

**ENEL 674 Industrial and Commercial Power Systems**

Group 7

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**Project Milestone 3**

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# **Connected Load vs Load Demand:**

Total connected load (continuous and non-continuous loads) in the system is as follows,

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Load Type** | **Connected Load** | | | | | **Demand Factor** | **Total Load Demand** | **Remarks** |
| **Distribution Board - 1P** | **Distribution Board - 2P** | **Distribution Board - 3P** | **Distribution Board - U** | **Total** |
| **VA** | **VA** | **VA** | **VA** | **VA** | **VA** |
| **Lighting** | 2469.1 | 0.0 | 0.0 | 1137.1 | 3606.2 | 0.7 | 15353.1 | 1. As per CEC for first 10KVA Diversity factor is 1 & for rest 0.5. 2. However, for emergency lights which run continuously during the emergency, we have considered demand factor 1. |
| **Receptacles** | 17100.0 | 0.0 | 0.0 | 0.0 | 17100.0 |
| **Furnace** | 0.0 | 0.0 | 15113.3 | 0.0 | 15113.3 | 0.5 | 7556.7 | 1. Non continuous load |
| **Condensing Units** | 0.0 | 0.0 | 38862.7 | 0.0 | 38862.7 | 0.5 | 19431.4 | 1. As cooling and heating can not run simultaneously, hence we have considered the demand factor of 0.5 |
| **Baseboard Heaters** | 4123.7 | 10320.0 | 0.0 | 0.0 | 14443.7 | 0.5 | 7221.9 |
| **Exhaust Fan** | 0.0 | 0.0 | 1239.9 | 206.0 | 1445.9 | 1.0 | 1445.9 | 1. Non continuous load |
| **Spare** | 5760.0 | 960.0 | 0.0 | 4320.0 | 11040.0 | 0.6 | 6624.0 | 1. Non continuous load |
| **EV charger** | 0.0 | 0.0 | 7220.0 | 0.0 | 7220.0 | 0.5 | 3610.0 | 1. Non continuous load |
| **Others i.e. dryer, over, CCTV, Fridge, Projector, etc…** | 20476.2 | 0.0 | 0.0 | 60.6 | 20536.8 | 0.4 | 8214.7 | 1. Non continuous load |
| **Fire Pump** | 0.0 | 0.0 | 0.0 | 16531.9 | 16531.9 | 1.0 | 16531.9 | 1. Continuous load |
| **Total** |  |  |  |  | **145900** | 0.6 | **85989** |  |

**Key highlights**

Total Connected load: - 145,900 VA

Total Demand Factor of the building: - 0.6

Total Load Demand: - 85,989 VA

Further calculation for the distribution panels is as below.

# **Distribution Board – 1P Incomer 3, 4W, 175A breaker size calculation**

As per our calculation mentioned in excel sheet named “Panel Board ” (Milestone /Panel Schedule(s)/Panel Schedule.xlsx). The same calculation is as follows,

|  |  |  |
| --- | --- | --- |
|  | Connected Load (VA) | Spare (VA) |
| Phase R |  | 1920 |
| Phase Y |  |  |
| Phase B |  |  |

Table

|  |  |  |  |
| --- | --- | --- | --- |
| Load Summary (VA) | | Diversity | Demand Load |
| Receptacle |  | As per CEC for first Diversity Factor is & for rest |  |
| Lighting |  |
| Other |  |  |  |
| Spare |  |  |  |

Table

Without considering demand factor, the total load and maximum current requirements at distribution board 1P breaker I/C is as following:

|  |  |
| --- | --- |
| Connected Load without considering demand factor | |
| Total Demand (KVA) | 45.8053 |
| Total Demand (Amps) | 127.146 |

Table 3

As per CEC, breaker size should be considered 125% of continuous load current.

The minimum breaker requirement

As per CEC, we decided to go with available breaker size of

## Conductor Sizing

We need bus bar at Distribution board with I/C cable that can handle line current. According to CEC standard, we did the following calculations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Conductor | Ampacity correction factor |  | Size of conductor | Allowable ampere at temperature |
|  |  |  | AWG or kcmil | 60 degrees Celsius |
|  |  |  |  | 240 |

Table

We are considering 3, 4W cable that needs ampacity correction factor of 0.8 as per above table.

