 18.80 | 2.51 | 6.27 | 5.76 | 1.67 | 0.74 | 1.46 |
| 7 | 27.30 | 3.64 | 9.10 | 8.37 | 2.43 | 1.08 | 2.12 |
| 8 | 27.40 | 3.65 | 9.14 | 8.40 | 2.44 | 1.08 | 2.13 |
| 9 | 27.50 | 3.67 | 9.17 | 8.43 | 2.45 | 1.08 | 2.14 |
| 10 | 27.70 | 3.69 | 9.24 | 8.49 | 2.46 | 1.09 | 2.16 |
| 11 | 27.89 | 3.72 | 9.30 | 8.55 | 2.48 | 1.10 | 2.17 |
| 12 | 21.50 | 2.87 | 7.17 | 6.59 | 1.91 | 0.85 | 1.67 |
| 13 | 26.80 | 3.57 | 8.94 | 8.22 | 2.38 | 1.06 | 2.09 |
| 14 | 27.00 | 3.60 | 9.00 | 8.28 | 2.40 | 1.06 | 2.10 |
| 15 | 26.40 | 3.52 | 8.80 | 8.09 | 2.35 | 1.04 | 2.05 |
| 16 | 26.30 | 3.51 | 8.77 | 8.06 | 2.34 | 1.04 | 2.05 |
| 17 | 21.30 | 2.60 | 6.50 | 5.98 | 1.73 | 0.77 | 1.52 |
| 18 | 25.60 | 3.00 | 7.50 | 6.90 | 2.00 | 0.89 | 1.75 |
| 19 | 26.00 | 3.47 | 8.67 | 7.97 | 2.31 | 1.03 | 2.02 |
| 20 | 26.50 | 3.53 | 8.84 | 8.12 | 2.36 | 1.05 | 2.06 |
| 21 | 25.50 | 3.20 | 8.00 | 7.35 | 2.13 | 0.95 | 1.87 |
| 22 | 24.30 | 3.00 | 7.50 | 6.90 | 2.00 | 0.89 | 1.75 |
| 23 | 24.30 | 2.40 | 6.00 | 5.52 | 1.60 | 0.71 | 1.40 |
| 24 | 22.40 | 1.90 | 4.75 | 4.37 | 1.27 | 0.56 | 1.11 |
| 25 | 21.20 | 1.80 | 4.50 | 4.14 | 1.20 | 0.53 | 1.05 |
| 26 | 18.50 | 1.90 | 4.75 | 4.37 | 1.27 | 0.56 | 1.11 |
| 27 | 17.40 | 1.56 | 3.90 | 3.59 | 1.04 | 0.46 | 0.91 |
| 28 | 15.50 | 2.00 | 5.00 | 4.60 | 1.33 | 0.59 | 1.17 |
| 29 | 16.90 | 2.25 | 5.64 | 5.18 | 1.50 | 0.67 | 1.31 |
| 30 | 18.80 | 2.60 | 6.50 | 5.98 | 1.73 | 0.77 | 1.52 |
| 31 | 27.30 | 3.64 | 9.10 | 8.37 | 2.43 | 1.08 | 2.12 |
| 32 | 27.40 | 3.65 | 9.14 | 8.40 | 2.44 | 1.08 | 2.13 |
| 33 | 27.50 | 3.67 | 9.17 | 8.43 | 2.45 | 1.08 | 2.14 |
| 34 | 27.70 | 3.69 | 9.24 | 8.49 | 2.46 | 1.09 | 2.16 |
| 35 | 27.80 | 3.72 | 9.30 | 8.55 | 2.48 | 1.10 | 2.17 |

Reactive power load bus data of EDL 21-bus System (continued)

| Hour | Reactive Power Load Bus (MVAR) | | | | | | |
|------|--------------------------------|-------|-------|--------|--------|--------|--------|
| | Bus 6 | Bus 7 | Bus 8 | Bus 10 | Bus 11 | Bus 12 | Bus 13 |
| 36 | 20.80 | 2.87 | 7.17 | 6.59 | 1.91 | 0.85 | 1.67 |
| 37 | 26.80 | 3.30 | 8.25 | 7.58 | 2.20 | 0.98 | 1.93 |
| 38 | 27.00 | 3.60 | 9.00 | 8.28 | 2.40 | 1.06 | 2.10 |
| 39 | 26.40 | 3.52 | 8.80 | 8.09 | 2.35 | 1.04 | 2.05 |
| 40 | 26.30 | 2.90 | 7.25 | 6.67 | 1.93 | 0.86 | 1.69 |
| 41 | 21.30 | 2.60 | 6.50 | 5.98 | 1.73 | 0.77 | 1.52 |
| 42 | 25.60 | 3.00 | 7.50 | 6.90 | 2.00 | 0.89 | 1.75 |
| 43 | 26.00 | 3.47 | 8.67 | 7.97 | 2.31 | 1.03 | 2.02 |
| 44 | 26.50 | 3.60 | 9.00 | 8.27 | 2.40 | 1.06 | 2.10 |
| 45 | 25.50 | 3.20 | 8.00 | 7.35 | 2.13 | 0.95 | 1.87 |
| 46 | 24.30 | 3.00 | 7.50 | 6.90 | 2.00 | 0.89 | 1.75 |
| 47 | 24.30 | 2.40 | 6.00 | 5.52 | 1.60 | 0.71 | 1.40 |
| 48 | 22.40 | 1.90 | 4.75 | 4.37 | 1.27 | 0.56 | 1.11 |
| 49 | 19.00 | 1.80 | 4.50 | 4.14 | 1.20 | 0.53 | 1.05 |
| 50 | 18.50 | 1.90 | 4.75 | 4.37 | 1.27 | 0.56 | 1.11 |
| 51 | 17.40 | 1.80 | 4.50 | 4.14 | 1.20 | 0.53 | 1.05 |
| 52 | 15.50 | 1.60 | 4.00 | 3.68 | 1.07 | 0.47 | 0.93 |
| 53 | 16.90 | 2.25 | 5.64 | 5.18 | 1.50 | 0.67 | 1.31 |
| 54 | 18.80 | 2.50 | 6.25 | 5.75 | 1.67 | 0.74 | 1.46 |
| 55 | 27.30 | 3.60 | 9.00 | 8.27 | 2.40 | 1.06 | 2.10 |
| 56 | 27.40 | 3.65 | 9.13 | 8.39 | 2.43 | 1.08 | 2.13 |
| 57 | 27.50 | 3.67 | 9.17 | 8.43 | 2.45 | 1.08 | 2.14 |
| 58 | 27.70 | 3.69 | 9.24 | 8.49 | 2.46 | 1.09 | 2.16 |
| 59 | 27.89 | 3.72 | 9.30 | 8.55 | 2.48 | 1.10 | 2.17 |
| 60 | 20.80 | 2.87 | 7.17 | 6.59 | 1.91 | 0.85 | 1.67 |
| 61 | 26.80 | 3.50 | 8.75 | 8.04 | 2.33 | 1.03 | 2.04 |
| 62 | 27.00 | 3.60 | 9.00 | 8.28 | 2.40 | 1.06 | 2.10 |
| 63 | 26.40 | 3.52 | 8.80 | 8.09 | 2.35 | 1.04 | 2.05 |
| 64 | 26.30 | 3.20 | 8.00 | 7.35 | 2.13 | 0.95 | 1.87 |
| 65 | 21.30 | 2.50 | 6.25 | 5.75 | 1.67 | 0.74 | 1.46 |
| 66 | 25.60 | 2.90 | 7.25 | 6.67 | 1.93 | 0.86 | 1.69 |
| 67 | 26.00 | 3.40 | 8.50 | 7.81 | 2.27 | 1.01 | 1.98 |
| 68 | 26.50 | 3.53 | 8.84 | 8.12 | 2.36 | 1.05 | 2.06 |
| 69 | 24.30 | 3.20 | 8.00 | 7.35 | 2.13 | 0.95 | 1.87 |
| 70 | 24.30 | 3.00 | 7.50 | 6.90 | 2.00 | 0.89 | 1.75 |
| 71 | 22.40 | 2.40 | 6.00 | 5.52 | 1.60 | 0.71 | 1.40 |
| 72 | 21.20 | 1.90 | 4.75 | 4.37 | 1.27 | 0.56 | 1.11 |

Reactive power load bus data of EDL 21-bus System (continued)

| Hour | Reactive Power Load Bus (MVAR) | | | | | | | |
|------|--------------------------------|--------|--------|--------|--------|--------|--------|--------|
| | Bus 14 | Bus 15 | Bus 16 | Bus 17 | Bus 18 | Bus 19 | Bus 20 | Bus 21 |
| 1 | 2.33 | 54.98 | 1.30 | 3.26 | 4.37 | 3.96 | 10.36 | 2.00 |
| 2 | 2.22 | 52.23 | 1.24 | 3.10 | 4.15 | 3.76 | 9.84 | 1.90 |
| 3 | 1.82 | 42.88 | 1.01 | 2.55 | 3.41 | 3.09 | 8.08 | 1.56 |
| 4 | 2.33 | 54.98 | 1.30 | 3.26 | 4.37 | 3.96 | 10.36 | 2.00 |
| 5 | 2.63 | 61.96 | 1.47 | 3.68 | 4.92 | 4.47 | 11.68 | 2.25 |
| 6 | 2.93 | 68.93 | 1.63 | 4.09 | 5.47 | 4.97 | 12.99 | 2.51 |
| 7 | 4.25 | 100.10 | 2.37 | 5.94 | 7.95 | 7.21 | 18.86 | 3.64 |
| 8 | 4.26 | 100.46 | 2.38 | 5.96 | 7.98 | 7.24 | 18.93 | 3.65 |
| 9 | 4.28 | 100.83 | 2.39 | 5.99 | 8.01 | 7.27 | 19.00 | 3.67 |
| 10 | 4.31 | 101.56 | 2.40 | 6.03 | 8.06 | 7.32 | 19.14 | 3.69 |
| 11 | 4.34 | 102.26 | 2.42 | 6.07 | 8.12 | 7.37 | 19.27 | 3.72 |
| 12 | 3.35 | 78.83 | 1.87 | 4.68 | 6.26 | 5.68 | 14.85 | 2.87 |
| 13 | 4.17 | 98.26 | 2.33 | 5.83 | 7.80 | 7.08 | 18.52 | 3.57 |
| 14 | 4.20 | 99.00 | 2.34 | 5.88 | 7.86 | 7.13 | 18.66 | 3.60 |
| 15 | 4.11 | 96.80 | 2.29 | 5.75 | 7.69 | 6.98 | 18.24 | 3.52 |
| 16 | 4.09 | 96.43 | 2.28 | 5.72 | 7.66 | 6.95 | 18.17 | 3.51 |
| 17 | 3.03 | 71.47 | 1.69 | 4.24 | 5.68 | 5.15 | 13.47 | 2.60 |
| 18 | 3.50 | 82.47 | 1.95 | 4.90 | 6.55 | 5.94 | 15.54 | 3.00 |
| 19 | 4.05 | 95.33 | 2.26 | 5.66 | 7.57 | 6.87 | 17.96 | 3.47 |
| 20 | 4.12 | 97.16 | 2.30 | 5.77 | 7.72 | 7.00 | 18.31 | 3.53 |
| 21 | 3.73 | 87.97 | 2.08 | 5.22 | 6.98 | 6.34 | 16.58 | 3.20 |
| 22 | 3.50 | 82.47 | 1.95 | 4.90 | 6.55 | 5.94 | 15.54 | 3.00 |
| 23 | 2.80 | 65.97 | 1.56 | 3.92 | 5.24 | 4.75 | 12.43 | 2.40 |
| 24 | 2.22 | 52.23 | 1.24 | 3.10 | 4.15 | 3.76 | 9.84 | 1.90 |
| 25 | 2.10 | 49.48 | 1.17 | 2.94 | 3.93 | 3.57 | 9.32 | 1.80 |
| 26 | 2.22 | 52.23 | 1.24 | 3.10 | 4.15 | 3.76 | 9.84 | 1.90 |
| 27 | 1.82 | 42.88 | 1.01 | 2.55 | 3.41 | 3.09 | 8.08 | 1.56 |
| 28 | 2.33 | 54.98 | 1.30 | 3.26 | 4.37 | 3.96 | 10.36 | 2.00 |
| 29 | 2.63 | 61.96 | 1.47 | 3.68 | 4.92 | 4.47 | 11.68 | 2.25 |
| 30 | 3.03 | 71.47 | 1.69 | 4.24 | 5.68 | 5.15 | 13.47 | 2.60 |
| 31 | 4.25 | 100.10 | 2.37 | 5.94 | 7.95 | 7.21 | 18.86 | 3.64 |
| 32 | 4.26 | 100.46 | 2.38 | 5.96 | 7.98 | 7.24 | 18.93 | 3.65 |
| 33 | 4.28 | 100.83 | 2.39 | 5.99 | 8.01 | 7.27 | 19.00 | 3.67 |
| 34 | 4.31 | 101.56 | 2.40 | 6.03 | 8.06 | 7.32 | 19.14 | 3.69 |
| 35 | 4.34 | 102.26 | 2.42 | 6.07 | 8.12 | 7.37 | 19.27 | 3.72 |

