IEEE.1584.1-2022 Update: What Is It and Why Is It Relevant to Me?

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Presentation will start at the top of the hour.

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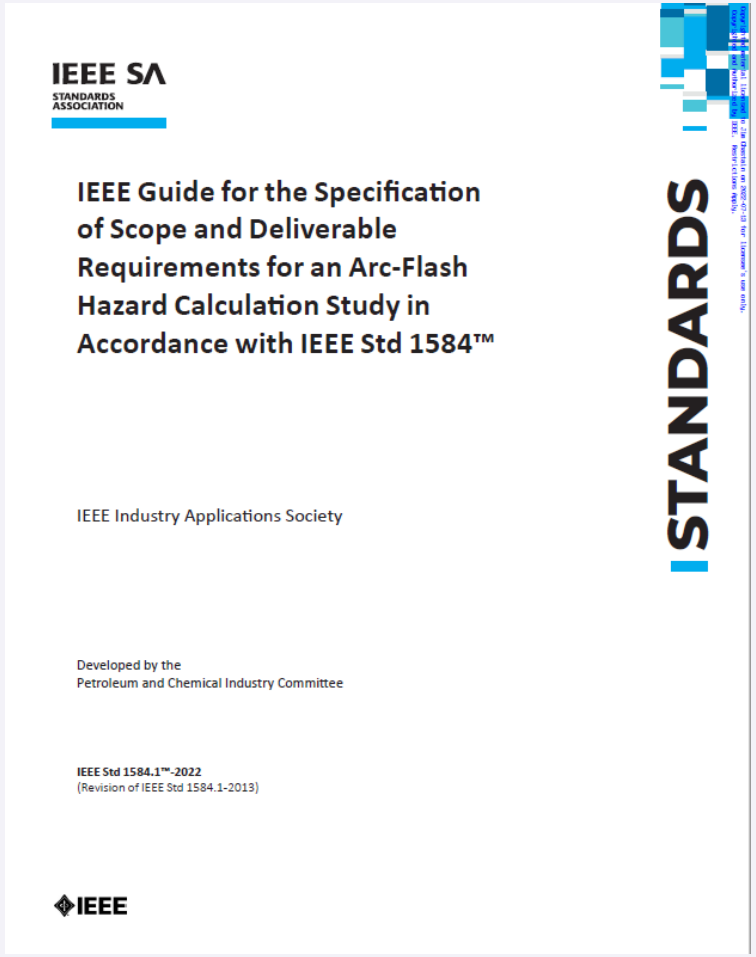
Poll Questions

- 1 Having used 1584-2002 in the past, are you now comfortable using 1584-2018?
- 2 Which correction factors of 1584-2018 do you need to update usually?
- 3 Do you utilize the ‘2 second rule’?

IEEE Std1584.1-2022

- Title:
  - IEEE Guide for the Specification of Scope and Deliverable Requirements for an Arc Flash Hazard Calculation Study in Accordance with IEEE Std 1584



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1.4 Does Not Address

- Arc flash PPE recommendations*
- Label content recommendations*
- Mitigation recommendations*
- Performing short-circuit and coordination studies as long as:
  - 3 phase rms symmetrical bolted fault current
  - Device characteristics to determine arcing duration
- Data verification supplied by owner*
- Evaluation of the suitability of installed equipment vs ratings
- Estimation of arc-flash for:
  - Three phase AC above 15 kV
  - Single phase AC
  - DC systems

4.2 Expanded Bibliography

Bibliography

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

[B1] CSA Z462, Workplace Electrical Safety.[16]

Bibliographical references are resources that provide additional or helpful material but do not need to be understood or used to implement this standard. Reference to these resources is made for informational use only.

[B5] IEEE Std 399™-1997, IEEE Recommended Practice for Industrial and Commercial Power Systems Analysis (*IEEE Brown Book*™).

[B6] IEEE Std 551™-2006, IEEE Recommended Practice for Calculating AC Short-Circuit Currents in Industrial and Commercial Power Systems (*IEEE Violet Book*™).