As per standards, we are going with 300 kcmil conductor size that can carry 240 (which is greater than ) at degree Celsius.

For 300 kcmil conductor with jacket, conduit size will be 78mm. In addition to that minimum radius to center of conduit is 330. Final design for distribution board – 1P incomer cable is as follows,

|  |  |  |  |
| --- | --- | --- | --- |
| Maximum allowable ampacity | Cable size | Conduit size | Conduit bends |
|  |  |  |  |

Table

# **Distribution Board – 2P Incomer 3, 4W, 40A breaker size calculation**

As per our calculation mentioned in excel sheet named “Panel Board ” (Milestone /Panel Schedule(s)/Panel Schedule.xlsx). The same calculation is as follows,

|  |  |  |
| --- | --- | --- |
|  | Connected Load (VA) | Spare (VA) |
| Phase R-Y-B |  |  |

Table 6

|  |  |  |  |
| --- | --- | --- | --- |
| Load Summary (VA) | | Diversity | Demand Load |
| Receptacle |  | As per CEC for first Diversity Factor is & for rest |  |
| Lighting |  |
| Baseboard Heater |  |  |  |
| Spare |  |  |  |

Table 7

Without considering demand factor, the total load and maximum current requirements at distribution board 2P breaker I/C is as following:

|  |  |
| --- | --- |
| Connected Load without considering demand factor | |
| Total Demand (KVA) | 11.28 |
| Total Demand (Amps) | 31.31106769 |

Table 8

As per CEC, breaker size should be considered 125% of continuous load current.

The minimum breaker requirement

As per CEC, we decided to go with available breaker size of

## Conductor Sizing

We need bus bar at Distribution board with I/C cable that can handle line current. According to CEC standard, we did the following calculations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Conductor | Ampacity correction factor |  | Size of conductor | Allowable ampere at temperature |
|  |  |  | AWG or kcmil | 60 degree Celsius |
|  |  |  |  | 55 |

Table 9

We are considering 3, 4W cable that needs ampacity correction factor of 0.8 as per above table.

As per standards, we are going with conductor size that can carry at degree Celsius.

For conductor with jacket, conduit size will be . In addition to that minimum radius to center of conduit is . Final design for distribution board – 2P incomer cable is as follows,

|  |  |  |  |
| --- | --- | --- | --- |
| Maximum allowable ampacity | Cable size | Conduit size | Conduit bends |
|  |  |  |  |

Table 10

# **Distribution Board – 3P Incomer breaker size calculation**

As per our calculation mentioned in excel sheet named “Panel Board ” (Milestone /Panel Schedule(s)/Panel Schedule.xlsx). The same calculation is as follows,

|  |  |  |
| --- | --- | --- |
|  | Connected Load (VA) | Spare (VA) |
| Phase R-Y |  |  |

Table 11

|  |  |  |  |
| --- | --- | --- | --- |
| Load Summary (VA) | | Diversity | Demand Load |
| Receptacle |  | As per CEC for first Diversity Factor is & for rest |  |
| Lighting |  |
| Condensing Unit | 38862.72 |  |  |
| Exhaust Fan |  |  |  |
| Furnace | 15113.28 |  |  |
| EV Charger | 7220 |  |  |

Table 12

Without considering demand factor, the total load and maximum current requirements at distribution board 3P breaker I/C is as following:

|  |  |
| --- | --- |
| Connected Load without considering demand factor | |
| Total Demand (KVA) | 62.43 |
| Total Demand (Amps) | 173.31 |

Table 13

As per CEC, breaker size should be considered 125% of continuous load current.

The minimum breaker requirement

As per CEC, we decided to go with available breaker size of

## Conductor Sizing

We need bus bar at Distribution board with I/C cable that can handle line current. According to CEC standard, we did the following calculations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Conductor | Ampacity correction factor |  | Size of conductor | Allowable ampere at temperature |
|  |  |  | AWG or kcmil | 60 degree Celsius |
|  |  |  | 500 kcmil | 320 |

Table 14

We are considering , cable that needs ampacity correction factor of as per above table.

As per standards, we are going with conductor size that can carry (which is greater than ) at degree Celsius.

