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# The facts on field modification of UL Classified wire mesh cable tray

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Recent concerns have been raised in the field and in the trade press as to whether modifications, including tees, bends, and offsets, of wire-basket cable tray such as that manufactured by the Legrand/Cablofil company can be performed in the field without creating a violation of the National Electrical Code or sacrificing its UL Classification. Provided the work is performed in accordance with the relevant installation instructions, the answer is "Yes" in most cases.

### General Information

Cable tray must be primarily understood not as a wiring method, but instead as a mechanical support for other Chapter 3 wiring methods. There are exceptions to this that will be discussed subsequently, but the primary use is for wiring support. This concept is addressed in the definition of the subject as found in NEC 392.2:

> **Cable Tray System.** A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.

Cable trays are therefore defined as structural systems that fasten or support cables or raceways. To do this they employ one or more units or sections, assembled with associated fittings. The term "fitting" is defined in Article 100 as follows:

> **Fitting.** An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

Although many NEC provisions recognize the use of fittings for electrical functions, such as bonding, they do not have non-mechanical functions unless and to the extent provisions in the NEC recognize those functions. A classic example involves locknuts used to mechanically secure conduit to enclosures. This is a primarily mechanical function, but if performed in accordance with 250.12 (paint removed separately or by action of the locknut tangs in these cases) and made tight in accordance with 250.120(A) with suitable tools, the locknuts are permitted to establish grounding continuity. Note also that if the circuit voltage-to-ground exceeds 250, 250.97 generally disallows this electrical function except in instances where additional qualifications have been complied with, as covered in the exception that follows.

### Construction Requirements

As assembled, cable tray systems must comply with 392.5, both out of the box and after any modifications have been performed.

> **392.5 Construction Specifications.**
>
> **(A) Strength and Rigidity.** Cable trays shall have suitable strength and rigidity to provide adequate support for all contained wiring.
>
> **(B) Smooth Edges.** Cable trays shall not have sharp edges, burrs, or projections that could damage the insulation or jackets of the wiring.
>
> **(C) Corrosion Protection.** Cable tray systems shall be corrosion resistant. If made of ferrous material, the system shall be protected from corrosion as required by 300.6.
>
> **(D) Side Rails.** Cable trays shall have side rails or equivalent structural members.
>
> **(E) Fittings.** Cable trays shall include fittings or other suitable means for changes in direction and elevation of runs.
>
> **(F) Nonmetallic Cable Tray.** Nonmetallic cable trays shall be made of flame-retardant material.

Manufacturers in this market including Cablofil publish loading tables for its wire-basket tray and if these limitations are complied with, including the installation provisions in their literature governing field modifications, the tray can be expected to retain its rigidity so as to provide the intended support for the installed wiring. Note that the existence (or lack of it) of a UL classification mark has no relevance to a finding of suitability for this purpose, as covered later in this report. Only data from the manufacturer and other standards can be used for this purpose.

AUGUST 2010

# WHITE PAPER

## The facts on field modification of UL Classified wire mesh cable tray

Some published information by competitors shows completed wire-basket trays with unprotected cut ends, which clearly violate 392.5(B). It is important to recognize that such practice does not accord with the installation instructions that are provided with this tray. These instructions clearly specify the use of a side-action bolt cutter placed directly adjacent to a welded member running at right angles to the cut. The result is not a spear-point end, but rather a protected cut with the cut surface sloping away from any cable exposure. In the event that an exposed end is left by mistake, the wire can be cut back or a protector can be applied to the end.

Wire-basket cable trays are generally available in corrosion-resistant forms. Cablofil tray is a good example, being available in two grades of stainless steel, as well as both electroplated and hot-dipped galvanized steel and painted configurations, so the installer can easily select a style that is appropriate for the atmosphere. Wire-basket trays, essentially by definition, all contain side rails as part of their construction.

The last topic in 392.5, covering fittings, has been the focus of some competitive discussion relative to whether a field fabricated bend with the rear-ranged steel ribs secured with metal closures meets these requirements. Referring to the discussion of the NEC defined term "fitting" at the outset of this report, it is clear that this hardware, as surely as a locknut, lines up very well with this definition. In fact, the prefabricated bends, tees, and crosses provided by some competitors are arguably additional sections of tray, and not fittings at all. Those competitive sections of tray, just as straight runs of the Cablofil and comparable product lines that are extended end-to-end, are then joined with comparable hardware items, all of which are equally classified as fittings and duly accord with this paragraph.

**UL Classification: What does it mean? What doesn't it mean?**

As just noted, where cable trays must change direction or elevation, fittings or other suitable means must be provided with the tray system to accomplish these installation details. In the case of Cablofil and comparable trays, the fittings provided for these purposes are themselves classified by UL. It would be difficult to understand why UL would classify these splicing components for field-modified cable tray if it were to be understood that field-modifying a tray voided a UL classification applicable to the tray itself. Actually, however, the UL classification has nothing to do with the mechanical features or load bearing qualities of the tray, and therefore the status of a classification is entirely irrelevant to a decision about mechanical features of a given cable tray installation. The authority having jurisdiction must review published data from the manufacturer and other sources in order to make a fair approval decision.

