# Appendix 3F Cable Trays and Cable Tray Supports

This appendix provides the design criteria for seismic Category I cable trays and their supports. Seismic Category II cable trays and their supports are also designed utilizing the design criteria of this appendix.

## 3F.1 Codes and Standards

The design of cable trays and their supports conform to the following codes and standards:

- American Iron and Steel Institute (AISI), Specification for the Design of Cold Formed Steel Structural Members, 1996 Edition and Supplement No. 1, July 30, 1999
- American Institute of Steel Construction (AISC), Specification for the Design, Fabrication and Erection of Steel Safety Related Structures for Nuclear Facilities, AISC-N690-1994
- Institute of Electrical and Electronic Engineers (IEEE), Standard 344-1987, IEEE Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations
- National Electrical Manufacturers Association (NEMA), Standard Publication No. VE 1-1998, Metallic Cable Tray Systems

## 3F.2 Loads and Load Combinations

### 3F.2.1 Loads

#### 3F.2.1.1 Dead Load (D)

Dead load includes the weight of the cable trays, their supports and the cables inside the trays and any permanently attached items. Temporary items used during construction or maintenance are removed prior to operation.

It also includes the weight of

- Cable tray covers and
- Other components and fittings

#### 3F.2.1.2 Construction Live Load (L)

Live load consists of a load of 250 pounds to be applied only during construction on the tray at a critical location to maximize flexural and shear stresses. This load is not combined with seismic loads.

#### 3F.2.1.3 Safe Shutdown Earthquake ($E_S$)

Seismic response of the cable trays and their supports are produced due to seismic excitation of the supports.

#### 3F.2.1.4 Thermal Load

These loads are usually not considered and trays are provided with expansion joints in accordance with NEMA.

#### 3F.2.2 Load Combinations

The following load combinations are used for designing the cable trays and their supports:

(a) D + L

(b) D + $E_s$

### 3F.3 Analysis and Design

Cable trays and their supports are designed to maintain structural integrity. The stresses are maintained within the allowable limits as specified in Subsection 3F.3.3. Section properties and weights of the trays are obtained from manufacturer's data.

#### 3F.3.1 Damping

The maximum damping ratio is 10 percent unless the configuration is demonstrated to be similar to that of the tests described in (Reference 19) of Subsection 3.7.6.

As stated in Subsection 3.7.1.3, the damping ratio used for the AP1000 cable tray systems may be based on test results presented in Reference 19 (Subsection 3.7.6). The cable tray test program conducted by ANCO Engineers Inc. included more than 2000 dynamic tests of representative cable tray system design and construction. The test configurations included items such as various tray types on rigid supports, various tray hanger systems, effects of tray types, effects of strut connections and effects of bracing spacing, unbraced and braced tray systems. Cable ties were also used during the test program. Based on observations during the tests, the high damping values within the cable tray system are provided mainly by the movement, sliding or bouncing of the cables within the tray. The tests show that, for unloaded trays, the damping ratio closely approximates the 7 percent used for bolted structures, and a minimum damping value of 20 percent is maintained with cable ties at spacing greater than or equal to four feet. The tests show that for loaded trays, the damping ratio increases with increased cable loading, reaching a value of 30 percent at cable fill ratio of 50 percent to 100 percent. The major factors which affect the damping ratio of the cable tray systems are the input acceleration level, cable fill ratio, and the ability of the cables to move within the trays during a safe shutdown earthquake.

The AP1000 cable tray system design requires no sprayed-on material for fire protection. Cable ties are provided at spacing greater than 4 feet, thereby permitting cable movement within the trays. The damping ratio used for the cable tray system is dependent on the level of seismic input and the amount of cable fill within the trays. As shown in Figure 3.7.1-13, the 20 percent constant damping ratio may be used for trays loaded to more than 50 percent and subjected to input floor acceleration greater than 0.35g. For cable trays loaded to less than 50 percent and lower than 0.35g input floor acceleration, linearly interpolated lower damping values may be used.

#### 3F.3.2 Seismic Analysis

The methodology for seismic analysis is provided in Subsection 3.7.3. Seismic loads are determined by either using the equivalent static load method of analysis or by performing dynamic analysis.

Stresses are determined for the seismic excitation in two horizontal and one vertical direction. The stresses in the three directions are combined using the square root of the sum of the squares (SRSS) method or the 100-40-40 method as described in Subsection 3.7.3.6.

### 3F.3.3 Allowable Stresses

The basic stress allowables for the cable trays are based on the American Iron and Steel Institute specification. The basic stress allowables for cable tray supports utilizing light gage cold rolled channel type sections are based on the manufacturer's published catalog values. The basic stress allowables for cable tray supports utilizing rolled structural shapes are in accordance with ANSI/AISC N-690 and the supplemental requirements described in Subsection 3.8.4.5.2.

The allowable stresses for the load combinations are as follows:

| | |
|---|---|
| D + L | Basic Allowable |
| D + $E_s$ | 1.6 times basic allowable for tension and 1.4 times basic allowable for compression |

### 3F.3.4 Connections

Connections are designed in accordance with the applicable codes and standards listed in Section 3F.1. For connections used with light gage cold rolled channel type sections, design is based on the manufacturer's published catalog values. Supports are attached to the building structure by bolted or welded connections. Fastening of the supports to concrete structures meets the supplemental requirements given in Subsection 3.8.4.5.1.