Reactive power load bus data of EDL 21-bus System (continued)

| Hour | Reactive Power Load Bus (MVAR) | | | | | | | |
|------|--------------------------------|--------|-------|-------|-------|-------|-------|--------|
| | Bus14 | Bus 15 | Bus16 | Bus17 | Bus18 | Bus19 | Bus20 | Bus 21 |
| 36 | 3.35 | 78.83 | 1.87 | 4.68 | 6.26 | 5.68 | 14.85 | 2.87 |
| 37 | 3.85 | 90.71 | 2.15 | 5.38 | 7.20 | 6.54 | 17.09 | 3.30 |
| 38 | 4.20 | 99.00 | 2.34 | 5.88 | 7.86 | 7.13 | 18.66 | 3.60 |
| 39 | 4.11 | 96.80 | 2.29 | 5.75 | 7.69 | 6.98 | 18.24 | 3.52 |
| 40 | 3.38 | 79.72 | 1.89 | 4.73 | 6.33 | 5.75 | 15.02 | 2.90 |
| 41 | 3.03 | 71.47 | 1.69 | 4.24 | 5.68 | 5.15 | 13.47 | 2.60 |
| 42 | 3.50 | 82.47 | 1.95 | 4.90 | 6.55 | 5.94 | 15.54 | 3.00 |
| 43 | 4.05 | 95.33 | 2.26 | 5.66 | 7.57 | 6.87 | 17.96 | 3.47 |
| 44 | 4.20 | 98.96 | 2.34 | 5.87 | 7.86 | 7.13 | 18.65 | 3.60 |
| 45 | 3.73 | 87.97 | 2.08 | 5.22 | 6.98 | 6.34 | 16.58 | 3.20 |
| 46 | 3.50 | 82.47 | 1.95 | 4.90 | 6.55 | 5.94 | 15.54 | 3.00 |
| 47 | 2.80 | 65.97 | 1.56 | 3.92 | 5.24 | 4.75 | 12.43 | 2.40 |
| 48 | 2.22 | 52.23 | 1.24 | 3.10 | 4.15 | 3.76 | 9.84 | 1.90 |
| 49 | 2.10 | 49.48 | 1.17 | 2.94 | 3.93 | 3.57 | 9.32 | 1.80 |
| 50 | 2.22 | 52.23 | 1.24 | 3.10 | 4.15 | 3.76 | 9.84 | 1.90 |
| 51 | 2.10 | 49.48 | 1.17 | 2.94 | 3.93 | 3.57 | 9.32 | 1.80 |
| 52 | 1.87 | 43.98 | 1.04 | 2.61 | 3.49 | 3.17 | 8.29 | 1.60 |
| 53 | 2.63 | 61.96 | 1.47 | 3.68 | 4.92 | 4.47 | 11.68 | 2.25 |
| 54 | 2.92 | 68.72 | 1.63 | 4.08 | 5.46 | 4.95 | 12.95 | 2.50 |
| 55 | 4.20 | 98.96 | 2.34 | 5.87 | 7.86 | 7.13 | 18.65 | 3.60 |
| 56 | 4.26 | 100.34 | 2.37 | 5.96 | 7.97 | 7.23 | 18.91 | 3.65 |
| 57 | 4.28 | 100.83 | 2.39 | 5.99 | 8.01 | 7.27 | 19.00 | 3.67 |
| 58 | 4.31 | 101.56 | 2.40 | 6.03 | 8.06 | 7.32 | 19.14 | 3.69 |
| 59 | 4.34 | 102.26 | 2.42 | 6.07 | 8.12 | 7.37 | 19.27 | 3.72 |
| 60 | 3.35 | 78.83 | 1.87 | 4.68 | 6.26 | 5.68 | 14.85 | 2.87 |
| 61 | 4.08 | 96.21 | 2.28 | 5.71 | 7.64 | 6.93 | 18.13 | 3.50 |
| 62 | 4.20 | 99.00 | 2.34 | 5.88 | 7.86 | 7.13 | 18.66 | 3.60 |
| 63 | 4.11 | 96.80 | 2.29 | 5.75 | 7.69 | 6.98 | 18.24 | 3.52 |
| 64 | 3.73 | 87.97 | 2.08 | 5.22 | 6.98 | 6.34 | 16.58 | 3.20 |
| 65 | 2.92 | 68.72 | 1.63 | 4.08 | 5.46 | 4.95 | 12.95 | 2.50 |
| 66 | 3.38 | 79.72 | 1.89 | 4.73 | 6.33 | 5.75 | 15.02 | 2.90 |
| 67 | 3.97 | 93.46 | 2.21 | 5.55 | 7.42 | 6.74 | 17.61 | 3.40 |
| 68 | 4.12 | 97.16 | 2.30 | 5.77 | 7.72 | 7.00 | 18.31 | 3.53 |
| 69 | 3.73 | 87.97 | 2.08 | 5.22 | 6.98 | 6.34 | 16.58 | 3.20 |
| 70 | 3.50 | 82.47 | 1.95 | 4.90 | 6.55 | 5.94 | 15.54 | 3.00 |
| 71 | 2.80 | 65.97 | 1.56 | 3.92 | 5.24 | 4.75 | 12.43 | 2.40 |
| 72 | 2.22 | 52.23 | 1.24 | 3.10 | 4.15 | 3.76 | 9.84 | 1.90 |

Bus voltage data of EDL 21-bus System

| Hour | Bus voltage (pu) | | | | | | |
|------|------------------|--------|--------|--------|--------|--------|--------|
| | Bus 1 | Bus 2 | Bus 3 | Bus 4 | Bus 5 | Bus 6 | Bus 7 |
| 1 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9829 | 0.9777 | 0.9891 |
| 2 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9837 | 0.9786 | 0.9930 |
| 3 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9855 | 0.9810 | 0.9959 |
| 4 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9873 | 0.9837 | 0.9929 |
| 5 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9854 | 0.9813 | 0.9883 |
| 6 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9820 | 0.9766 | 0.9841 |
| 7 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9692 | 0.9595 | 0.9737 |
| 8 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9674 | 0.9572 | 0.9680 |
| 9 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9666 | 0.9561 | 0.9672 |
| 10 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9660 | 0.9554 | 0.9667 |
| 11 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9655 | 0.9547 | 0.9663 |
| 12 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9787 | 0.9725 | 0.9808 |
| 13 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9674 | 0.9573 | 0.9681 |
| 14 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9670 | 0.9567 | 0.9681 |
| 15 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9670 | 0.9565 | 0.9732 |
| 16 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9701 | 0.9607 | 0.9757 |
| 17 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9801 | 0.9740 | 0.9856 |
| 18 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9731 | 0.9647 | 0.9776 |
| 19 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9700 | 0.9607 | 0.9694 |
| 20 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9691 | 0.9595 | 0.9684 |
| 21 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9708 | 0.9617 | 0.9721 |
| 22 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9725 | 0.9640 | 0.9760 |
| 23 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9743 | 0.9661 | 0.9828 |
| 24 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9783 | 0.9714 | 0.9889 |
| 25 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9801 | 0.9737 | 0.9920 |
| 26 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9837 | 0.9786 | 0.9930 |
| 27 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9855 | 0.9810 | 0.9959 |
| 28 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9873 | 0.9837 | 0.9929 |
| 29 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9854 | 0.9813 | 0.9883 |
| 30 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9820 | 0.9766 | 0.9841 |
| 31 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9692 | 0.9595 | 0.9737 |
| 32 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9674 | 0.9572 | 0.9680 |
| 33 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9666 | 0.9561 | 0.9672 |
| 34 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9660 | 0.9554 | 0.9667 |
| 35 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9655 | 0.9547 | 0.9663 |

Bus voltage data of EDL 21-bus System (continued)

| Hour | Bus voltage (pu) | | | | | | |
|------|------------------|--------|--------|--------|--------|--------|--------|
| | Bus 1 | Bus 2 | Bus 3 | Bus 4 | Bus 5 | Bus 6 | Bus 7 |
| 36 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9787 | 0.9725 | 0.9808 |
| 37 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9674 | 0.9573 | 0.9681 |
| 38 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9670 | 0.9567 | 0.9681 |
| 39 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9670 | 0.9565 | 0.9732 |
| 40 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9701 | 0.9607 | 0.9757 |
| 41 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9801 | 0.9740 | 0.9856 |
| 42 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9731 | 0.9647 | 0.9776 |
| 43 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9700 | 0.9607 | 0.9694 |
| 44 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9691 | 0.9595 | 0.9684 |
| 45 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9708 | 0.9617 | 0.9721 |
| 46 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9725 | 0.9640 | 0.9760 |
| 47 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9743 | 0.9661 | 0.9828 |
| 48 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9783 | 0.9714 | 0.9889 |
| 49 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9801 | 0.9737 | 0.9920 |
| 50 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9837 | 0.9786 | 0.9930 |
| 51 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9855 | 0.9810 | 0.9959 |
| 52 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9873 | 0.9837 | 0.9929 |
| 53 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9854 | 0.9813 | 0.9883 |
| 54 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9820 | 0.9766 | 0.9841 |
| 55 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9692 | 0.9595 | 0.9737 |
| 56 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9674 | 0.9572 | 0.9680 |
| 57 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9666 | 0.9561 | 0.9672 |
| 58 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9660 | 0.9554 | 0.9667 |
| 59 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9655 | 0.9547 | 0.9663 |
| 60 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9787 | 0.9725 | 0.9808 |
| 61 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9674 | 0.9573 | 0.9681 |
| 62 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9670 | 0.9567 | 0.9681 |
| 63 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9670 | 0.9565 | 0.9732 |
| 64 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9701 | 0.9607 | 0.9757 |
| 65 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9801 | 0.9740 | 0.9856 |
| 66 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9731 | 0.9647 | 0.9776 |
| 67 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9700 | 0.9607 | 0.9694 |
| 68 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9691 | 0.9595 | 0.9684 |
| 69 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9708 | 0.9617 | 0.9721 |
| 70 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9725 | 0.9640 | 0.9760 |
| 71 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9743 | 0.9661 | 0.9828 |
| 72 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 0.9783 | 0.9714 | 0.9889 |

