

1. INTRODUCTION

This document provides the Tier 1 material of the ESBWR Design Control Document (DCD).

1.1 DEFINITIONS AND GENERAL PROVISIONS

1.1.1 Definitions

The definitions below apply to terms which may be used in the Design Descriptions and associated Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC).

Acceptance Criteria means the performance, physical condition, or analysis results for a structure, system, or component that demonstrates a Design Commitment is met.

Analysis means a calculation, mathematical computation, or engineering or technical evaluation. Engineering or technical evaluations could include, but are not limited to, comparisons with operating experience or design of similar structures, systems, or components.

As-built means the physical properties of the structure, system, or component, following the completion of its installation or construction activities at its final location at the plant site. Determination of physical properties of the as-built structure, system, or component may be based on measurements, inspections, or tests that occur prior to installation provided that subsequent fabrication, handling, installation, and testing do not alter the properties. Many ITAAC require verification of “as-built” structures, systems, or components (SSCs). However, some of these ITAAC will involve measurements and/or testing that can only be conducted at the vendor site due to the configuration of equipment or modules or the nature of the test (e.g., measurements of reactor vessel internals). For these specific items where access to the component for inspection or test is impractical after installation in the plant, the ITAAC closure documentation (e.g., test or inspection record) will be generated at the vendor site and provided to the licensee.

ASME Code means Section III of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. Some Tier 1 ITAAC design commitments in the ESBWR DCD specify that structures, systems, and components be designed and constructed in accordance with ASME Code Section III requirements. When this language is used, it indicates that the ITAAC for that design commitment will be met by satisfying the edition and addenda of the ASME Boiler and Pressure Vessel Code, Section III as specified in the DCD and as incorporated by reference in 10 CFR 50.55a subject to the conditions listed in 10 CFR 50.55a(b), or in accordance with alternatives to paragraphs (b), (c), (d), or (e) of 10 CFR 50.55a as authorized by the NRC pursuant to 10 CFR 50.55a(a)(3).

ASME Code Report means a report required by the ASME Code and whose content requirements are stipulated by the ASME Code. Each such ASME Code report is final, and when required is certified in accordance with the Code.

Cold shutdown means a Safe Shutdown with the average reactor coolant temperature $\leq 93.3^{\circ}\text{C}$ (200°F).

Component as used in Tier 1 for reference to ASME components means that subset of equipment that does not include piping.

Containment means the Reinforced Concrete Containment Vessel (RCCV) and the Passive Containment Cooling System (PCCS) Heat Exchangers, unless explicitly stated otherwise.

Design Commitment means that portion of the Design Description that is verified by ITAAC.

Design Description means that portion of the design that is certified.

Division is the designation applied to a given safety-related system or set of components that enables the establishment and maintenance of physical, electrical, and functional independence from other redundant sets of components.

Equipment as used in Tier 1 as related to ASME Code and Seismic Category I requirements means both components and piping.

Equipment Identification Number or **Equipment Identifier** as used in Tier 1 means the designation on a Tier 1 figure and is not representative of an actual equipment number or tag number.

Equipment Qualification

For purposes of ITAAC:

Environmental Qualification: Type tests, or type tests and analyses, of the safety-related electrical equipment demonstrate qualification to applicable normal, abnormal and design basis accident conditions without loss of the safety-related function for the time needed during and following the conditions to perform the safety-related function. These harsh environmental conditions, as applicable to the bounding design basis accident(s), are as follows: expected time-dependent temperature and pressure profiles, humidity, chemical effects, radiation, aging, submergence, and their synergistic effects which have a significant effect on equipment performance.

As used in the associated ITAAC, the term “safety-related electrical equipment” constitutes the equipment itself, connected instrumentation and controls, connected electrical components (such as cabling, wiring, and terminations), and the lubricants necessary to support performance of the safety-related functions of the safety-related electrical components identified as being subject to the environmental qualification requirements.

Type tests, or type tests and analyses, of the safety-related mechanical equipment demonstrate qualification to applicable normal, abnormal and design basis accident conditions without loss of the safety-related function for the time needed during and following the conditions to perform the safety-related function considering the applicable

harsh environmental conditions. As used in this paragraph, “safety-related mechanical components” refers to mechanical parts, subassemblies or assemblies that are categorized as Quality Group A, B, or C. Mechanical components qualification also may be by type tests, type tests and analyses, or a combination of type tests and analyses of individual parts or subassemblies or of complete assemblies rather than by type testing the individual parts or subassemblies separately. ITAAC address analyses of material data for safety-related mechanical equipment located in a harsh environment.