[B7] IEEE Std 3002.3™-2018, IEEE Recommended Practice for Conducting Short-Circuit Studies and Analysis of Industrial and Commercial Power Systems.

[B8] Mohla, D., W. Lee, J. Phillips, and A. Marroquin, "Introduction to IEEE Standard 1584 – IEEE Guide for Performing Arc-flash Hazard Calculations – 2018 Edition," IEEE Industry Applications Magazine, vol. 26, no. 5, pp. 64–76, September/October 2020, http://dx.doi.org/10.1109/MIAS.2020.2982574.

[B9] NFPA 70E®, Standard for Electrical Safety in the Workplace.[20]

4.3 Typical bus gap and enclosure size

- Data based on actual working distance and enclosure size preferred.
- Typical gap based on lab test set up.
- Actual working distance, conductor gap or enclosure opening preferred, if available.
  - (Table duplicated from 1584-2018)

4.4 Minimum Scope of Work

- All locations to be:
  - Agreed upon by owner and qualified person
  - Could include locations where workers may be exposed to arc flash hazards during:
    - Examination,
    - Adjustment,
    - Servicing ,
    - Or Maintenance of equipment while energized

4.5 Minimum Deliverables

- AF hazard calculation study can include spreadsheet with following for each piece of electrical equipment within scope:

See Annex B for further information on suggested deliverables to be provided by the qualified person performing the arc-flash hazard calculation study.

  - Arcing duration
  - AF boundary distance
  - Incident energy level
  - Working distance

Annex B Suggested Deliverables

Suggested deliverables for arc flash study report

This can be used as an example of a checklist to help define the scope of deliverables for the arc-flash hazard calculation study as well as who is responsible for providing each item. If the owner does not complete the checklist, then the qualified person(s) performing the arc-flash hazard calculation study may clarify responsibilities in their proposal.

Table B.1—Checklist to define scope of deliverables

Task	Owner	Qualified Person Performing the Study	Other (Identify 3rd Party)	Comments
Data Collection (Clauses 4 and 6)				
Current system one-line diagram (Annex A)				
Arc Duration (Clause 8)				
Utility Information (Annex A)				
Bolted fault current data (Clause 7)				
Listing of electrical equipment within the scope of the study (Annex A)				
Determine system modes of operation (Clause 5)				
Review of owner-provided documentation (Clause 4 and Annex A)				
Equipment data collection (Clause 6 and Annex A)				
Data on cables, busway, or other conductors (Annex A)				
Model system or update existing model (A.2)				
Short-circuit analysis (see Clause 7)				
Coordination Analysis (see Clause 8 and Annex C)				
Arc-flash Hazard Calculation Study Report				
Study narrative including description of system modes of operation considered (Clause 10)				
Description of basis of calculations (Clause 10)				

Table continues

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Annex B Suggested Deliverables continued

Suggested deliverables for arc flash study report

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Current system one-line diagram (Annex A)				
Arc Duration (Clause 8)				
Utility Information (Annex A)				
Bolted fault current data (Clause 7)				
Listing of electrical equipment within the scope of the study (Annex A)				
Determine system modes of operation (Clause 5)				
Review of owner-provided documentation (Clause 4 and Annex A)				
Equipment data collection (Clause 6 and Annex A)				
Data on cables, busway, or other conductors (Annex A)				
Model system or update existing model (A.2)				
Short-circuit analysis (see Clause 7)				
Coordination Analysis (see Clause 8 and Annex C)				
Arc-flash Hazard Calculation Study Report				
Study narrative including description of system modes of operation considered (Clause 10)				
Description of basis of calculations (Clause 10)				

Table continues

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Annex B Suggested Deliverables Cont.

Table B.1—Checklist to define scope of deliverables *(continued)*

Task	Owner	Qualified Person Performing the Study	Other (Identify 3rd Party)	Comments
Data to be included in the arc-flash results, including bolted fault current, arcing current, arc duration, incident energy, arc-flash boundary distance, and working distance (Clause 10 and IEEE Std 1584-2018)				
Incident energy reduction considerations (Annexes A and D)				Only if part of the scope
Updated or newly-created system single-line diagram (Clause 10)				
Updated or newly-created power system model (Clause 10)				

5. System modes of operation

- Simple radial may have only 1 mode.
- Complex systems may require more time to accurately model and to run relevant scenarios.
- Individuals familiar with the operating modes and configurations of the system (e.g., owners, operators) should be consulted when selecting the study scenarios.