Bus voltage data of EDL 21-bus System (continued)

| Hour | Bus voltage (pu) | | | | | | |
|------|------------------|--------|--------|--------|--------|--------|--------|
| | Bus 8 | Bus 9 | Bus 10 | Bus 11 | Bus 12 | Bus 13 | Bus 14 |
| 1 | 0.9777 | 0.9595 | 0.9492 | 0.9554 | 0.9877 | 0.9872 | 0.9806 |
| 2 | 0.9850 | 0.9786 | 0.9775 | 0.9747 | 0.9916 | 0.9911 | 0.9864 |
| 3 | 0.9891 | 0.9851 | 0.9856 | 0.9817 | 0.9947 | 0.9943 | 0.9921 |
| 4 | 0.9845 | 0.9774 | 0.9758 | 0.9734 | 0.9915 | 0.9910 | 0.9867 |
| 5 | 0.9786 | 0.9692 | 0.9663 | 0.9649 | 0.9868 | 0.9862 | 0.9769 |
| 6 | 0.9726 | 0.9597 | 0.9544 | 0.9550 | 0.9825 | 0.9818 | 0.9688 |
| 7 | 0.9576 | 0.9359 | 0.9252 | 0.9297 | 0.9714 | 0.9705 | 0.9484 |
| 8 | 0.9511 | 0.9277 | 0.9158 | 0.9213 | 0.9657 | 0.9647 | 0.9360 |
| 9 | 0.9492 | 0.9242 | 0.9112 | 0.9176 | 0.9647 | 0.9637 | 0.9350 |
| 10 | 0.9481 | 0.9220 | 0.9082 | 0.9154 | 0.9641 | 0.9631 | 0.9342 |
| 11 | 0.9476 | 0.9211 | 0.9072 | 0.9145 | 0.9637 | 0.9627 | 0.9334 |
| 12 | 0.9671 | 0.9494 | 0.9409 | 0.9441 | 0.9787 | 0.9779 | 0.9632 |
| 13 | 0.9503 | 0.9255 | 0.9125 | 0.9191 | 0.9657 | 0.9647 | 0.9368 |
| 14 | 0.9506 | 0.9261 | 0.9135 | 0.9197 | 0.9657 | 0.9647 | 0.9363 |
| 15 | 0.9565 | 0.9333 | 0.9214 | 0.9272 | 0.9709 | 0.9700 | 0.9476 |
| 16 | 0.9624 | 0.9445 | 0.9362 | 0.9387 | 0.9736 | 0.9728 | 0.9511 |
| 17 | 0.9742 | 0.9603 | 0.9544 | 0.9553 | 0.9839 | 0.9833 | 0.9723 |
| 18 | 0.9637 | 0.9461 | 0.9379 | 0.9406 | 0.9754 | 0.9746 | 0.9557 |
| 19 | 0.9525 | 0.9291 | 0.9172 | 0.9229 | 0.9670 | 0.9661 | 0.9393 |
| 20 | 0.9509 | 0.9262 | 0.9134 | 0.9200 | 0.9660 | 0.9650 | 0.9376 |
| 21 | 0.9565 | 0.9360 | 0.9259 | 0.9303 | 0.9699 | 0.9691 | 0.9445 |
| 22 | 0.9615 | 0.9432 | 0.9344 | 0.9379 | 0.9739 | 0.9731 | 0.9525 |
| 23 | 0.9710 | 0.9583 | 0.9531 | 0.9538 | 0.9811 | 0.9804 | 0.9660 |
| 24 | 0.9790 | 0.9701 | 0.9673 | 0.9662 | 0.9874 | 0.9869 | 0.9782 |
| 25 | 0.9839 | 0.9774 | 0.9762 | 0.9737 | 0.9907 | 0.9902 | 0.9842 |
| 26 | 0.9850 | 0.9786 | 0.9775 | 0.9747 | 0.9916 | 0.9911 | 0.9864 |
| 27 | 0.9891 | 0.9851 | 0.9856 | 0.9817 | 0.9947 | 0.9943 | 0.9921 |
| 28 | 0.9845 | 0.9774 | 0.9758 | 0.9734 | 0.9915 | 0.9910 | 0.9867 |
| 29 | 0.9786 | 0.9692 | 0.9663 | 0.9649 | 0.9868 | 0.9862 | 0.9769 |
| 30 | 0.9726 | 0.9597 | 0.9544 | 0.9550 | 0.9825 | 0.9818 | 0.9688 |
| 31 | 0.9576 | 0.9359 | 0.9252 | 0.9297 | 0.9714 | 0.9705 | 0.9484 |
| 32 | 0.9511 | 0.9277 | 0.9158 | 0.9213 | 0.9657 | 0.9647 | 0.9360 |
| 33 | 0.9492 | 0.9242 | 0.9112 | 0.9176 | 0.9647 | 0.9637 | 0.9350 |
| 34 | 0.9481 | 0.9220 | 0.9082 | 0.9154 | 0.9641 | 0.9631 | 0.9342 |
| 35 | 0.9476 | 0.9211 | 0.9072 | 0.9145 | 0.9637 | 0.9627 | 0.9334 |

Bus voltage data of EDL 21-bus System (continued)

| Hour | Bus voltage (pu) | | | | | | |
|------|------------------|--------|--------|--------|--------|--------|--------|
| | Bus 8 | Bus 9 | Bus 10 | Bus 11 | Bus 12 | Bus 13 | Bus 14 |
| 36 | 0.9671 | 0.9494 | 0.9409 | 0.9441 | 0.9787 | 0.9779 | 0.9632 |
| 37 | 0.9503 | 0.9255 | 0.9125 | 0.9191 | 0.9657 | 0.9647 | 0.9368 |
| 38 | 0.9506 | 0.9261 | 0.9135 | 0.9197 | 0.9657 | 0.9647 | 0.9363 |
| 39 | 0.9565 | 0.9333 | 0.9214 | 0.9272 | 0.9709 | 0.9700 | 0.9476 |
| 40 | 0.9624 | 0.9445 | 0.9362 | 0.9387 | 0.9736 | 0.9728 | 0.9511 |
| 41 | 0.9742 | 0.9603 | 0.9544 | 0.9553 | 0.9839 | 0.9833 | 0.9723 |
| 42 | 0.9637 | 0.9461 | 0.9379 | 0.9406 | 0.9754 | 0.9746 | 0.9557 |
| 43 | 0.9525 | 0.9291 | 0.9172 | 0.9229 | 0.9670 | 0.9661 | 0.9393 |
| 44 | 0.9509 | 0.9262 | 0.9134 | 0.9200 | 0.9660 | 0.9650 | 0.9376 |
| 45 | 0.9565 | 0.9360 | 0.9259 | 0.9303 | 0.9699 | 0.9691 | 0.9445 |
| 46 | 0.9615 | 0.9432 | 0.9344 | 0.9379 | 0.9739 | 0.9731 | 0.9525 |
| 47 | 0.9710 | 0.9583 | 0.9531 | 0.9538 | 0.9811 | 0.9804 | 0.9660 |
| 48 | 0.9790 | 0.9701 | 0.9673 | 0.9662 | 0.9874 | 0.9869 | 0.9782 |
| 49 | 0.9839 | 0.9774 | 0.9762 | 0.9737 | 0.9907 | 0.9902 | 0.9842 |
| 50 | 0.9850 | 0.9786 | 0.9775 | 0.9747 | 0.9916 | 0.9911 | 0.9864 |
| 51 | 0.9891 | 0.9851 | 0.9856 | 0.9817 | 0.9947 | 0.9943 | 0.9921 |
| 52 | 0.9845 | 0.9774 | 0.9758 | 0.9734 | 0.9915 | 0.9910 | 0.9867 |
| 53 | 0.9786 | 0.9692 | 0.9663 | 0.9649 | 0.9868 | 0.9862 | 0.9769 |
| 54 | 0.9726 | 0.9597 | 0.9544 | 0.9550 | 0.9825 | 0.9818 | 0.9688 |
| 55 | 0.9576 | 0.9359 | 0.9252 | 0.9297 | 0.9714 | 0.9705 | 0.9484 |
| 56 | 0.9511 | 0.9277 | 0.9158 | 0.9213 | 0.9657 | 0.9647 | 0.9360 |
| 57 | 0.9492 | 0.9242 | 0.9112 | 0.9176 | 0.9647 | 0.9637 | 0.9350 |
| 58 | 0.9481 | 0.9220 | 0.9082 | 0.9154 | 0.9641 | 0.9631 | 0.9342 |
| 59 | 0.9476 | 0.9211 | 0.9072 | 0.9145 | 0.9637 | 0.9627 | 0.9334 |
| 60 | 0.9671 | 0.9494 | 0.9409 | 0.9441 | 0.9787 | 0.9779 | 0.9632 |
| 61 | 0.9503 | 0.9255 | 0.9125 | 0.9191 | 0.9657 | 0.9647 | 0.9368 |
| 62 | 0.9506 | 0.9261 | 0.9135 | 0.9197 | 0.9657 | 0.9647 | 0.9363 |
| 63 | 0.9565 | 0.9333 | 0.9214 | 0.9272 | 0.9709 | 0.9700 | 0.9476 |
| 64 | 0.9624 | 0.9445 | 0.9362 | 0.9387 | 0.9736 | 0.9728 | 0.9511 |
| 65 | 0.9742 | 0.9603 | 0.9544 | 0.9553 | 0.9839 | 0.9833 | 0.9723 |
| 66 | 0.9637 | 0.9461 | 0.9379 | 0.9406 | 0.9754 | 0.9746 | 0.9557 |
| 67 | 0.9525 | 0.9291 | 0.9172 | 0.9229 | 0.9670 | 0.9661 | 0.9393 |
| 68 | 0.9509 | 0.9262 | 0.9134 | 0.9200 | 0.9660 | 0.9650 | 0.9376 |
| 69 | 0.9565 | 0.9360 | 0.9259 | 0.9303 | 0.9699 | 0.9691 | 0.9445 |
| 70 | 0.9615 | 0.9432 | 0.9344 | 0.9379 | 0.9739 | 0.9731 | 0.9525 |
| 71 | 0.9710 | 0.9583 | 0.9531 | 0.9538 | 0.9811 | 0.9804 | 0.9660 |
| 72 | 0.9790 | 0.9701 | 0.9673 | 0.9662 | 0.9874 | 0.9869 | 0.9782 |

Bus voltage data of EDL 21-bus System (continued)