Many are confused by the classification marking. Cable tray is only available as a classified product and not as a listed product. This distinction is crucial because a listing denotes general suitability for a particular field application; whereas classification means it has been evaluated for one or more very specific application details. The particular details addressed in a classification are set forth in the guide card information that goes with the product category, in this case "Cable Trays (CYNW)." This information (in relevant part) is as follows:

**USE**

This category covers cable trays intended for assembly in the field and for use in accordance with Article 392 of ANSI/NFPA 70, "National Electrical Code" (NEC). They have been Classified as to their suitability for use as equipment grounding conductors in accordance with Sections 392.3(C) and 392.7(B) of the NEC. The cable trays are marked on the outer surface of the sidewall of the tray indicating the cross-sectional area of the grounding metal.

**INSTALLATION**

Cable tray assemblies have been investigated for bonding between sections using the minimum hardware provided by the manufacturer. The manufacturer may supply cable tray sections and fittings without a

# WHITE PAPER

## The facts on field modification of UL Classified wire mesh cable tray

positive mechanical means for completing the grounding connection. Assemblies not provided with positive mechanical grounding connections are intended to be bonded with mechanical connectors or bonding jumpers provided by the installer, in accordance with 392.7(B)(4) of the NEC.

**UL MARK**

The Classification Mark of Underwriters Laboratories Inc. on the product is the only method provided by UL to identify products manufactured under its Classification and Follow-Up Service. The Classification Mark for these products includes the UL symbol, the word "CLASSIFIED" above the UL symbol (as illustrated in the Introduction of this Directory), and the following additional information:

**CABLE TRAY**
**AS TO ITS SUITABILITY AS AN**
**EQUIPMENT GROUNDING CONDUCTOR ONLY**
**Control No.**

This makes it very clear that the extent of the classification markings on cable tray components only address equipment grounding performance and nothing else. It is therefore impossible to compromise a cable tray classification based on field installation criteria unless the cable tray is to be used as an equipment grounding conductor. This is an unusual condition, covered at the end of this analysis.

### Other Standards Apply

Further guidance on the subject of installation provisions, including field bends and joints, is provided by the applicable NEMA Standard, VE 2-2006. Paragraph 4.5.2 (and the associated drawing 4.33B) shows cuts to wire mesh trays with offset bolt cutters, as also required in the Cablofil installation directions. In addition, Paragraph 4.5.5 ("Wire Mesh Fittings Fabrication") shows field horizontal bends, gradual sweeps formed from the removal of alternating segments of the floor of the tray, half-ninety elbows formed in the same way, as well as tees, crosses, drops, risers, and reducers. Each of these drawings lines up with the Cablofil and similar installation directions.

It is apparent that conventional field splicing procedures for wire-basket cable tray that are performed in accordance with the installation instructions provided by their manufacturer and using the splicing components so specified can meet the provisions of 392.5. The final decision depends on the judgment of the authority having jurisdiction applying the specific provisions of that section. However, any decision regarding loading suitability or other mechanical criterion should be based on the actual workmanship and adherence to manufacturing design that was observed in the field. It should never rely on some blanket enforcement of a necessarily non-existent UL listing, or even the far more limiting coverage of the UL Classification.

### Bonding and Grounding

The other area of concern is covered in NEC 392.7. This section is comprised of two paragraphs, which address two very different issues that need to be considered separately. The first applies to metallic tray generally, whether or not it will be used as an equipment grounding conductor. This part requires conductive tray to be bonded as if it were an enclosure as required in 250.96, and also as required by Part IV of Article 250. Beginning with the 250.96 reference [of which only (A) is relevant in this context] the text is:

**(A) General.** Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non–current-carrying parts that are to serve as equipment grounding conductors, with or without the use of supplementary equipment grounding conductors, shall be bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings designed so

# WHITE PAPER

## The facts on field modification of UL Classified wire mesh cable tray

> as to make such removal unnecessary. {The word "equipment" as underlined above is being added to the 2011 NEC for clarification; it does not appear in the 2008 NEC.}

This requirement is a bonding requirement located in Part V of Article 250 ("Bonding") and it applies to the function of a cable tray as an equipment grounding conductor. The 2011 NEC clarification makes this even clearer. The equipment grounding aspect of cable tray usage will be covered later in this report. Suffice it to say at this juncture, no provision in the NEC requires a cable tray to serve as an equipment grounding conductor. This is a design option provided in 392.3(C), and is conditional on compliance with all parts of 392.7, as well as the additional requirement that "Metallic cable trays shall be permitted to be used as equipment grounding conductors where continuous maintenance and supervision ensure that qualified persons service the installed cable tray system ..."