6. Data required and collection

- The qualified person(s) performing the arc-flash hazard calculation study determines the information required to conduct this study.
  - Previously was 3 pages
  - Now Table A.1 and Annex A for details
    - Example spreadsheet for division of responsibilities

Task Matrix Table A.1

Annex A

(normative)

Task matrix and data collections considerations

A.1 Task matrix of work items for arc-flash hazard calculation study

This task matrix may be used as an example of a checklist (see Table A.1) to help define the scope of work specifically related to gathering data required for the arc-flash hazard calculation study by clarifying which item(s) are required and who may be responsible for gathering or providing this information. If the owner does not complete the checklist, then the qualified person(s) performing the arc-flash hazard calculation study may clarify responsibilities included in the proposal.

Data may be provided on marked-up single-lines or on data sheets supplied by the person providing the arc-flash hazard calculation study. Guidance on conducting system studies or confirmation of the accuracy of information provided is outside the approved scope of this standard. The process and methodology of calculating short-circuit and performing protective-device coordination is covered in standards such as IEEE Std 551 (*IEEE Violet Book*) [B6], IEEE Std 3002.3 [B7], IEC 60909-0 [B2], IEEE Std 242 (*IEEE Buff Book*) [B4], IEEE Std 399 (*IEEE Brown Book*) [B5], and other applicable standards. Follow the guidance in the applicable documents utilized for performing short-circuit studies.

Table A.1—Checklist for data collection and defining scope of work

Task	Owner	Qualified Person Performing Study	Quantity/Other	Comments
General information				
Utility information—Three-phase rms symmetrical bolted fault current including system impedances				If a short-circuit study is required see A.3
Utility protective device for service, including mfg., type, model, ratings, and settings				
Supply transformer with primary/secondary voltages, grounding methods, rating in kVA, percent impedance, nominal operating voltage (if different from transformer rated voltage), and transformer tap information				If a short-circuit study is required and available short-circuit information is not available
Level of incident energy to provide incident energy reduction recommendations				Owner to decide on performance requirements
Determination of the suitability for the potential use of main overcurrent devices located internal to equipment for arc-flash calculations (enclosure isolation) (see C.3)				
Modes of operation to be evaluated				If necessary, attach a document with details
Fuses: size, manufacturer, model				
Circuit breakers: size, manufacturer, model, settings				

Table continues

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Task Matrix Table A.1 cont.

Table A.1—Checklist for data collection and defining scope of work *(continued)*

Task	Owner	Qualified Person Performing Study	Quantity/Other	Comments
Protective relays: manufacturer, model, settings, and CT (current transformer) ratings				
Single-line diagrams				
Available drawing number(s)				
Equipment to be included in the arc-flash hazard calculation study				
Medium-Voltage Equipment (> 1 kV – 15 kV)				
Switchgear				
Switches, fused cutouts, and circuit breakers				
MCC (Motor control centers)				
Power factor correction capacitors, or reactors				
Transformers				
Generators, and generator excitation equipment				
Adjustable speed drives				
Low-Voltage Equipment (≤ 1 kV)				
Switchgear				
Switchboards				
Distribution panels				
Lighting panels				
Misc. power panels				
UPS (uninterruptable power supplies)				
ATS (automatic transfer switches)				
Adjustable speed drives				
Plug-in busways				
Separately mounted fused switches or circuit breakers				
Motor local disconnect switches				
Motor terminal boxes				Not commonly included in the analysis
Industrial control panels and dimensions				
Motor starters (if not integral to an MCC)				
Other				
Study data gathering tasks if short-circuit or coordination studies are required to be performed				
Wire information: material (Al or Cu), cable construction (1/C,3/C), sizes (AWG), raceway type (metallic or non-metallic), conductor lengths, and number of conductors per phase				

Table continues

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Task Matrix Table A.1 cont.