| Hour | Bus voltage (pu) | | | | | | |
|------|------------------|--------|--------|--------|--------|--------|--------|
| | Bus 15 | Bus 16 | Bus 17 | Bus 18 | Bus 19 | Bus 20 | Bus 21 |
| 1 | 0.9689 | 0.9998 | 0.9967 | 0.9982 | 0.9982 | 0.9711 | 0.9760 |
| 2 | 0.9763 | 1.0017 | 0.9988 | 0.9987 | 0.9999 | 0.9779 | 0.9771 |
| 3 | 0.9846 | 1.0041 | 1.0015 | 1.0019 | 1.0000 | 0.9863 | 0.9799 |
| 4 | 0.9769 | 1.0004 | 0.9974 | 0.9994 | 0.9996 | 0.9784 | 0.9808 |
| 5 | 0.9626 | 0.9963 | 0.9930 | 0.9955 | 0.9992 | 0.9650 | 0.9777 |
| 6 | 0.9510 | 0.9925 | 0.9888 | 0.9921 | 0.9990 | 0.9536 | 0.9733 |
| 7 | 0.9216 | 0.9813 | 0.9766 | 0.9836 | 0.9979 | 0.9238 | 0.9573 |
| 8 | 0.9037 | 0.9769 | 0.9720 | 0.9792 | 0.9978 | 0.9083 | 0.9547 |
| 9 | 0.9026 | 0.9764 | 0.9714 | 0.9787 | 0.9977 | 0.9070 | 0.9535 |
| 10 | 0.9015 | 0.9760 | 0.9709 | 0.9783 | 0.9977 | 0.9059 | 0.9529 |
| 11 | 0.9005 | 0.9759 | 0.9707 | 0.9780 | 0.9977 | 0.9047 | 0.9522 |
| 12 | 0.9434 | 0.9899 | 0.9858 | 0.9903 | 0.9986 | 0.9459 | 0.9681 |
| 13 | 0.9052 | 0.9775 | 0.9726 | 0.9796 | 0.9978 | 0.9098 | 0.9546 |
| 14 | 0.9043 | 0.9772 | 0.9722 | 0.9793 | 0.9978 | 0.9088 | 0.9541 |
| 15 | 0.9208 | 0.9815 | 0.9766 | 0.9833 | 0.9979 | 0.9229 | 0.9548 |
| 16 | 0.9249 | 0.9827 | 0.9780 | 0.9848 | 0.9980 | 0.9279 | 0.9581 |
| 17 | 0.9562 | 0.9941 | 0.9903 | 0.9939 | 0.9990 | 0.9581 | 0.9709 |
| 18 | 0.9323 | 0.9867 | 0.9824 | 0.9874 | 0.9983 | 0.9359 | 0.9622 |
| 19 | 0.9088 | 0.9788 | 0.9740 | 0.9806 | 0.9979 | 0.9132 | 0.9575 |
| 20 | 0.9064 | 0.9779 | 0.9730 | 0.9798 | 0.9978 | 0.9108 | 0.9564 |
| 21 | 0.9161 | 0.9818 | 0.9773 | 0.9830 | 0.9981 | 0.9210 | 0.9592 |
| 22 | 0.9277 | 0.9856 | 0.9813 | 0.9862 | 0.9984 | 0.9317 | 0.9615 |
| 23 | 0.9470 | 0.9929 | 0.9893 | 0.9920 | 0.9990 | 0.9506 | 0.9650 |
| 24 | 0.9646 | 0.9992 | 0.9961 | 0.9973 | 0.9995 | 0.9679 | 0.9706 |
| 25 | 0.9732 | 1.0015 | 0.9986 | 0.9994 | 0.9997 | 0.9755 | 0.9734 |
| 26 | 0.9763 | 1.0017 | 0.9988 | 0.9987 | 0.9999 | 0.9779 | 0.9771 |
| 27 | 0.9846 | 1.0041 | 1.0015 | 1.0019 | 1.0000 | 0.9863 | 0.9799 |
| 28 | 0.9769 | 1.0004 | 0.9974 | 0.9994 | 0.9996 | 0.9784 | 0.9808 |
| 29 | 0.9626 | 0.9963 | 0.9930 | 0.9955 | 0.9992 | 0.9650 | 0.9777 |
| 30 | 0.9510 | 0.9925 | 0.9888 | 0.9921 | 0.9990 | 0.9536 | 0.9733 |
| 31 | 0.9216 | 0.9813 | 0.9766 | 0.9836 | 0.9979 | 0.9238 | 0.9573 |
| 32 | 0.9037 | 0.9769 | 0.9720 | 0.9792 | 0.9978 | 0.9083 | 0.9547 |
| 33 | 0.9026 | 0.9764 | 0.9714 | 0.9787 | 0.9977 | 0.9070 | 0.9535 |
| 34 | 0.9015 | 0.9760 | 0.9709 | 0.9783 | 0.9977 | 0.9059 | 0.9529 |
| 35 | 0.9005 | 0.9759 | 0.9707 | 0.9780 | 0.9977 | 0.9047 | 0.9522 |

Bus voltage data of EDL 21-bus System (continued)

| Hour | Bus voltage (pu) | | | | | | |
|------|------------------|--------|--------|--------|--------|--------|--------|
| | Bus 15 | Bus 16 | Bus 17 | Bus 18 | Bus 19 | Bus 20 | Bus 21 |
| 36 | 0.9434 | 0.9899 | 0.9858 | 0.9903 | 0.9986 | 0.9459 | 0.9681 |
| 37 | 0.9052 | 0.9775 | 0.9726 | 0.9796 | 0.9978 | 0.9098 | 0.9546 |
| 38 | 0.9043 | 0.9772 | 0.9722 | 0.9793 | 0.9978 | 0.9088 | 0.9541 |
| 39 | 0.9208 | 0.9815 | 0.9766 | 0.9833 | 0.9979 | 0.9229 | 0.9548 |
| 40 | 0.9249 | 0.9827 | 0.9780 | 0.9848 | 0.9980 | 0.9279 | 0.9581 |
| 41 | 0.9562 | 0.9941 | 0.9903 | 0.9939 | 0.9990 | 0.9581 | 0.9709 |
| 42 | 0.9323 | 0.9867 | 0.9824 | 0.9874 | 0.9983 | 0.9359 | 0.9622 |
| 43 | 0.9088 | 0.9788 | 0.9740 | 0.9806 | 0.9979 | 0.9132 | 0.9575 |
| 44 | 0.9064 | 0.9779 | 0.9730 | 0.9798 | 0.9978 | 0.9108 | 0.9564 |
| 45 | 0.9161 | 0.9818 | 0.9773 | 0.9830 | 0.9981 | 0.9210 | 0.9592 |
| 46 | 0.9277 | 0.9856 | 0.9813 | 0.9862 | 0.9984 | 0.9317 | 0.9615 |
| 47 | 0.9470 | 0.9929 | 0.9893 | 0.9920 | 0.9990 | 0.9506 | 0.9650 |
| 48 | 0.9646 | 0.9992 | 0.9961 | 0.9973 | 0.9995 | 0.9679 | 0.9706 |
| 49 | 0.9732 | 1.0015 | 0.9986 | 0.9994 | 0.9997 | 0.9755 | 0.9734 |
| 50 | 0.9763 | 1.0017 | 0.9988 | 0.9987 | 0.9999 | 0.9779 | 0.9771 |
| 51 | 0.9846 | 1.0041 | 1.0015 | 1.0019 | 1.0000 | 0.9863 | 0.9799 |
| 52 | 0.9769 | 1.0004 | 0.9974 | 0.9994 | 0.9996 | 0.9784 | 0.9808 |
| 53 | 0.9626 | 0.9963 | 0.9930 | 0.9955 | 0.9992 | 0.9650 | 0.9777 |
| 54 | 0.9510 | 0.9925 | 0.9888 | 0.9921 | 0.9990 | 0.9536 | 0.9733 |
| 55 | 0.9216 | 0.9813 | 0.9766 | 0.9836 | 0.9979 | 0.9238 | 0.9573 |
| 56 | 0.9037 | 0.9769 | 0.9720 | 0.9792 | 0.9978 | 0.9083 | 0.9547 |
| 57 | 0.9026 | 0.9764 | 0.9714 | 0.9787 | 0.9977 | 0.9070 | 0.9535 |
| 58 | 0.9015 | 0.9760 | 0.9709 | 0.9783 | 0.9977 | 0.9059 | 0.9529 |
| 59 | 0.9005 | 0.9759 | 0.9707 | 0.9780 | 0.9977 | 0.9047 | 0.9522 |
| 60 | 0.9434 | 0.9899 | 0.9858 | 0.9903 | 0.9986 | 0.9459 | 0.9681 |
| 61 | 0.9052 | 0.9775 | 0.9726 | 0.9796 | 0.9978 | 0.9098 | 0.9546 |
| 62 | 0.9043 | 0.9772 | 0.9722 | 0.9793 | 0.9978 | 0.9088 | 0.9541 |
| 63 | 0.9208 | 0.9815 | 0.9766 | 0.9833 | 0.9979 | 0.9229 | 0.9548 |
| 64 | 0.9249 | 0.9827 | 0.9780 | 0.9848 | 0.9980 | 0.9279 | 0.9581 |
| 65 | 0.9562 | 0.9941 | 0.9903 | 0.9939 | 0.9990 | 0.9581 | 0.9709 |
| 66 | 0.9323 | 0.9867 | 0.9824 | 0.9874 | 0.9983 | 0.9359 | 0.9622 |
| 67 | 0.9088 | 0.9788 | 0.9740 | 0.9806 | 0.9979 | 0.9132 | 0.9575 |
| 68 | 0.9064 | 0.9779 | 0.9730 | 0.9798 | 0.9978 | 0.9108 | 0.9564 |
| 69 | 0.9161 | 0.9818 | 0.9773 | 0.9830 | 0.9981 | 0.9210 | 0.9592 |
| 70 | 0.9277 | 0.9856 | 0.9813 | 0.9862 | 0.9984 | 0.9317 | 0.9615 |
| 71 | 0.9470 | 0.9929 | 0.9893 | 0.9920 | 0.9990 | 0.9506 | 0.9650 |
| 72 | 0.9646 | 0.9992 | 0.9961 | 0.9973 | 0.9995 | 0.9679 | 0.9706 |

APPENDIX C

Detail of Compared by using artificial neural network with Y-bus matrix method at bus 6, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|----------------|--------|-------|-------|----------------|--------|-------|-------|
| | Reactive Bus 6 | | | | Reactive Bus 6 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 0.000 | 19.126 | 0.000 | 0.000 | 0.000 | 19.000 | 0.000 | 0.000 |
| 2 | 0.000 | 18.921 | 0.000 | 0.000 | 0.000 | 18.500 | 0.000 | 0.000 |
| 3 | 0.000 | 18.385 | 0.000 | 0.000 | 0.000 | 17.400 | 0.000 | 0.000 |
| 4 | 0.000 | 16.725 | 0.000 | 0.000 | 0.000 | 15.500 | 0.000 | 0.000 |
| 5 | 0.000 | 18.450 | 0.000 | 0.000 | 0.000 | 16.900 | 0.000 | 0.000 |
| 6 | 0.000 | 19.772 | 0.000 | 0.000 | 0.000 | 18.800 | 0.000 | 0.000 |
| 7 | 0.000 | 19.772 | 0.000 | 0.000 | 0.000 | 27.300 | 0.000 | 0.000 |
| 8 | 0.000 | 27.594 | 0.000 | 0.000 | 0.000 | 27.400 | 0.000 | 0.000 |
| 9 | 0.000 | 27.867 | 0.000 | 0.000 | 0.000 | 27.500 | 0.000 | 0.000 |
| 10 | 0.000 | 28.056 | 0.000 | 0.000 | 0.000 | 27.700 | 0.000 | 0.000 |
| 11 | 0.000 | 28.162 | 0.000 | 0.000 | 0.000 | 27.890 | 0.000 | 0.000 |
| 12 | 0.000 | 21.384 | 0.000 | 0.000 | 0.000 | 20.800 | 0.000 | 0.000 |
| 13 | 0.000 | 26.810 | 0.000 | 0.000 | 0.000 | 26.800 | 0.000 | 0.000 |
| 14 | 0.000 | 27.303 | 0.000 | 0.000 | 0.000 | 27.000 | 0.000 | 0.000 |
| 15 | 0.000 | 26.537 | 0.000 | 0.000 | 0.000 | 26.400 | 0.000 | 0.000 |
| 16 | 0.000 | 25.449 | 0.000 | 0.000 | 0.000 | 26.300 | 0.000 | 0.000 |
| 17 | 0.000 | 20.914 | 0.000 | 0.000 | 0.000 | 21.300 | 0.000 | 0.000 |
| 18 | 0.000 | 24.085 | 0.000 | 0.000 | 0.000 | 25.600 | 0.000 | 0.000 |
| 19 | 0.000 | 25.766 | 0.000 | 0.000 | 0.000 | 26.000 | 0.000 | 0.000 |
| 20 | 0.000 | 26.553 | 0.000 | 0.000 | 0.000 | 26.500 | 0.000 | 0.000 |
| 21 | 0.000 | 24.183 | 0.000 | 0.000 | 0.000 | 24.300 | 0.000 | 0.000 |
| 22 | 0.000 | 23.628 | 0.000 | 0.000 | 0.000 | 24.300 | 0.000 | 0.000 |
| 23 | 0.000 | 21.282 | 0.000 | 0.000 | 0.000 | 22.400 | 0.000 | 0.000 |
| 24 | 0.000 | 20.136 | 0.000 | 0.000 | 0.000 | 21.200 | 0.000 | 0.000 |

