6. POWER SYSTEM STUDIES

6.1 Short-Circuit Studies

1. Scope of Study

Determine the short-circuit current available at each component of the electrical system and the ability of the component to withstand and/or interrupt the current. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.

2. Procedure


3. Study Report

Results of the short-circuit study shall be summarized in a final report containing the following items:

1. Basis, description, purpose, and scope of the study.

2. Tabulations of the data used to model the system components and a corresponding one-line diagram.

3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment short-circuit ratings.


5. Conclusions and recommendations.
6. POWER SYSTEM STUDIES

6.2 Coordination Studies

1. Scope of Study

1. Determine the extent of overcurrent protective device coordination for the scope:

1. Selective coordination: determine the protective device types, characteristics, settings, or ampere ratings which provide selective coordination, equipment protection, and correct interrupting ratings for the full range of available short-circuit currents at points of application for each overcurrent protective device.

2. Compromised coordination: determine protective device types, characteristics, settings, or ampere ratings which permit ranges of non-coordination of overcurrent protective devices. In this case, overcurrent protective device coordination may be compromised due to the overcurrent protective devices selected or already installed or in order to achieve protection of equipment that is selected or already installed. Objective is to maximize coordination of overcurrent protective devices to extent possible based on the type of devices. Determine protective device characteristics, settings, or sizes which provide a balance between equipment protection and selective device operation that is optimum for the electrical system.

2. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.

2. Procedure

The coordination study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399 and ANSI/IEEE standard 242. Protective device selection and settings shall comply with requirements of the National Electrical Code.

3. Study Report

Results of the coordination study shall be summarized in a final report containing the following items:

1. Basis, description, purpose, and scope of the study and a corresponding one-line diagram.

2. Time-current curves, selective coordination ratios of fuses, or selective coordination tables of circuit breakers demonstrating the coordination of overcurrent protective devices to the scope.

3. Tabulations of protective devices identifying circuit location, manufacturer, type, range of adjustment, IEEE device number, current transformer ratios, recommended settings or device size, and referenced time-current curve.
6. POWER SYSTEM STUDIES

6.2 Coordination Studies (continued)


4. Implementation

The owner shall engage an independent testing firm for the purpose of inspecting, setting, testing, and calibrating the protective relays, circuit breakers, fuses, and other applicable devices as outlined in this specification.
6. POWER SYSTEM STUDIES

6.3 Arc-Flash Hazard Analysis

1. Scope of Study

Determine arc-flash incident energy levels and flash protection boundary distances based on the results of the short-circuit and coordination studies. Perform the analysis under worst-case arc-flash conditions for all modes of operation. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions to the subject system.

2. Procedure

Identify all locations and equipment to be included in the arc-flash hazard analysis.

1. Prepare a one-line diagram of the power system.
2. Perform a short-circuit study in accordance with Section 6.1.
3. Perform a coordination study in accordance with Section 6.2.
4. Identify the possible system operating modes, including tie-breaker positions, parallel generation, etc.
5. Calculate the arcing fault current flowing through each branch for each fault location using empirical formula in accordance with NFPA, IEEE, or other standards.
6. Determine the time required to clear the arcing fault current using the protective device settings and associated trip curves.
7. Select the working distances based on system voltage and equipment class.
8. Calculate the incident energy at each fault location at the prescribed working distance.
9. Determine the hazard/risk category (HRC) for the estimated incident energy level.
10. Calculate the flash protection boundary at each fault location.
11. Document the assessment in reports and one-line diagrams.
12. Place appropriate labels on the equipment.

3. Study Report

Results of the arc-flash study shall be summarized in a final report containing the following items:

1. Basis, method of hazard assessment, description, purpose, scope, and date of the study.
6. POWER SYSTEM STUDIES

6.3 Arc-Flash Hazard Analysis (continued)

2. Tabulations of the data used to model the system components and a corresponding one-line diagram.

3. Descriptions of the scenarios evaluated and identification of the scenario used to evaluate equipment ratings.

4. Tabulations of equipment incident energies, hazard risk categories, and flash protection boundaries. The tabulation shall identify and clearly note equipment that exceeds allowable incident energy ratings.

5. Required arc-flash labeling and placement of labels.

6. Conclusions and recommendations.
6. POWER SYSTEM STUDIES

6.4 Load-Flow Studies

1. Scope of Study

Determine active and reactive power, voltage, current, and power factor throughout the electrical system. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.

2. Procedure

The load-flow study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399.

3. Study Report

Results of the load-flow study shall be summarized in a final report containing the following items:

1. Basis, description, purpose, and scope of the study.
2. Tabulations of the data used to model the system components and a corresponding one-line diagram.
3. Descriptions of the scenarios evaluated and the basis for each.
4. Tabulations of power and current flow versus equipment ratings. The tabulation shall identify percentage of rated load and the scenario for which the percentage is based. Overloaded equipment shall be clearly noted.
5. Tabulations of system voltages versus equipment ratings. The tabulation shall identify percentage of rated voltage and the scenario for which the percentage is based. Voltage levels outside the ranges recommended by equipment manufacturers, ANSI C84.1, or other appropriate standards shall be clearly noted.
6. Tabulations of system real and reactive power losses with areas of concern clearly noted.
7. Conclusions and recommendations.
6. POWER SYSTEM STUDIES

6.5 Stability Studies

1. Scope of Study

Determine the ability of the electrical system’s synchronous machines to remain in step with one another following a disturbance. Provide an analysis of disturbances for all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.

2. Procedure

The stability study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399.

3. Study Report

Results of the stability study shall be summarized in a final report containing the following items:

1. Basis, description, purpose, and scope of the study.

2. Tabulations of the data used to model the system components and a corresponding one-line diagram.

3. Descriptions of the scenarios evaluated and tabulations or graphs showing the calculation results.

6. POWER SYSTEM STUDIES

6.6 Harmonic-Analysis Studies

1. Scope of Study

Determine the impact of nonlinear loads and their associated harmonic contributions on the voltage and currents throughout the electrical system. Provide an analysis of all possible operating scenarios which will be or have been influenced by the proposed or completed additions or changes to the subject system.

2. Procedure

The harmonic-analysis study shall be performed in accordance with the recommended practices and procedures set forth in ANSI/IEEE standard 399.

3. Study Report

Results of the harmonic-analysis study shall be summarized in a final report containing the following items:

1. Basis, description, purpose, and scope of the study.

2. Tabulations of the data used to model the system components and a corresponding one-line diagram.

3. Descriptions of the scenarios evaluated and the basis for each.

4. Tabulations of rms voltages, peak voltages, rms currents, and total capacitor bank loading versus associated equipment ratings. Equipment with insufficient ratings shall be clearly identified for each of the scenarios evaluated.

5. Tabulations of calculated voltage distortion factors, current distortion factors, and individual harmonics versus the limits specified by IEEE standard 519. Calculated values exceeding the limits specified in the standard shall be clearly noted.

6. Plots of impedance versus frequency showing resonant frequencies to be avoided.

7. Tabulations of the system transformer capabilities based on the calculated nonsinusoidal load current and the procedures set forth in ANSI/IEEE C57.110. Overloaded transformers shall be clearly noted.

8. Conclusions and recommendations.