Table A.1—Checklist for data collection and defining scope of work *(continued)*

Task	Owner	Qualified Person Performing Study	Quantity/Other	Comments
Transformer: type, size in kVA (nominal), and percent impedance				
Motor ratings: information needed to establish the short-circuit contribution of the motors				
Generator nameplate data and/or data sheets showing impedance data, etc.				
Copy of existing studies				
Enclosure sizes (See 4.2)				

A.2 Owner-supplied information

The owner to provide to the qualified person(s) performing the arc-flash hazard calculation, study the following data as necessary:

- Available three-phase rms bolted fault current and protective device setting data from the utility
- Single-line diagrams
- Modes of operation and system configuration
- Overcurrent protective device diagrams (fuses, relays, circuit breakers, etc.), settings, if available
- Short-circuit, overcurrent protective device coordination studies, including software data files (libraries, back-up files, etc.), if available

NOTE—Arc-flash hazard calculation studies, including software data files if available, may assist in conducting new arc-flash hazard calculation studies.

A.3 Collection of system data (only if part of the agreed scope)

If the owner and qualified person(s) performing the arc-flash hazard calculation study agree to include collection of system data in the scope of work, the following is applicable. See Annex B for additional details.

All site work should be performed in accordance with the applicable facility safety requirements and applicable electrical safety standards. Field inspections will likely be required to obtain the required electrical equipment data. The following system data, among other items, may need to be collected:

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Fault Current & Arc Duration

- 7. Bolted fault current
  - One input to 1584-2018 model is available three phase rms symmetrical short circuit current.
  - See Clause 10 & Annex B
- 8. Arc duration
  - One input to 1584-2018 model is arc duration.
  - See Annex C for further information

Annex C Arc duration considerations

- C1 Complexity of system
  - Simple system use of TCC curves can be sufficirnt
  - Complex system may require special consideration
    - Differential relaying or optical relaying
    - Table C.1 for breaker opening time estimate is required

Table C.1—Circuit Breaker Operating Times

Circuit breaker rating and type	Opening time at 60 Hz (cycles)	Opening time (seconds)
< 1 kV (molded case) (integral trip)	1.5	0.025
< 1 kV insulated case or power circuit breaker (integral trip or relay operated)	3.0	0.050
Circuit Breakers 1 kV-15 kV	5.0	0.080

C.3 OCPD considerations

- Describes the need to ‘exclude’ main breakers
  - Only an upstream protective device that is isolated from an enclosure can limit incident energy for that enclosure.
  - Note – Consult with manufacturer to confirm if equipment provides isolation between main breaker compartment and other compartments

Additional Considerations

- 9.1 Electrode configurations
  - Evaluate equipment
  - For some equipment it may be possible to use more than one configuration
- 9.2 Enclosure size considerations
  - Refer to Annex G of IEEE 1584-2018
  - Use typical dimensions if actual dimensions not availble

10. Arc-flash study report (2013)

- Report
- Recommendations

10.1 Arc-flash study report

The arc-flash study report should include the following information as a minimum (see Annex D for deliverables checklist with options):

- Executive summary.
- Narrative describing the scope and results of the study and the methodology used.
- Description of modes of operation (power system) and details of the scenarios evaluated.
- Results of short-circuit analysis listing equipment that is applied above its short-circuit current rating, and recommendations if appropriate.
- Results and recommendations of time-current analysis, including time-current curves.
- Arc-flash spreadsheet: A tabulated form including a listing of all equipment that had arc-flash hazard values calculated as part of the study. This listing should include the calculated three-phase bolted fault current, arcing fault current, identity of overcurrent protection device with its opening time, working distance, arc-flash protection boundary, and incident energy.
- A tabulated form showing the worst case incident energy calculated for each bus and the associated mode of power system operation. Report may include incident energy calculated for each bus for each mode of operation.
  NOTE—This may be part of the arc-flash spreadsheet.
- Documentation of all study input data, including utility available fault currents; cable sizes, types, and lengths; motor data; breaker types and settings; fuse sizes and types; etc.
- Up-to-date single-line diagram(s). Optionally, further detailed single-line diagrams including small motors, and 208 V/240 V panelboards may be included for use by maintenance personnel.
- Documentation of the software manufacturer, exact version of software used, and configuration settings used to do the study.
- List of assumptions that were made for cable lengths, CT ratios, transformer impedances, etc.
- Additional information may be included where it enhances understanding of the electrical system and arc-flash study.
- Advisory statements covering the impact of changes to the power system, including overcurrent protective devices or system operation and potential impact on arc-flash incident energies.