Compared by using artificial neural network with Y-bus matrix method at bus 7, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|----------------|-------|-------|-------|----------------|-------|-------|-------|
| | Reactive Bus 7 | | | | Reactive Bus 7 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 1.438 | 0.000 | 0.109 | 0.038 | 1.654 | 0.000 | 0.102 | 0.044 |
| 2 | 1.746 | 0.000 | 0.115 | 0.046 | 1.746 | 0.000 | 0.107 | 0.047 |
| 3 | 1.640 | 0.000 | 0.112 | 0.048 | 1.654 | 0.000 | 0.102 | 0.044 |
| 4 | 1.650 | 0.000 | 0.076 | 0.038 | 1.470 | 0.000 | 0.090 | 0.039 |
| 5 | 2.274 | 0.000 | 0.133 | 0.042 | 2.068 | 0.000 | 0.127 | 0.055 |
| 6 | 2.470 | 0.000 | 0.166 | 0.048 | 2.298 | 0.000 | 0.141 | 0.061 |
| 7 | 2.970 | 0.000 | 0.217 | 0.073 | 3.308 | 0.000 | 0.203 | 0.088 |
| 8 | 3.236 | 0.000 | 0.225 | 0.076 | 3.354 | 0.000 | 0.206 | 0.089 |
| 9 | 3.270 | 0.000 | 0.234 | 0.079 | 3.373 | 0.000 | 0.207 | 0.090 |
| 10 | 3.233 | 0.000 | 0.231 | 0.075 | 3.391 | 0.000 | 0.208 | 0.090 |
| 11 | 3.284 | 0.000 | 0.234 | 0.081 | 3.419 | 0.000 | 0.210 | 0.091 |
| 12 | 2.719 | 0.000 | 0.163 | 0.068 | 2.638 | 0.000 | 0.162 | 0.070 |
| 13 | 3.205 | 0.000 | 0.171 | 0.090 | 3.217 | 0.000 | 0.198 | 0.086 |
| 14 | 3.232 | 0.000 | 0.228 | 0.071 | 3.308 | 0.000 | 0.203 | 0.088 |
| 15 | 3.218 | 0.000 | 0.232 | 0.073 | 3.235 | 0.000 | 0.199 | 0.086 |
| 16 | 3.043 | 0.000 | 0.156 | 0.064 | 2.941 | 0.000 | 0.181 | 0.078 |
| 17 | 2.468 | 0.000 | 0.136 | 0.052 | 2.298 | 0.000 | 0.141 | 0.061 |
| 18 | 2.803 | 0.000 | 0.141 | 0.060 | 2.665 | 0.000 | 0.164 | 0.071 |
| 19 | 3.177 | 0.000 | 0.167 | 0.075 | 3.125 | 0.000 | 0.192 | 0.083 |
| 20 | 3.265 | 0.000 | 0.169 | 0.078 | 3.244 | 0.000 | 0.199 | 0.086 |
| 21 | 3.025 | 0.000 | 0.164 | 0.071 | 2.941 | 0.000 | 0.181 | 0.078 |
| 22 | 2.901 | 0.000 | 0.155 | 0.067 | 2.757 | 0.000 | 0.170 | 0.074 |
| 23 | 2.295 | 0.000 | 0.115 | 0.049 | 2.206 | 0.000 | 0.136 | 0.059 |
| 24 | 1.501 | 0.000 | 0.100 | 0.039 | 1.746 | 0.000 | 0.107 | 0.047 |

Compared by using artificial neural network with Y-bus matrix method at bus 8, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|----------------|-------|-------|-------|----------------|-------|-------|-------|
| | Reactive Bus 8 | | | | Reactive Bus 8 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 4.526 | 0.000 | 0.249 | 0.041 | 4.209 | 0.000 | 0.242 | 0.049 |
| 2 | 4.749 | 0.000 | 0.232 | 0.044 | 4.443 | 0.000 | 0.256 | 0.051 |
| 3 | 4.541 | 0.000 | 0.216 | 0.043 | 4.209 | 0.000 | 0.242 | 0.049 |
| 4 | 3.943 | 0.000 | 0.238 | 0.040 | 3.742 | 0.000 | 0.215 | 0.043 |
| 5 | 5.297 | 0.000 | 0.291 | 0.055 | 5.276 | 0.000 | 0.303 | 0.061 |
| 6 | 5.764 | 0.000 | 0.306 | 0.063 | 5.846 | 0.000 | 0.336 | 0.068 |
| 7 | 7.764 | 0.000 | 0.425 | 0.073 | 8.419 | 0.000 | 0.484 | 0.097 |
| 8 | 8.647 | 0.000 | 0.541 | 0.078 | 8.540 | 0.000 | 0.491 | 0.099 |
| 9 | 8.767 | 0.000 | 0.546 | 0.084 | 8.578 | 0.000 | 0.493 | 0.099 |
| 10 | 8.822 | 0.000 | 0.559 | 0.106 | 8.643 | 0.000 | 0.497 | 0.100 |
| 11 | 9.012 | 0.000 | 0.538 | 0.107 | 8.699 | 0.000 | 0.500 | 0.100 |
| 12 | 6.497 | 0.000 | 0.373 | 0.063 | 6.707 | 0.000 | 0.386 | 0.077 |
| 13 | 8.075 | 0.000 | 0.471 | 0.090 | 8.185 | 0.000 | 0.471 | 0.095 |
| 14 | 8.447 | 0.000 | 0.450 | 0.089 | 8.419 | 0.000 | 0.484 | 0.097 |
| 15 | 8.164 | 0.000 | 0.471 | 0.095 | 8.232 | 0.000 | 0.473 | 0.095 |
| 16 | 7.144 | 0.000 | 0.419 | 0.092 | 7.483 | 0.000 | 0.430 | 0.086 |
| 17 | 5.771 | 0.000 | 0.311 | 0.066 | 5.846 | 0.000 | 0.336 | 0.068 |
| 18 | 6.440 | 0.000 | 0.352 | 0.073 | 6.782 | 0.000 | 0.390 | 0.078 |
| 19 | 7.762 | 0.000 | 0.387 | 0.090 | 7.951 | 0.000 | 0.457 | 0.092 |
| 20 | 8.284 | 0.000 | 0.488 | 0.094 | 8.269 | 0.000 | 0.476 | 0.095 |
| 21 | 7.273 | 0.000 | 0.435 | 0.083 | 7.483 | 0.000 | 0.430 | 0.086 |
| 22 | 6.731 | 0.000 | 0.419 | 0.074 | 7.016 | 0.000 | 0.404 | 0.081 |
| 23 | 5.555 | 0.000 | 0.341 | 0.055 | 5.612 | 0.000 | 0.323 | 0.065 |
| 24 | 4.691 | 0.000 | 0.244 | 0.049 | 4.443 | 0.000 | 0.256 | 0.051 |



Compared by using artificial neural network with Y-bus matrix method at bus 10, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 10 | | | | Reactive Bus 10 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 3.231 | 0.000 | 0.132 | 0.263 | 3.739 | 0.000 | 0.149 | 0.252 |
| 2 | 3.667 | 0.000 | 0.138 | 0.262 | 3.946 | 0.000 | 0.158 | 0.266 |
| 3 | 3.446 | 0.000 | 0.142 | 0.217 | 3.739 | 0.000 | 0.149 | 0.252 |
| 4 | 3.248 | 0.000 | 0.141 | 0.227 | 3.323 | 0.000 | 0.133 | 0.224 |
| 5 | 4.941 | 0.000 | 0.203 | 0.370 | 4.678 | 0.000 | 0.187 | 0.315 |
| 6 | 5.727 | 0.000 | 0.232 | 0.408 | 5.193 | 0.000 | 0.208 | 0.350 |
| 7 | 6.727 | 0.000 | 0.252 | 0.480 | 7.468 | 0.000 | 0.298 | 0.503 |
| 8 | 7.380 | 0.000 | 0.261 | 0.500 | 7.577 | 0.000 | 0.303 | 0.511 |
| 9 | 7.491 | 0.000 | 0.294 | 0.522 | 7.613 | 0.000 | 0.304 | 0.513 |
| 10 | 7.556 | 0.000 | 0.309 | 0.535 | 7.667 | 0.000 | 0.306 | 0.517 |
| 11 | 7.461 | 0.000 | 0.329 | 0.575 | 7.721 | 0.000 | 0.309 | 0.520 |
| 12 | 6.461 | 0.000 | 0.218 | 0.378 | 5.951 | 0.000 | 0.238 | 0.401 |
| 13 | 7.236 | 0.000 | 0.281 | 0.392 | 7.260 | 0.000 | 0.290 | 0.489 |
| 14 | 7.437 | 0.000 | 0.284 | 0.494 | 7.477 | 0.000 | 0.299 | 0.504 |
| 15 | 7.283 | 0.000 | 0.246 | 0.411 | 7.306 | 0.000 | 0.292 | 0.492 |
| 16 | 6.725 | 0.000 | 0.236 | 0.378 | 6.637 | 0.000 | 0.265 | 0.447 |
| 17 | 5.574 | 0.000 | 0.203 | 0.306 | 5.193 | 0.000 | 0.208 | 0.350 |
| 18 | 6.187 | 0.000 | 0.210 | 0.350 | 6.023 | 0.000 | 0.241 | 0.406 |
| 19 | 7.011 | 0.000 | 0.317 | 0.465 | 7.053 | 0.000 | 0.282 | 0.475 |
| 20 | 7.275 | 0.000 | 0.323 | 0.503 | 7.333 | 0.000 | 0.293 | 0.494 |
| 21 | 7.010 | 0.000 | 0.303 | 0.493 | 6.637 | 0.000 | 0.265 | 0.447 |
| 22 | 6.567 | 0.000 | 0.224 | 0.450 | 6.231 | 0.000 | 0.249 | 0.420 |
| 23 | 5.202 | 0.000 | 0.215 | 0.308 | 4.985 | 0.000 | 0.199 | 0.336 |
| 24 | 3.407 | 0.000 | 0.182 | 0.292 | 3.946 | 0.000 | 0.158 | 0.266 |

Compared by using artificial neural network with Y-bus matrix method at bus 11, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 11 | | | | Reactive Bus 11 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 1.030 | 0.000 | 0.039 | 0.082 | 1.055 | 0.000 | 0.049 | 0.097 |
| 2 | 1.090 | 0.000 | 0.047 | 0.092 | 1.116 | 0.000 | 0.052 | 0.102 |
| 3 | 1.020 | 0.000 | 0.039 | 0.089 | 1.055 | 0.000 | 0.049 | 0.097 |
| 4 | 0.890 | 0.000 | 0.043 | 0.085 | 0.940 | 0.000 | 0.043 | 0.086 |
| 5 | 1.213 | 0.000 | 0.054 | 0.102 | 1.318 | 0.000 | 0.061 | 0.121 |
| 6 | 1.408 | 0.000 | 0.057 | 0.116 | 1.468 | 0.000 | 0.068 | 0.134 |
| 7 | 1.908 | 0.000 | 0.083 | 0.183 | 2.109 | 0.000 | 0.097 | 0.193 |
| 8 | 2.099 | 0.000 | 0.091 | 0.186 | 2.136 | 0.000 | 0.099 | 0.195 |
| 9 | 2.182 | 0.000 | 0.097 | 0.189 | 2.153 | 0.000 | 0.099 | 0.197 |
| 10 | 2.129 | 0.000 | 0.100 | 0.172 | 2.162 | 0.000 | 0.100 | 0.198 |
| 11 | 2.130 | 0.000 | 0.118 | 0.209 | 2.180 | 0.000 | 0.101 | 0.200 |
| 12 | 1.836 | 0.000 | 0.067 | 0.133 | 1.679 | 0.000 | 0.078 | 0.154 |
| 13 | 2.155 | 0.000 | 0.083 | 0.181 | 2.048 | 0.000 | 0.095 | 0.187 |
| 14 | 2.150 | 0.000 | 0.084 | 0.187 | 2.109 | 0.000 | 0.097 | 0.193 |
| 15 | 2.176 | 0.000 | 0.079 | 0.183 | 2.066 | 0.000 | 0.095 | 0.189 |
| 16 | 1.932 | 0.000 | 0.075 | 0.148 | 1.872 | 0.000 | 0.086 | 0.171 |
| 17 | 1.438 | 0.000 | 0.063 | 0.124 | 1.468 | 0.000 | 0.068 | 0.134 |
| 18 | 1.689 | 0.000 | 0.076 | 0.142 | 1.696 | 0.000 | 0.078 | 0.155 |
| 19 | 1.998 | 0.000 | 0.096 | 0.148 | 1.995 | 0.000 | 0.092 | 0.183 |
| 20 | 2.056 | 0.000 | 0.110 | 0.195 | 2.074 | 0.000 | 0.096 | 0.190 |
| 21 | 2.000 | 0.000 | 0.093 | 0.166 | 1.872 | 0.000 | 0.086 | 0.171 |
| 22 | 1.808 | 0.000 | 0.076 | 0.157 | 1.758 | 0.000 | 0.081 | 0.161 |
| 23 | 1.239 | 0.000 | 0.056 | 0.147 | 1.406 | 0.000 | 0.065 | 0.129 |
| 24 | 1.002 | 0.000 | 0.048 | 0.105 | 1.116 | 0.000 | 0.052 | 0.102 |