For conductor with jacket, conduit size will be . In addition to that minimum radius to center of conduit is . Final design for distribution board – 3P incomer cable is as follows,

|  |  |  |  |
| --- | --- | --- | --- |
| Maximum allowable ampacity | Cable size | Conduit size | Conduit bends |
|  |  |  |  |

Table 15

# **Distribution Board – U Incomer breaker size calculation**

As per our calculation mentioned in excel sheet named “Panel Board ” (Milestone /Panel Schedule(s)/Panel Schedule.xlsx). The same calculation is as follows,

|  |  |  |
| --- | --- | --- |
|  | Connected Load (VA) | Spare (VA) |
| Phase R-Y-B |  |  |

Table 16

|  |  |  |  |
| --- | --- | --- | --- |
| Load Summary (VA) | | Diversity | Demand Load |
| Receptacle |  | As per CEC for first Diversity Factor is & for rest (As this is emergency panel, it might required to turn on simultaneously in case of emergency. Thus demand factor is considered 1.0) |  |
| Lighting |  |
| Fire Pump |  | In case of emergency, it must be turn on regardless of other loading on the panel. Thus, diversity factor is considered 1.0 |  |
| Others |  |  |  |
| Spare |  | Future load that will connect to emergency bus must remain turn on during the emergency. Thus, demand factor considered on higher side compared to other. |  |

Table 17

Without considering demand factor, the total load and maximum current requirements at distribution board U breaker I/C is as following:

|  |  |
| --- | --- |
| Connected Load without considering demand factor | |
| Total Demand (KVA) | 22.25 |
| Total Demand (Amps) | 61.77 |

Table 18

As per CEC, breaker size should be considered 125% of continuous load current.

The minimum breaker requirement

As per CEC, we decided to go with available breaker size of

However, one of the circuits from the busbar fed to 20 hp fire pump, thus the breaker requirement for that load is . Thus, income breaker of the busbar should be kept as same rating or higher than that.

Final breaker selection for the I/C breaker is .

## Conductor Sizing

We need bus bar at Distribution board with I/C cable that can handle line current. According to CEC standard, we did the following calculations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Conductor | Ampacity correction factor |  | Size of conductor | Allowable ampere at temperature |
|  |  |  | AWG or kcmil | 60 degree Celsius |
|  |  |  | 3/0 | 165 |

Table 19

We are considering , cable that needs ampacity correction factor of as per above table.

As per standards, we are going with conductor size that can carry (which is greater than ) at degree Celsius.

For conductor with jacket, conduit size will be . In addition to that minimum radius to center of conduit is . Final design for distribution board – UPS incomer cable is as follows,

|  |  |  |  |
| --- | --- | --- | --- |
| Maximum allowable ampacity | Cable size | Conduit size | Conduit bends |
|  |  |  |  |

Table 20

# **TR outgoing L.T. bkr to BUS-BAR Chamber breaker size calculation**

As per our calculation mentioned above in section 1. To 4. The total demand in Amps is as follows,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Distribution board - 1P load demand in Amps | Distribution board - 2P load demand in Amps | Distribution board - 3P load demand in Amps | Distribution board - UPS load demand in Amps | Total load demand in Amps |
|  |  |  |  |  |

Table 21

As per CEC, breaker size should be considered 125% of continuous load current.

The minimum breaker requirement

As per CEC, we decided to go with available breaker size of

## Conductor Sizing

We need bus bar at BUS-BAR Chamber with I/C cable that can handle line current. According to CEC standard, we did the following calculations.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Number of Conductor | Ampacity correction factor |  | Size of conductor | Allowable ampere at temperature |
|  |  |  | AWG or kcmil | 60 degree Celsius |
|  |  |  |  |  |

Table 22

We are considering , cable that needs ampacity correction factor of as per above table.

As per standards, we are going with conductor size that can carry (which is greater than ) at degree Celsius.

For conductor with jacket, conduit size will be . Final design for distribution board – UPS incomer cable is as follows,

|  |  |  |
| --- | --- | --- |
| Maximum allowable ampacity | Cable size | Conduit size |
|  |  |  |

Table 23

# **24.9kV/208V (delta/star) transformer sizing for given building**

As per our calculations in section 5., we have considered transformer outgoing L.T. breaker size 300A, 208V.

For above mentioned load requirement, transformer loading can be calculated as follows,

Considering the nearby value, given transformer by utility having rating is ideal.