Safety-related equipment located in a mild environment will be qualified for its environmental conditions through specifications and certifications to the environments; however, for a mild environment, only safety-related digital instrumentation and control equipment will be addressed by ITAAC. Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) susceptibility and emissions qualification is performed by type testing for the safety-related digital instrumentation and control equipment.

ITAAC are located in Section 3.8. to cover environmental qualification for digital instrumentation and control equipment (including digital components in the safety-related electrical distribution system) located in a mild environment. Environmental qualification of safety-related electrical (including I&C equipment) and mechanical equipment in a harsh environment is covered in Section 3.8 ITAAC. Equipment inside containment that supports RTNSS functions is covered in Section 3.8 ITAAC. The scope of equipment located in a harsh environment subject to environmental qualification is identified in a table in Section 3.8. The scope of digital I&C equipment located in a mild environment subject to environmental qualification is determined through the completion of Design Acceptance Criteria ITAAC in Section 3.8.

Seismic Qualification: Type tests, analyses, or a combination of type tests and analyses of the Seismic Category I mechanical and electrical equipment (including connected instrumentation and controls) may be used to demonstrate that the as-built equipment, including associated anchorage, is qualified to withstand design basis dynamic loads without loss of its safety function. Seismic qualification for digital instrumentation and controls equipment is addressed in Section 3.8 ITAAC, with the determination of the scope of equipment being designated as Design Acceptance Criteria. Seismic qualification for mechanical and electrical equipment is addressed in system ITAAC throughout Tier 1. Seismic qualification results are documented in DQDs for both system-based ITAAC and the Section 3.8 ITAAC for digital instrumentation and controls equipment. System-based ITAAC address performance of inspections and analyses to verify equipment seismic qualification is bounded by the testing or analyzed conditions. The “inspections and analyses” include verification that the associated DQD exists and concludes that the as-built equipment is seismically qualified.

Exists, when used in Acceptance Criteria, means that the item is present and meets the design description.

Functional Arrangement/Physical Arrangement (for a Building) means the arrangement of the building features (e.g., floors, ceilings, walls, basemat and doorways) and of the structures, systems, or components within, as specified in the building Design Descriptions.

Functional Arrangement (for a System) means the physical arrangement of systems and components to provide the service for which the system is intended, and which is described in the system Design Description.

Hot shutdown means a Safe Shutdown with the average reactor coolant temperature $> 215.6^{\circ}\text{C}$ (420°F).

Inspect or **Inspection** means visual observations, physical examinations, or review of records based on visual observation or physical examination that compare the structure, system, or component condition to one or more Design Commitments. Examples include, but are not limited to, walk-downs, configuration checks, measurements of dimensions, and non-destructive examinations. Inspections also may include review of design and construction documents including drawings, calculations, analyses, test procedures and results, certificates of compliance, purchase records, and other documents that may verify that the acceptance criteria of a particular ITAAC are met.

Inspect for Retrievability of a display means to visually observe that the specified information appears on a monitor when summoned by the operator.

Operate means the actuation, control, running, or shutting down (e.g., closing, turning off) of equipment.

Reactor Pressure Vessel (RPV) Water Level means the various levels used as reference points for instrumentation ranges. Figure 1.1.1-1 shows the relative location of the defined water levels and the overlap in the level measurement ranges.

Report means, as used in the Acceptance Criteria, a document created by or for the licensee that verifies that the acceptance criteria of the subject ITAAC have been met and references the supporting documentation. Reports typically include but are not limited to: results of walkdowns, results of visual inspections, field measurements, and reviews of design and construction documents. The Functional Arrangement verification report, for ASME Code Section III components or systems, may be or may include an ASME Code report.

Safe Shutdown (generic definition) is a shutdown with:

- (1) The reactivity of the reactor kept to a margin below criticality consistent with Technical Specifications;
- (2) The core decay heat being removed at a controlled rate sufficient to prevent core or reactor coolant system thermal design limits from being exceeded;

- (3) Components and systems necessary to maintain these conditions operating within their design limits; and
- (4) Components and systems, necessary to keep doses within prescribed limits, operating properly.

Safe Shutdown for Station Blackout means bringing the plant to those shutdown conditions specified in plant Technical Specifications as Hot Shutdown or Stable Shutdown.