Compared by using artificial neural network with Y-bus matrix method at bus 12, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 12 | | | | Reactive Bus 12 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 0.434 | 0.000 | 0.031 | 0.010 | 0.491 | 0.000 | 0.028 | 0.009 |
| 2 | 0.433 | 0.000 | 0.029 | 0.011 | 0.519 | 0.000 | 0.030 | 0.010 |
| 3 | 0.505 | 0.000 | 0.030 | 0.008 | 0.491 | 0.000 | 0.028 | 0.009 |
| 4 | 0.540 | 0.000 | 0.027 | 0.006 | 0.457 | 0.000 | 0.025 | 0.008 |
| 5 | 0.577 | 0.000 | 0.035 | 0.014 | 0.621 | 0.000 | 0.036 | 0.012 |
| 6 | 0.650 | 0.000 | 0.045 | 0.014 | 0.686 | 0.000 | 0.040 | 0.013 |
| 7 | 0.850 | 0.000 | 0.058 | 0.017 | 0.982 | 0.000 | 0.057 | 0.019 |
| 8 | 1.003 | 0.000 | 0.057 | 0.019 | 1.001 | 0.000 | 0.058 | 0.020 |
| 9 | 1.006 | 0.000 | 0.059 | 0.021 | 1.001 | 0.000 | 0.058 | 0.020 |
| 10 | 1.008 | 0.000 | 0.058 | 0.023 | 1.010 | 0.000 | 0.059 | 0.020 |
| 11 | 1.015 | 0.000 | 0.060 | 0.024 | 1.019 | 0.000 | 0.059 | 0.020 |
| 12 | 0.749 | 0.000 | 0.049 | 0.017 | 0.788 | 0.000 | 0.046 | 0.016 |
| 13 | 0.822 | 0.000 | 0.057 | 0.017 | 0.954 | 0.000 | 0.055 | 0.019 |
| 14 | 0.940 | 0.000 | 0.059 | 0.016 | 0.982 | 0.000 | 0.057 | 0.019 |
| 15 | 0.945 | 0.000 | 0.052 | 0.018 | 0.964 | 0.000 | 0.056 | 0.019 |
| 16 | 0.750 | 0.000 | 0.050 | 0.015 | 0.880 | 0.000 | 0.051 | 0.017 |
| 17 | 0.642 | 0.000 | 0.046 | 0.012 | 0.686 | 0.000 | 0.040 | 0.013 |
| 18 | 0.690 | 0.000 | 0.042 | 0.013 | 0.797 | 0.000 | 0.046 | 0.016 |
| 19 | 0.870 | 0.000 | 0.049 | 0.019 | 0.936 | 0.000 | 0.054 | 0.019 |
| 20 | 0.984 | 0.000 | 0.062 | 0.020 | 0.973 | 0.000 | 0.056 | 0.020 |
| 21 | 0.905 | 0.000 | 0.057 | 0.019 | 0.880 | 0.000 | 0.051 | 0.018 |
| 22 | 0.871 | 0.000 | 0.042 | 0.019 | 0.825 | 0.000 | 0.048 | 0.017 |
| 23 | 0.585 | 0.000 | 0.037 | 0.011 | 0.658 | 0.000 | 0.038 | 0.013 |
| 24 | 0.507 | 0.000 | 0.033 | 0.009 | 0.519 | 0.000 | 0.030 | 0.010 |

Compared by using artificial neural network with Y-bus matrix method at bus 13, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 13 | | | | Reactive Bus 13 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 0.899 | 0.000 | 0.061 | 0.021 | 0.968 | 0.000 | 0.057 | 0.024 |
| 2 | 1.001 | 0.000 | 0.070 | 0.025 | 1.024 | 0.000 | 0.061 | 0.026 |
| 3 | 0.961 | 0.000 | 0.061 | 0.026 | 0.968 | 0.000 | 0.057 | 0.024 |
| 4 | 0.949 | 0.000 | 0.053 | 0.022 | 0.858 | 0.000 | 0.051 | 0.021 |
| 5 | 1.248 | 0.000 | 0.075 | 0.029 | 1.208 | 0.000 | 0.072 | 0.030 |
| 6 | 1.403 | 0.000 | 0.090 | 0.033 | 1.346 | 0.000 | 0.080 | 0.034 |
| 7 | 1.703 | 0.000 | 0.102 | 0.039 | 1.937 | 0.000 | 0.115 | 0.048 |
| 8 | 1.891 | 0.000 | 0.116 | 0.040 | 1.964 | 0.000 | 0.117 | 0.049 |
| 9 | 1.942 | 0.000 | 0.114 | 0.043 | 1.974 | 0.000 | 0.117 | 0.049 |
| 10 | 1.963 | 0.000 | 0.116 | 0.059 | 1.992 | 0.000 | 0.118 | 0.050 |
| 11 | 2.028 | 0.000 | 0.126 | 0.061 | 2.001 | 0.000 | 0.119 | 0.050 |
| 12 | 1.732 | 0.000 | 0.083 | 0.030 | 1.640 | 0.000 | 0.091 | 0.039 |
| 13 | 1.971 | 0.000 | 0.112 | 0.046 | 1.881 | 0.000 | 0.112 | 0.047 |
| 14 | 1.680 | 0.000 | 0.116 | 0.049 | 1.937 | 0.000 | 0.115 | 0.048 |
| 15 | 1.650 | 0.000 | 0.115 | 0.044 | 1.891 | 0.000 | 0.112 | 0.047 |
| 16 | 1.563 | 0.000 | 0.115 | 0.040 | 1.725 | 0.000 | 0.102 | 0.043 |
| 17 | 1.425 | 0.000 | 0.093 | 0.036 | 1.346 | 0.000 | 0.080 | 0.034 |
| 18 | 1.379 | 0.000 | 0.086 | 0.034 | 1.559 | 0.000 | 0.092 | 0.039 |
| 19 | 1.815 | 0.000 | 0.107 | 0.041 | 1.826 | 0.000 | 0.108 | 0.046 |
| 20 | 1.882 | 0.000 | 0.119 | 0.050 | 1.900 | 0.000 | 0.113 | 0.048 |
| 21 | 1.850 | 0.000 | 0.114 | 0.047 | 1.725 | 0.000 | 0.102 | 0.043 |
| 22 | 1.778 | 0.000 | 0.086 | 0.038 | 1.614 | 0.000 | 0.096 | 0.040 |
| 23 | 1.175 | 0.000 | 0.063 | 0.033 | 1.291 | 0.000 | 0.077 | 0.032 |
| 24 | 1.095 | 0.000 | 0.051 | 0.021 | 1.024 | 0.000 | 0.061 | 0.026 |

Compared by using artificial neural network with Y-bus matrix method at bus 14, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 14 | | | | Reactive Bus 14 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 1.821 | 0.000 | 0.222 | 0.021 | 1.832 | 0.000 | 0.243 | 0.024 |
| 2 | 1.938 | 0.000 | 0.258 | 0.028 | 1.937 | 0.000 | 0.257 | 0.026 |
| 3 | 1.755 | 0.000 | 0.246 | 0.025 | 1.832 | 0.000 | 0.243 | 0.024 |
| 4 | 1.519 | 0.000 | 0.252 | 0.023 | 1.632 | 0.000 | 0.217 | 0.022 |
| 5 | 2.391 | 0.000 | 0.340 | 0.026 | 2.295 | 0.000 | 0.305 | 0.030 |
| 6 | 2.509 | 0.000 | 0.435 | 0.039 | 2.548 | 0.000 | 0.338 | 0.034 |
| 7 | 3.509 | 0.000 | 0.485 | 0.039 | 3.665 | 0.000 | 0.487 | 0.049 |
| 8 | 3.798 | 0.000 | 0.507 | 0.045 | 3.717 | 0.000 | 0.494 | 0.049 |
| 9 | 3.570 | 0.000 | 0.573 | 0.046 | 3.734 | 0.000 | 0.496 | 0.050 |
| 10 | 3.830 | 0.000 | 0.571 | 0.050 | 3.761 | 0.000 | 0.499 | 0.050 |
| 11 | 3.859 | 0.000 | 0.527 | 0.050 | 3.787 | 0.000 | 0.503 | 0.050 |
| 12 | 2.906 | 0.000 | 0.410 | 0.040 | 2.923 | 0.000 | 0.388 | 0.039 |
| 13 | 3.421 | 0.000 | 0.427 | 0.042 | 3.560 | 0.000 | 0.473 | 0.047 |
| 14 | 3.490 | 0.000 | 0.482 | 0.045 | 3.665 | 0.000 | 0.487 | 0.049 |
| 15 | 3.414 | 0.000 | 0.435 | 0.043 | 3.586 | 0.000 | 0.476 | 0.048 |
| 16 | 3.394 | 0.000 | 0.434 | 0.038 | 3.255 | 0.000 | 0.432 | 0.043 |
| 17 | 2.571 | 0.000 | 0.363 | 0.033 | 2.591 | 0.000 | 0.344 | 0.034 |
| 18 | 3.073 | 0.000 | 0.475 | 0.034 | 2.949 | 0.000 | 0.392 | 0.039 |
| 19 | 3.451 | 0.000 | 0.492 | 0.045 | 3.464 | 0.000 | 0.460 | 0.046 |
| 20 | 3.611 | 0.000 | 0.493 | 0.050 | 3.595 | 0.000 | 0.477 | 0.048 |
| 21 | 3.335 | 0.000 | 0.410 | 0.041 | 3.255 | 0.000 | 0.432 | 0.043 |
| 22 | 3.033 | 0.000 | 0.333 | 0.032 | 3.054 | 0.000 | 0.406 | 0.041 |
| 23 | 2.487 | 0.000 | 0.312 | 0.030 | 2.443 | 0.000 | 0.324 | 0.032 |
| 24 | 1.976 | 0.000 | 0.297 | 0.023 | 1.937 | 0.000 | 0.257 | 0.026 |