However, cable trays are required to be connected to the grounding conductor(s) of any supply circuits through the inclusion of the Article 250, Part IV reference. In the case of a cable tray used for service conductors, 250.80 requires that the connection must be to the grounded service conductor (grounded systems) or to the grounding electrode conductor (ungrounded systems). In the case of tray used for branch circuits or feeders, 250.86 requires that the connection be made to the equipment grounding conductor(s) of the circuits that energize the enclosed cables.

These connections are easily made at the originating and terminating enclosures at each end of the tray. The NEC is unclear as to whether intermediate connections must be made, and under what circumstances. If the tray supports make frequent connections to building steel that has been properly bonded in accordance with 250.104(C) or 250.104(D)(2) as applicable (and to which the enclosed grounding conductors are ultimately bonded as required in other NEC articles), then additional bonding serves no purpose. Where such connections are not made, one simple approach is to extend the largest relevant grounding conductor from end-to-end, picking up any sections that were cut [or isolated; remember that cable tray can be discontinuous as covered in 392.6(A)] for field installation problems.

That protocol would be sufficient where the tray supports cable assemblies with their enclosed equipment grounding conductors, because such tray applications are not considered to be likely to become energized. This is because a combination of at least two failures (cable jacket and conductor insulation) must both occur in order to energize the tray. However, in the unusual event that the tray supported individual conductors, as only permitted for industrial occupancies with qualified maintenance and supervision, the tray should be considered likely to become energized, and the periodic bonding should comply with the note to Table 250.122 because energized tray that did not promptly open an overcurrent device under the conditions cited [See 250.4(A)(5) and 250.4(B)(4)] could lead to catastrophic results. This would mean making an engineering judgment relative to the impedance of the steel members of the tray (frequently higher than that of the applicable equipment grounding conductor.

Cablofil has published a recommendation in this regard, suggesting a range of 50 to 65 feet as the maximum unbonded length of wire mesh cable tray that is appropriate under these circumstances. This could be subject to additional engineering evaluation, since the size of the tray and the number and size of the longitudinal steel members will influence the impedance of the potential fault path. In addition, the size and characteristics of the relevant overcurrent protection are also factors in the speed of fault clearing. Although not directly relevant here, Table 392.7(B) is another example of this principle at work.

**Cable Tray as an Equipment Grounding Conductor**

We now come to the unusual instance where a cable tray installation is to be relied upon as the equipment grounding conductor. The NEC parameters for the tray in this context occur in 392.7(B), and set different overcurrent protective device limitations

# WHITE PAPER

## The facts on field modification of UL Classified wire mesh cable tray

ahead of such a tray based on the impedance of the tray, tabulated on the basis of tray material and its cross-sectional area.

In general, cable trays support Chapter 3 wiring methods, and these wiring methods virtually always include an equipment grounding conductor either by NEC rule or the relevant product standard, or both. Therefore in order for the tray to actually be a required equipment grounding conductor it must support single conductors (limited to a minimum of 1/0 AWG in industrial occupancies with qualified maintenance and supervision) and there must be no separate equipment grounding conductor run in or along the tray (the usual engineering specification in such cases). Very few cable trays are installed in this way, and it would be almost unheard of for a wire-basket tray to be so applied.

However, in the event that all the conditions apply, then the UL classification becomes directly relevant and must be applied without exception. As noted in the excerpt from the UL White Book, the tray is marked on the outer surface of the sidewall with the cross-sectional area of the longitudinal metal members, and this number must be taken into Table 392.7(B) to determine the suitability of the tray for use in the context of the maximum overcurrent device setting that applies to the circuits contained within the tray. When any of those members are cut to reconfigure a portion of the tray, the UL classification is necessarily invalid for that portion.

In such cases, some manufacturers have pre-fabricated assemblies that produce tees or other directional changes for an installation, and fully maintain the equipment grounding continuity of and grounding return path. If an installer chooses to avoid the use of a separate equipment grounding conductor in his tray, then he can choose such a manufacturer. The NEC never precludes the use of installation techniques that go beyond its minimum requirements. Alternatively, an installer always has the option of bonding the various segments of the tray together using bonding jumpers sized in accordance with 250.102 as covered in 392.7(B)(4).

The last sentence of the last installation paragraph of the UL Guide Card provisions (quoted in full above) expressly allows this, stating that "the manufacturer may supply cable tray sections and fittings without a positive mechanical means for completing the grounding connection." Remember that the UL classification remains fully valid for all undisturbed portions of the tray.

This clearly means that conventional wire-basket tray applications can be modified with bonding connections provided in the field without compromising the tray classification. Enforcement actions by authorities having jurisdiction that do not accord with these provisions of the classification provisions set forth by the very testing laboratory that promulgated them are incorrect.

Very truly yours,

Frederic P. Hartwell,
President