Stable Shutdown means a Safe Shutdown with the average reactor coolant temperature $\leq 215.6^{\circ}\text{C}$ (420°F) and $> 93^{\circ}\text{C}$ (200°F) (see “safe stable condition” in SECY-94-084 and stable shutdown in ESBWR Generic Technical Specifications).

Test or **Testing** means the actuation, operation, or establishment of specified conditions, to evaluate the performance or integrity of as-built structures, systems, or components, unless explicitly stated otherwise.

Train means a redundant, identical mechanical function within a system. For nonsafety-related systems, redundant trains may share passive components (e.g., piping, supports, manual shutoff valves).

Type Test means a test on one or more sample components of the same type and manufacturer to qualify other components of that same type and manufacturer. A type test is not necessarily a test of the as-built structures, systems, or components.

Verification of the Functional Arrangement of a system, as used in an ITAAC, means verifying that the system is constructed as depicted in the Tier 1 Design Description and figures, including equipment and instrument locations, if applicable.

1.1.2 General Provisions

The following general provisions are applicable to the design descriptions and associated ITAAC.

1.1.2.1 Treatment of Individual Items

The absence of any discussion or depiction of an item in the Design Description or accompanying figures shall not be construed as prohibiting a licensee from utilizing such an item, unless it would prevent an item from performing its safety functions, or impairing the performance of those safety functions, as discussed or depicted in the Design Description or accompanying figures.

If an inspection, test, or analyses requirement does not specify the temperature or other conditions under which a test must be run, then the test conditions are not constrained.

When the term “operate,” “operates” or “operation” is used with respect to an item discussed in the Acceptance Criteria, it refers to the actuation, control, running or shutting down of the item. When the term “exist,” “exists” or “existence” is used with respect to an item discussed in the Acceptance Criteria, it means that the item is present and meets the Design Description.

1.1.2.2 Implementation of ITAAC

Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) are provided in tables with the following three-column format:

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
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Each Design Commitment in the left-hand column of the ITAAC tables has an associated requirement for Inspections, Tests or Analyses (ITA) specified in the middle column of the tables. The identification of a separate ITA entry for each Design Commitment shall not be construed to require that separate inspections, tests, or analyses must be performed for each Design Commitment. Instead, the activities associated with more than one ITA entry may be combined, and a single inspection, test, or analysis may be sufficient to implement more than one ITA entry.

An ITA may be performed by the licensee of the plant or by its authorized vendors, contractors, or consultants. Furthermore, an ITA may be performed by more than a single individual or group, may be implemented through discrete activities separated by time, and may be performed at any time prior to fuel load (including before issuance of the Combined License for those ITAAC that do not require as-built equipment). Additionally, ITA may be performed as part of the activities that are required to be performed under 10 CFR 50 (including, for example, the Quality Assurance (QA) program required under Appendix B to Part 50). Therefore, an ITA need not be performed as a separate or discrete activity.

For the Acceptance Criteria, appropriate documentation may be a single document or a collection of documents that show that the stated Acceptance Criteria are met. Examples of appropriate documentation include design reports, test reports, inspection reports, analysis reports, evaluation reports, design and manufacturing procedures, certified data sheets, commercial dedication

procedures and records, quality assurance records, calculation notes, and equipment qualification data packages.

An entry in the ITA column of the ITAAC tables include the words “Inspection will be performed for the existence of a report verifying...” When these words are used it indicates that the ITA is tests, type tests, analyses, or a combination of tests, type tests, and analyses and a report will be produced documenting the results. This report will be available for inspection.

For those nonsystem-based ITAAC, which address piping and equipment qualification, the ITA and Acceptance Criteria may be satisfied on a system-by-system basis so as not to delay completion of ITAAC for a particular system. In this manner, a system may be turned over for operation following verification of the information needed to satisfy the nonsystem-based ITAAC. Documentation of completion of the ITAAC for a particular system will be retained in a manner that will allow verification of completion of the ITAAC for the nonsystem-based ITAAC. Notification to the NRC of completion of the nonsystem-based ITAAC may be on a system basis throughout construction and should be discussed with the NRC whether notification should be provided. Notification to the NRC will be made upon final completion of the nonsystem-based ITAAC for purposes of ensuring that the Acceptance Criteria have been met.

The Acceptance Criteria are generally stated in terms of a value with and acceptable range, or with a values that is either a minimum or maximum. For these ITAAC, the acceptance criteria for performing the ITAAC will be as stated in the Acceptance Criteria. In some cases, the Acceptance Criteria are stated in terms of nominal values without an acceptable range. For these ITAAC, the acceptable range will be determined at the time of performing the ITAAC.