Compared by using artificial neural network with Y-bus matrix method at bus 15, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|---------|-----------------|-------|-------|---------|
| | Reactive Bus 15 | | | | Reactive Bus 15 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 45.769 | 0.000 | 4.313 | 0.00048 | 44.871 | 0.000 | 4.608 | 0.00054 |
| 2 | 48.149 | 0.000 | 4.732 | 0.00055 | 47.365 | 0.000 | 4.864 | 0.00057 |
| 3 | 45.714 | 0.000 | 4.252 | 0.00047 | 44.871 | 0.000 | 4.608 | 0.00054 |
| 4 | 39.763 | 0.000 | 3.913 | 0.00045 | 39.884 | 0.000 | 4.096 | 0.00048 |
| 5 | 55.740 | 0.000 | 5.933 | 0.00057 | 56.189 | 0.000 | 5.770 | 0.00068 |
| 6 | 61.346 | 0.000 | 6.712 | 0.00064 | 62.319 | 0.000 | 6.400 | 0.00075 |
| 7 | 83.346 | 0.000 | 6.712 | 0.00104 | 89.743 | 0.000 | 9.216 | 0.00108 |
| 8 | 91.382 | 0.000 | 9.296 | 0.00104 | 90.994 | 0.000 | 9.344 | 0.00110 |
| 9 | 91.716 | 0.000 | 9.395 | 0.00107 | 91.438 | 0.000 | 9.390 | 0.00110 |
| 10 | 92.620 | 0.000 | 9.472 | 0.00110 | 92.100 | 0.000 | 9.458 | 0.00111 |
| 11 | 93.640 | 0.000 | 9.515 | 0.00126 | 92.735 | 0.000 | 9.523 | 0.00112 |
| 12 | 69.569 | 0.000 | 7.584 | 0.00066 | 71.488 | 0.000 | 7.341 | 0.00086 |
| 13 | 86.858 | 0.000 | 8.89 | 0.00103 | 87.249 | 0.000 | 8.960 | 0.00105 |
| 14 | 89.504 | 0.000 | 9.194 | 0.00103 | 89.779 | 0.000 | 9.219 | 0.00108 |
| 15 | 87.172 | 0.000 | 8.918 | 0.00103 | 87.784 | 0.000 | 9.014 | 0.00106 |
| 16 | 79.968 | 0.000 | 8.186 | 0.00076 | 79.776 | 0.000 | 8.192 | 0.00096 |
| 17 | 62.020 | 0.000 | 6.748 | 0.00065 | 62.319 | 0.000 | 6.400 | 0.00075 |
| 18 | 72.423 | 0.000 | 7.531 | 0.00077 | 72.295 | 0.000 | 7.424 | 0.00087 |
| 19 | 84.312 | 0.000 | 8.588 | 0.00106 | 84.755 | 0.000 | 8.703 | 0.00102 |
| 20 | 87.918 | 0.000 | 8.887 | 0.00121 | 88.110 | 0.000 | 9.048 | 0.00106 |
| 21 | 78.834 | 0.000 | 8.307 | 0.00076 | 79.776 | 0.000 | 8.192 | 0.00096 |
| 22 | 74.085 | 0.000 | 7.849 | 0.00070 | 74.789 | 0.000 | 7.680 | 0.00090 |
| 23 | 60.128 | 0.000 | 6.453 | 0.00062 | 59.825 | 0.000 | 6.143 | 0.00072 |
| 24 | 48.230 | 0.000 | 4.763 | 0.00043 | 47.365 | 0.000 | 4.864 | 0.00057 |

Compared by using artificial neural network with Y-bus matrix method at bus 16, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|---------|-----------------|-------|-------|---------|
| | Reactive Bus 16 | | | | Reactive Bus 16 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 1.008 | 0.000 | 0.197 | 0.00035 | 0.977 | 0.000 | 0.194 | 0.00045 |
| 2 | 1.115 | 0.000 | 0.215 | 0.00038 | 1.035 | 0.000 | 0.205 | 0.00048 |
| 3 | 1.004 | 0.000 | 0.199 | 0.00043 | 0.977 | 0.000 | 0.194 | 0.00045 |
| 4 | 0.991 | 0.000 | 0.175 | 0.00041 | 0.868 | 0.000 | 0.172 | 0.00040 |
| 5 | 1.168 | 0.000 | 0.245 | 0.00046 | 1.227 | 0.000 | 0.243 | 0.00057 |
| 6 | 1.307 | 0.000 | 0.286 | 0.00072 | 1.360 | 0.000 | 0.270 | 0.00063 |
| 7 | 1.807 | 0.000 | 0.345 | 0.00083 | 1.953 | 0.000 | 0.387 | 0.00090 |
| 8 | 1.920 | 0.000 | 0.447 | 0.00091 | 1.978 | 0.000 | 0.392 | 0.00091 |
| 9 | 1.981 | 0.000 | 0.443 | 0.00094 | 1.995 | 0.000 | 0.395 | 0.00092 |
| 10 | 2.078 | 0.000 | 0.449 | 0.00097 | 2.003 | 0.000 | 0.397 | 0.00092 |
| 11 | 2.032 | 0.000 | 0.446 | 0.00098 | 2.020 | 0.000 | 0.400 | 0.00093 |
| 12 | 1.445 | 0.000 | 0.287 | 0.00069 | 1.561 | 0.000 | 0.309 | 0.00072 |
| 13 | 1.641 | 0.000 | 0.360 | 0.00086 | 1.903 | 0.000 | 0.377 | 0.00088 |
| 14 | 1.862 | 0.000 | 0.337 | 0.00095 | 1.953 | 0.000 | 0.387 | 0.00090 |
| 15 | 1.823 | 0.000 | 0.342 | 0.00076 | 1.911 | 0.000 | 0.379 | 0.00088 |
| 16 | 1.565 | 0.000 | 0.335 | 0.00068 | 1.736 | 0.000 | 0.344 | 0.00080 |
| 17 | 1.271 | 0.000 | 0.258 | 0.00053 | 1.360 | 0.000 | 0.270 | 0.00063 |
| 18 | 1.412 | 0.000 | 0.310 | 0.00063 | 1.577 | 0.000 | 0.313 | 0.00073 |
| 19 | 1.825 | 0.000 | 0.367 | 0.00095 | 1.845 | 0.000 | 0.366 | 0.00085 |
| 20 | 1.954 | 0.000 | 0.412 | 0.00098 | 1.920 | 0.000 | 0.380 | 0.00088 |
| 21 | 1.609 | 0.000 | 0.300 | 0.00075 | 1.736 | 0.000 | 0.344 | 0.00080 |
| 22 | 1.467 | 0.000 | 0.289 | 0.00067 | 1.628 | 0.000 | 0.323 | 0.00075 |
| 23 | 1.225 | 0.000 | 0.234 | 0.00049 | 1.302 | 0.000 | 0.258 | 0.00060 |
| 24 | 1.179 | 0.000 | 0.207 | 0.00040 | 1.035 | 0.000 | 0.205 | 0.00048 |

Compared by using artificial neural network with Y-bus matrix method at bus 17, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|--------|---------|-----------------|-------|--------|---------|
| | Reactive Bus 17 | | | | Reactive Bus 17 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 2.4190 | 0.000 | 0.4900 | 0.00033 | 2.4707 | 0.000 | 0.4690 | 0.00029 |
| 2 | 2.5670 | 0.000 | 0.4880 | 0.00035 | 2.6051 | 0.000 | 0.4945 | 0.00030 |
| 3 | 2.4360 | 0.000 | 0.4618 | 0.00032 | 2.4707 | 0.000 | 0.4690 | 0.00029 |
| 4 | 2.4330 | 0.000 | 0.4190 | 0.00024 | 2.1934 | 0.000 | 0.4163 | 0.00026 |
| 5 | 2.8980 | 0.000 | 0.4700 | 0.00031 | 3.0926 | 0.000 | 0.5870 | 0.00036 |
| 6 | 3.4110 | 0.000 | 0.6740 | 0.00045 | 3.4287 | 0.000 | 0.6508 | 0.00040 |
| 7 | 4.4110 | 0.000 | 0.7400 | 0.00066 | 4.9330 | 0.000 | 0.9363 | 0.00058 |
| 8 | 4.8650 | 0.000 | 0.8540 | 0.00069 | 5.0086 | 0.000 | 0.9507 | 0.00059 |
| 9 | 5.0690 | 0.000 | 0.8770 | 0.00064 | 5.0338 | 0.000 | 0.9555 | 0.00059 |
| 10 | 4.9300 | 0.000 | 0.9110 | 0.00069 | 5.0674 | 0.000 | 0.9618 | 0.00059 |
| 11 | 4.7980 | 0.000 | 1.0010 | 0.00070 | 5.1010 | 0.000 | 0.9682 | 0.00060 |
| 12 | 3.9630 | 0.000 | 0.7900 | 0.00039 | 3.9329 | 0.000 | 0.7465 | 0.00046 |
| 13 | 4.9030 | 0.000 | 0.9420 | 0.00046 | 4.7985 | 0.000 | 0.9108 | 0.00056 |
| 14 | 5.1300 | 0.000 | 0.8430 | 0.00047 | 4.9414 | 0.000 | 0.9379 | 0.00058 |
| 15 | 5.0320 | 0.000 | 0.8580 | 0.00057 | 4.8321 | 0.000 | 0.9172 | 0.00056 |
| 16 | 4.4160 | 0.000 | 0.8344 | 0.00053 | 4.3867 | 0.000 | 0.8326 | 0.00051 |
| 17 | 3.5710 | 0.000 | 0.5500 | 0.00036 | 3.4287 | 0.000 | 0.6508 | 0.00040 |
| 18 | 4.1340 | 0.000 | 0.8300 | 0.00054 | 3.9749 | 0.000 | 0.7545 | 0.00046 |
| 19 | 4.7060 | 0.000 | 0.9840 | 0.00062 | 4.6640 | 0.000 | 0.8853 | 0.00054 |
| 20 | 4.8270 | 0.000 | 0.9560 | 0.00066 | 4.8489 | 0.000 | 0.9204 | 0.00057 |
| 21 | 4.4740 | 0.000 | 0.7360 | 0.00049 | 4.3867 | 0.000 | 0.8326 | 0.00051 |
| 22 | 4.3170 | 0.000 | 0.7010 | 0.00037 | 4.1178 | 0.000 | 0.7816 | 0.00048 |
| 23 | 3.4780 | 0.000 | 0.5230 | 0.00035 | 3.2942 | 0.000 | 0.6253 | 0.00038 |
| 24 | 2.5620 | 0.000 | 0.4750 | 0.00029 | 2.6051 | 0.000 | 0.4945 | 0.00030 |

Compared by using artificial neural network with Y-bus matrix method at bus 18, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|---------|-----------------|-------|--------|---------|
| | Reactive Bus 18 | | | | Reactive Bus 18 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 0.7800 | 0.000 | 3.280 | 0.00017 | 0.8479 | 0.000 | 3.0819 | 0.00019 |
| 2 | 0.9480 | 0.000 | 3.434 | 0.00019 | 0.8953 | 0.000 | 3.2545 | 0.00020 |
| 3 | 0.8590 | 0.000 | 3.349 | 0.00020 | 0.8479 | 0.000 | 3.0819 | 0.00019 |
| 4 | 0.6940 | 0.000 | 2.619 | 0.00016 | 0.7529 | 0.000 | 2.7369 | 0.00017 |
| 5 | 1.0700 | 0.000 | 4.182 | 0.00021 | 1.0615 | 0.000 | 3.8583 | 0.00024 |
| 6 | 1.2440 | 0.000 | 4.310 | 0.00022 | 1.1780 | 0.000 | 4.2818 | 0.00026 |
| 7 | 1.6440 | 0.000 | 5.810 | 0.00029 | 1.6957 | 0.000 | 6.1639 | 0.00038 |
| 8 | 1.7410 | 0.000 | 6.406 | 0.00033 | 1.7195 | 0.000 | 6.2502 | 0.00038 |
| 9 | 1.6730 | 0.000 | 6.308 | 0.00036 | 1.7281 | 0.000 | 6.2815 | 0.00038 |
| 10 | 1.6460 | 0.000 | 6.494 | 0.00038 | 1.7389 | 0.000 | 6.3207 | 0.00039 |
| 11 | 1.8310 | 0.000 | 6.611 | 0.00041 | 1.7518 | 0.000 | 6.3678 | 0.00039 |
| 12 | 1.4600 | 0.000 | 4.607 | 0.00026 | 1.3506 | 0.000 | 4.9092 | 0.00030 |
| 13 | 1.5950 | 0.000 | 5.761 | 0.00033 | 1.6483 | 0.000 | 5.9914 | 0.00037 |
| 14 | 1.5670 | 0.000 | 6.100 | 0.00037 | 1.6957 | 0.000 | 6.1639 | 0.00038 |
| 15 | 1.6060 | 0.000 | 5.861 | 0.00035 | 1.6591 | 0.000 | 6.0306 | 0.00037 |
| 16 | 1.4990 | 0.000 | 5.330 | 0.00033 | 1.5059 | 0.000 | 5.4738 | 0.00034 |
| 17 | 1.2150 | 0.000 | 4.239 | 0.00022 | 1.1780 | 0.000 | 4.2818 | 0.00026 |
| 18 | 1.3180 | 0.000 | 4.735 | 0.00033 | 1.3657 | 0.000 | 4.9641 | 0.00030 |
| 19 | 1.6910 | 0.000 | 5.673 | 0.00035 | 1.6008 | 0.000 | 5.8188 | 0.00036 |
| 20 | 1.6970 | 0.000 | 6.099 | 0.00040 | 1.6655 | 0.000 | 6.0541 | 0.00037 |
| 21 | 1.4610 | 0.000 | 5.204 | 0.00037 | 1.5059 | 0.000 | 5.4738 | 0.00034 |
| 22 | 1.3500 | 0.000 | 4.862 | 0.00029 | 1.4131 | 0.000 | 5.1366 | 0.00031 |
| 23 | 1.1050 | 0.000 | 4.156 | 0.00022 | 1.1305 | 0.000 | 4.1093 | 0.00025 |
| 24 | 0.7930 | 0.000 | 3.545 | 0.00019 | 0.8953 | 0.000 | 3.2545 | 0.00020 |