10.2 Recommendations

Recommendations should be made to reduce the arc-flash incident energy where reasonably possible. These recommendations can be categorized into three groups based on complexity and cost. The three groups could include:

- Simple: Low cost options such as overcurrent device setting changes or fuse size/type changes.
- Moderate: Moderate cost solutions such as additional overcurrent protection.
- Detailed: Higher cost options such as installing new distribution equipment or retrofitting circuit breakers with new trip units or specialty relay control schemes to reduce arc-flash hazards. Moderate and detailed recommendations do not need to be complete but only address a probable approach to reduce the incident energy exposure. Detailed design is not able to be approximated at the time of specification and therefore cannot be expected to be complete until additional decisions are resolved by the owner and engineer.

10.Arc-flash hazard calculation study report (2022)

The arc-flash hazard calculation study report may be provided in printed and/or electronic format, as agreed upon by the owner and the qualified person performing this study. The following information is suggested to be included in the report:

- Executive summary
- Scope
- Methodology used, including:
  - Other system studies that may have been utilized or performed in conjunction with performing the arc-flash hazard calculation study such as: short circuit and equipment evaluation studies and overcurrent protective device coordination studies
  - Basis of study, including assumptions made
  - Results of the study
- Description of modes of operation of the system and details of the modes evaluated
- All applicable protective devices within the scope of the study
- Arc-flash results: A tabulated form or spreadsheet including a listing of all electrical equipment that had arc-flash hazard values calculated as part of the analysis. Alternative reporting formats may be discussed by the qualified person performing the arc-flash hazard calculations study and the owner.
- For each location, include information as applicable:
  - Equipment identification
  - The three phase rms symmetrical bolted fault current from the short circuit study
  - The calculated arcing current (see 4.9 and 4.10 of IEEE Std 1584-2018)
  - Identification of overcurrent protection device with its clearing time
  - Enclosure dimensions and type (e.g., shallow or typical) (see 9.2)
  - Enclosure size correction factor
  - Electrode configurations used
  - Gap between conductors (actual or default) (see 4.2)
  - Working distance (actual or default) (see 4.2)
  - Incident energy at working distance
  - Arc-flash boundary
  - System mode of operation if applicable
- Documentation of the basis of calculations, such as study input data, including the source of the information (owner-provided, calculated, typical values, etc.):
  - System modes of operation
  - Circuit breaker/relay types, manufacturer, and settings
  - Fuse sizes, types, and manufacturer
  - Equipment types (LV and MV MCCs, switchgear, switchboards, panelboards, etc.), enclosure box sizes, electrode configurations, and gap(s) between conductors
- Some of the items above are suggested for inclusion in the arc-flash spreadsheet. Consideration may be given to organizing the protective devices listed in the output, along with their settings and ratings, based on the enclosure type. This will aid the owner in implementing the results of the study.
- Single-line diagram(s). The single-line diagrams may contain details on all elements within the scope of the arc-flash study as well as names/designations on the one-line diagram(s) consistent with the tabulation of study results shown in the report.
- Documentation of software identification (manufacturer, version, and option settings) used in the arc-flash hazard calculation study

Additional information is provided in Annex B and Table B.1.

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Summary

- Overall limited additional technical data
- Expanded guidelines (spreadsheets) encourage better communication before, during, and after the study.
  - Request for proposal
  - Submitting bids
  - Improved client involvement
  - Potential
    - Reduced cost
    - Better understanding between clients and service providers
    - Improved AF knowledge base of hands-on employees

Thank you for attending

- Get a copy of 1584.1- 2022.
  - https://standards.ieee.org/
- Questions?
- Jim@EasyPower.com

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