1.1.2.3 *Discussion of Matters Related to Operations*

In some cases, the Design Descriptions in this document refer to matters that relate to operation, such as normal valve or breaker alignment during normal operation modes. Such discussions are provided solely to place the Design Description provisions in context (e.g., to explain automatic features for opening or closing valves or breakers upon off-normal conditions). Such discussions shall not be construed as requiring operators during operation to take any particular action (e.g., to maintain valves or breakers in a particular position during normal operation).

1.1.2.4 *Interpretation of Figures*

In many but not all cases, the Design Descriptions in Section 2 include one or more figures, which may represent a functional diagram, general structural representation, or another general illustration. For instrumentation and control systems, the figures also represent aspects of the relevant logic of the system or part of the system. Unless specified explicitly, these figures are not indicative of the scale, location, dimensions, shape, or spatial relationships of as-built structures, systems, or components. In particular, the as-built attributes of structures, systems, or components

may vary from the attributes depicted on these figures, provided that those safety functions discussed in the Design Description pertaining to the figure are not adversely affected.

1.1.2.5 *Rated Reactor Core Thermal Power*

The initial rated reactor core thermal power for the standard ESBWR is 4500 megawatts thermal (MWt).

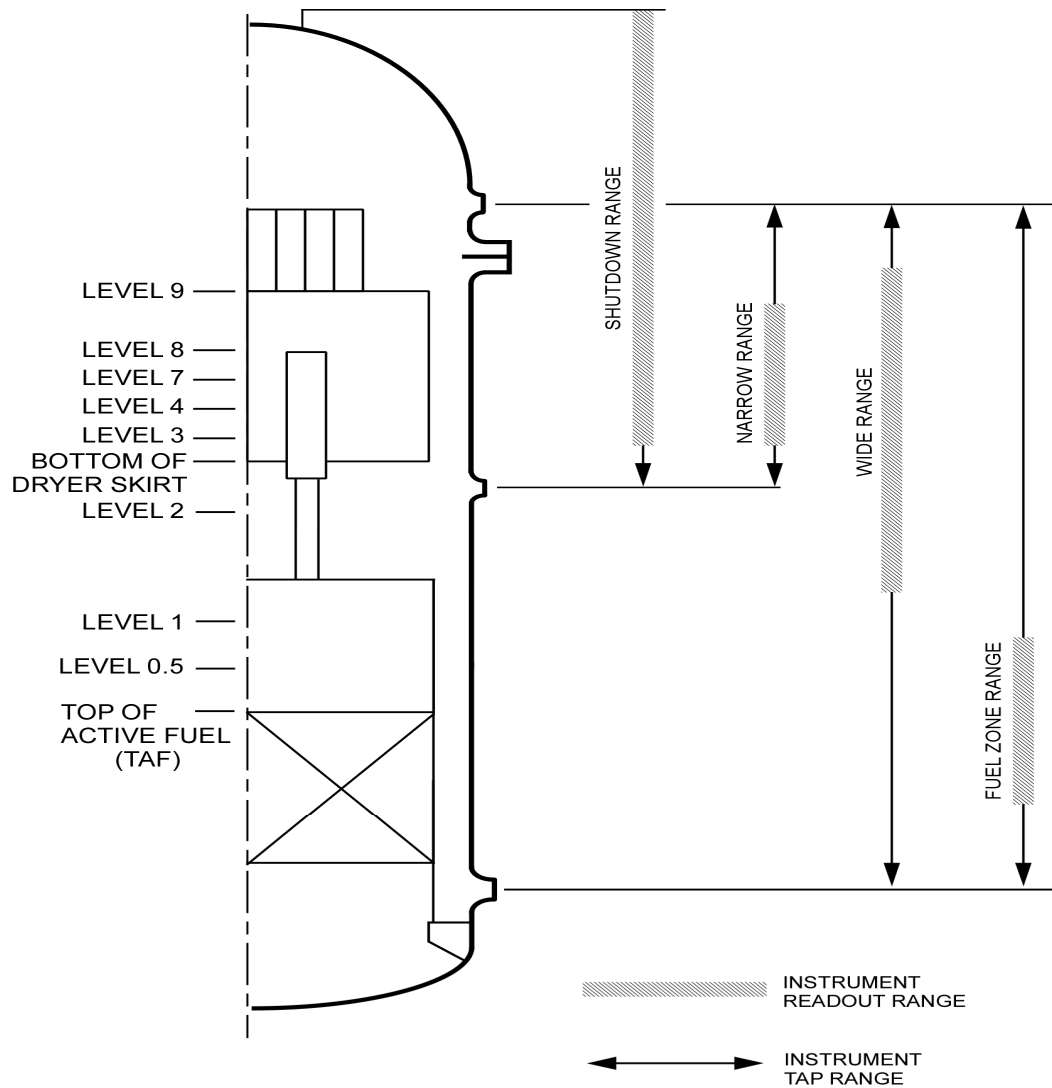


Figure 1.1.1-1 RPV Water Level Range Definition

1.2 FIGURE LEGEND

Certain Tier 1 sections include figures described in the design description. Figure legends are provided in Figures 1.2-1 and 1.2-2 for certain symbols used in system functional arrangement diagrams. The figure legend is provided for information and is not part of the Tier 1 Material. Many of the Tier 1 figures identify specific equipment and may include figure specific legends. Electrical and building drawings contain figure-specific legends and equipment nomenclature. Other figures may be labeled as necessary to explain the content of the figure.