Compared by using artificial neural network with Y-bus matrix method at bus 19, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 19 | | | | Reactive Bus 19 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 0.000 | 3.697 | 0.000 | 0.000 | 0.000 | 3.570 | 0.000 | 0.000 |
| 2 | 0.000 | 3.992 | 0.000 | 0.000 | 0.000 | 3.760 | 0.000 | 0.000 |
| 3 | 0.000 | 3.640 | 0.000 | 0.000 | 0.000 | 3.570 | 0.000 | 0.000 |
| 4 | 0.000 | 2.804 | 0.000 | 0.000 | 0.000 | 3.170 | 0.000 | 0.000 |
| 5 | 0.000 | 4.370 | 0.000 | 0.000 | 0.000 | 4.470 | 0.000 | 0.000 |
| 6 | 0.000 | 4.947 | 0.000 | 0.000 | 0.000 | 4.950 | 0.000 | 0.000 |
| 7 | 0.000 | 4.947 | 0.000 | 0.000 | 0.000 | 7.130 | 0.000 | 0.000 |
| 8 | 0.000 | 7.105 | 0.000 | 0.000 | 0.000 | 7.230 | 0.000 | 0.000 |
| 9 | 0.000 | 7.549 | 0.000 | 0.000 | 0.000 | 7.270 | 0.000 | 0.000 |
| 10 | 0.000 | 7.227 | 0.000 | 0.000 | 0.000 | 7.320 | 0.000 | 0.000 |
| 11 | 0.000 | 7.442 | 0.000 | 0.000 | 0.000 | 7.370 | 0.000 | 0.000 |
| 12 | 0.000 | 5.447 | 0.000 | 0.000 | 0.000 | 5.680 | 0.000 | 0.000 |
| 13 | 0.000 | 7.069 | 0.000 | 0.000 | 0.000 | 6.930 | 0.000 | 0.000 |
| 14 | 0.000 | 7.256 | 0.000 | 0.000 | 0.000 | 7.130 | 0.000 | 0.000 |
| 15 | 0.000 | 7.045 | 0.000 | 0.000 | 0.000 | 6.980 | 0.000 | 0.000 |
| 16 | 0.000 | 6.205 | 0.000 | 0.000 | 0.000 | 6.340 | 0.000 | 0.000 |
| 17 | 0.000 | 5.191 | 0.000 | 0.000 | 0.000 | 4.950 | 0.000 | 0.000 |
| 18 | 0.000 | 5.957 | 0.000 | 0.000 | 0.000 | 5.750 | 0.000 | 0.000 |
| 19 | 0.000 | 6.609 | 0.000 | 0.000 | 0.000 | 6.740 | 0.000 | 0.000 |
| 20 | 0.000 | 6.712 | 0.000 | 0.000 | 0.000 | 7.000 | 0.000 | 0.000 |
| 21 | 0.000 | 5.927 | 0.000 | 0.000 | 0.000 | 6.340 | 0.000 | 0.000 |
| 22 | 0.000 | 5.916 | 0.000 | 0.000 | 0.000 | 5.940 | 0.000 | 0.000 |
| 23 | 0.000 | 5.154 | 0.000 | 0.000 | 0.000 | 4.750 | 0.000 | 0.000 |
| 24 | 0.000 | 4.048 | 0.000 | 0.000 | 0.000 | 3.760 | 0.000 | 0.000 |

Compared by using artificial neural network with Y-bus matrix method at bus 20, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|--------|---------|-----------------|-------|--------|---------|
| | Reactive Bus 20 | | | | Reactive Bus 20 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 3.992 | 0.000 | 4.903 | 0.00027 | 4.010 | 0.000 | 5.310 | 0.00024 |
| 2 | 4.394 | 0.000 | 5.227 | 0.00023 | 4.234 | 0.000 | 5.606 | 0.00026 |
| 3 | 4.081 | 0.000 | 4.860 | 0.00019 | 4.010 | 0.000 | 5.310 | 0.00024 |
| 4 | 3.239 | 0.000 | 4.256 | 0.00016 | 3.567 | 0.000 | 4.723 | 0.00022 |
| 5 | 5.248 | 0.000 | 6.560 | 0.00027 | 5.026 | 0.000 | 6.654 | 0.00030 |
| 6 | 5.703 | 0.000 | 7.661 | 0.00029 | 5.573 | 0.000 | 7.378 | 0.00034 |
| 7 | 7.703 | 0.000 | 9.661 | 0.00040 | 8.025 | 0.000 | 10.625 | 0.00049 |
| 8 | 8.173 | 0.000 | 10.642 | 0.00042 | 8.137 | 0.000 | 10.773 | 0.00049 |
| 9 | 8.12 | 0.000 | 10.594 | 0.00049 | 8.176 | 0.000 | 10.824 | 0.00050 |
| 10 | 8.278 | 0.000 | 10.791 | 0.00049 | 8.236 | 0.000 | 10.904 | 0.00050 |
| 11 | 8.372 | 0.000 | 10.685 | 0.00060 | 8.292 | 0.000 | 10.978 | 0.00050 |
| 12 | 6.204 | 0.000 | 8.840 | 0.00033 | 6.390 | 0.000 | 8.460 | 0.00039 |
| 13 | 7.597 | 0.000 | 10.264 | 0.00052 | 7.802 | 0.000 | 10.329 | 0.00047 |
| 14 | 7.958 | 0.000 | 10.550 | 0.00058 | 8.030 | 0.000 | 10.630 | 0.00049 |
| 15 | 7.748 | 0.000 | 10.377 | 0.00053 | 7.849 | 0.000 | 10.391 | 0.00048 |
| 16 | 7.124 | 0.000 | 9.676 | 0.00047 | 7.135 | 0.000 | 9.445 | 0.00043 |
| 17 | 5.661 | 0.000 | 7.612 | 0.00035 | 5.573 | 0.000 | 7.378 | 0.00034 |
| 18 | 6.423 | 0.000 | 8.800 | 0.00033 | 6.463 | 0.000 | 8.557 | 0.00039 |
| 19 | 7.549 | 0.000 | 10.092 | 0.00055 | 7.578 | 0.000 | 10.032 | 0.00046 |
| 20 | 7.93 | 0.000 | 10.516 | 0.00057 | 7.879 | 0.000 | 10.431 | 0.00048 |
| 21 | 6.983 | 0.000 | 9.860 | 0.00046 | 7.135 | 0.000 | 9.445 | 0.00043 |
| 22 | 6.643 | 0.000 | 9.209 | 0.00034 | 6.687 | 0.000 | 8.853 | 0.00041 |
| 23 | 5.451 | 0.000 | 7.195 | 0.00029 | 5.349 | 0.000 | 7.081 | 0.00032 |
| 24 | 4.263 | 0.000 | 5.254 | 0.00025 | 4.234 | 0.000 | 5.606 | 0.00026 |

Compared by using artificial neural network with Y-bus matrix method at bus 21, for EDL 21-bus system

| Hours | ANN | | | | Y-Bus method | | | |
|-------|-----------------|-------|-------|-------|-----------------|-------|-------|-------|
| | Reactive Bus 21 | | | | Reactive Bus 21 | | | |
| | (MVAR) | | | | (MVAR) | | | |
| | G1 | G2 | G3 | G4 | G1 | G2 | G3 | G4 |
| 1 | 0.000 | 1.747 | 0.000 | 0.000 | 0.000 | 1.800 | 0.000 | 0.000 |
| 2 | 0.000 | 1.800 | 0.000 | 0.000 | 0.000 | 1.900 | 0.000 | 0.000 |
| 3 | 0.000 | 1.728 | 0.000 | 0.000 | 0.000 | 1.800 | 0.000 | 0.000 |
| 4 | 0.000 | 1.017 | 0.000 | 0.000 | 0.000 | 1.600 | 0.000 | 0.000 |
| 5 | 0.000 | 2.583 | 0.000 | 0.000 | 0.000 | 2.250 | 0.000 | 0.000 |
| 6 | 0.000 | 2.713 | 0.000 | 0.000 | 0.000 | 2.500 | 0.000 | 0.000 |
| 7 | 0.000 | 2.713 | 0.000 | 0.000 | 0.000 | 3.600 | 0.000 | 0.000 |
| 8 | 0.000 | 3.650 | 0.000 | 0.000 | 0.000 | 3.650 | 0.000 | 0.000 |
| 9 | 0.000 | 3.650 | 0.000 | 0.000 | 0.000 | 3.670 | 0.000 | 0.000 |
| 10 | 0.000 | 3.671 | 0.000 | 0.000 | 0.000 | 3.690 | 0.000 | 0.000 |
| 11 | 0.000 | 3.723 | 0.000 | 0.000 | 0.000 | 3.720 | 0.000 | 0.000 |
| 12 | 0.000 | 3.265 | 0.000 | 0.000 | 0.000 | 2.870 | 0.000 | 0.000 |
| 13 | 0.000 | 3.516 | 0.000 | 0.000 | 0.000 | 3.500 | 0.000 | 0.000 |
| 14 | 0.000 | 3.560 | 0.000 | 0.000 | 0.000 | 3.600 | 0.000 | 0.000 |
| 15 | 0.000 | 3.532 | 0.000 | 0.000 | 0.000 | 3.520 | 0.000 | 0.000 |
| 16 | 0.000 | 3.136 | 0.000 | 0.000 | 0.000 | 3.200 | 0.000 | 0.000 |
| 17 | 0.000 | 2.461 | 0.000 | 0.000 | 0.000 | 2.500 | 0.000 | 0.000 |
| 18 | 0.000 | 2.802 | 0.000 | 0.000 | 0.000 | 2.900 | 0.000 | 0.000 |
| 19 | 0.000 | 3.408 | 0.000 | 0.000 | 0.000 | 3.400 | 0.000 | 0.000 |
| 20 | 0.000 | 3.453 | 0.000 | 0.000 | 0.000 | 3.530 | 0.000 | 0.000 |
| 21 | 0.000 | 3.356 | 0.000 | 0.000 | 0.000 | 3.200 | 0.000 | 0.000 |
| 22 | 0.000 | 2.938 | 0.000 | 0.000 | 0.000 | 3.000 | 0.000 | 0.000 |
| 23 | 0.000 | 2.289 | 0.000 | 0.000 | 0.000 | 2.400 | 0.000 | 0.000 |
| 24 | 0.000 | 1.815 | 0.000 | 0.000 | 0.000 | 1.900 | 0.000 | 0.000 |

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Research

P. Saypaserth, S. Premrudeepreechacharn, "Allocating Reactive Power Using Artificial Neural Networks," APPEEC2011 Conference, Wuhan China, March 2011

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