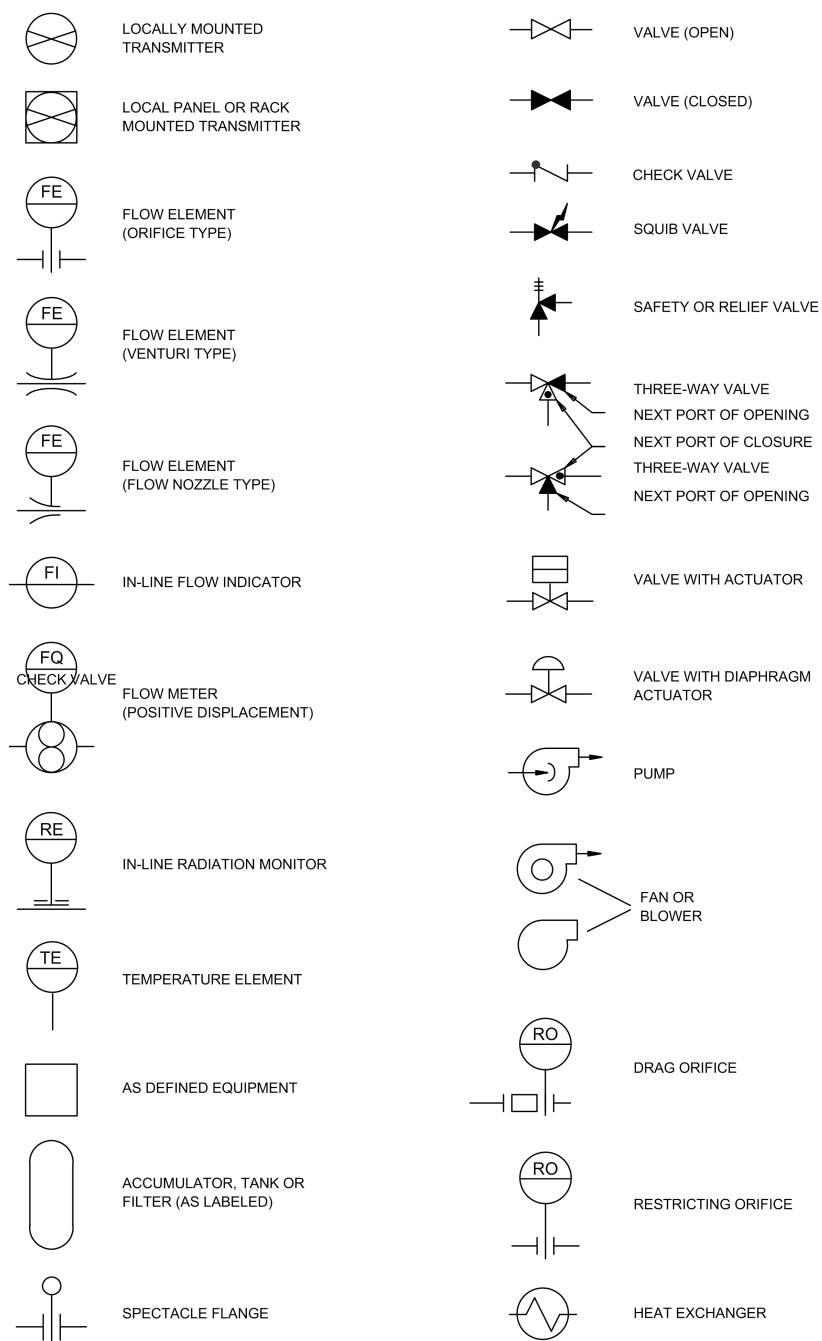


Figure 1.2-1. Legend for Tier 1 System Diagrams

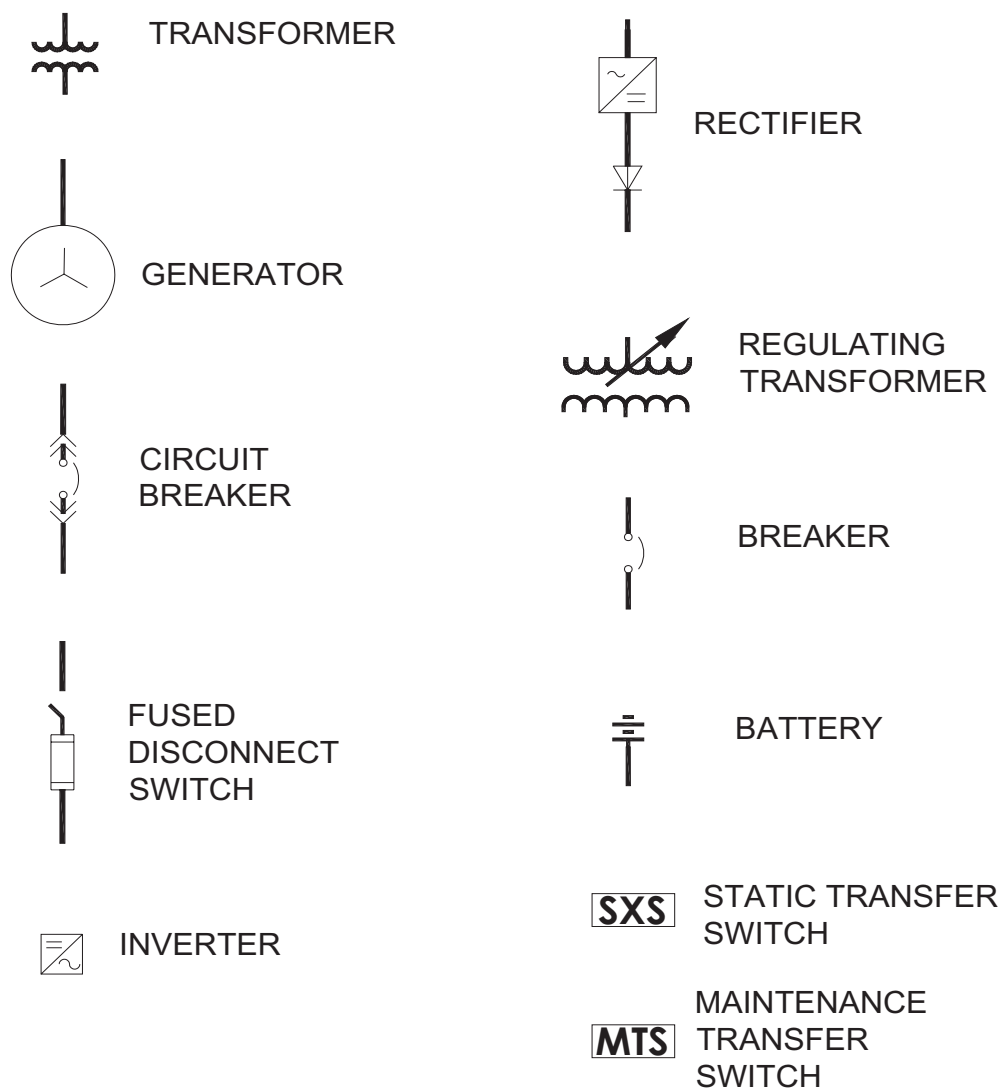


Figure 1.2-2. Legend for Tier 1 Electrical System Diagrams

1.3 TABLE LEGEND

A dash (-) in a table column means “not applicable”.

1.4 DESIGN ACCEPTANCE CRITERIA

Design Acceptance Criteria are a special type of ITAAC that set forth the processes and acceptance criteria for completing portions of design. These are designated as “{{Design Acceptance Criteria}}” in the two right columns of the ITAAC tables where appropriate.