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TECHNICAL ASSESSMENT:

CARLON
ELECTRICAL NONMETALLIC TUBING,
RIGID NONMETALLIC CONDUIT,
LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT AND
NONMETALLIC ELECTRICAL OUTLET BOXES
IN FIRE-RESISTANCE RATED WALLS AND FLOOR-CEILING ASSEMBLIES

For
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1.0. INTRODUCTION

This report provides a technical – engineering application describing the fire performance of a variety of Carlon electrical products in construction assemblies commonly found in fire resistive construction.

The specific Carlon products and applications addressed in this report are listed below:

1.1. Electrical Nonmetallic Tubing: Carlon Flex-Plus® Blue™ ENT.
1.2. Rigid Nonmetallic Conduit (RNC): Carlon Schedule 40.
1.3. Liquidtight Flexible Nonmetallic Conduit (LFNC-B): Carlon Carflex®.
1.4. Carlon's (Zip Box®)Nonmetallic Electrical outlet and switch boxes in fire-resistance rated walls and floor-ceiling assemblies
   1.4.1. Outlet Boxes
      1.4.1.1. Single, two, three and four-gang nonmetallic electrical outlet boxes used in fire-resistance rated walls
      1.4.1.2. Four inch square nonmetallic electrical outlet boxes and box extenders used in fire-resistance rated walls
   1.4.2 Ceiling Boxes
      1.4.2.1 4" Diameter or less nonmetallic electrical ceiling box used in fire-resistance rated floor-ceilings
      1.4.2.2 Single-gang nonmetallic electrical ceiling box used in fire-resistance rated floor-ceilings
   1.4.3 Floor Boxes – Single and two-gang nonmetallic electrical outlet boxes used in fire-resistance rated floor-ceiling assemblies

This report provides information and guidance based on standard fire endurance testing of typical non-combustible and combustible fire resistive walls and floor ceilings as commonly found and used in building types I thru IV. Because such assemblies designed and built for use in the field rarely are *identical* to a tested assembly, interpretation of the information in this report is necessary in virtually all cases to an assembly actually being built. For that reason, a discussion to assist in such interpretations is provided in section 3.7 of this report.

It is the objective of this report to provide necessary information and due diligence review of relevant fire performance properties which are of interest to building officials, fire officials, designers, architects and contractors involved with use of these products. The specific applications addressed in this report include installation and use of the Carlon products listed above in fire-resistive floor-ceiling assemblies and other fire-resistive constructions including fire rated walls.

2.0. DESCRIPTION

2.1. Carlon Nonmetallic Tubing and Conduit Products Addressed

The specific applications incorporating Carlon raceway products described below are addressed in this report:

2.1.1. General.
Carlon electrical nonmetallic tubing, rigid nonmetallic conduit and liquidtight flexible nonmetallic conduit described in this report shall be used in noncombustible and combustible, fire resistive load bearing and non-load-bearing walls and floor-ceiling assemblies. As demonstrated by the fire tests, use of the tubing and conduit in assemblies will not affect the fire-resistive assembly rating when installed within the limits prescribed by this report.

2.1.2. Electrical Nonmetallic Tubing Described
The Carlon Flex-Plus® Blue™ electrical nonmetallic tubing (ENT) is a polyvinyl chloride (PVC) tubing available in Trade Sizes (Metric Designator) ½ (16) or ¾ (21) for wall assemblies and ½ (16), ¾ (21) or 1 (27) for floor-ceiling assemblies.

2.1.3. Rigid Nonmetallic Conduit Described
The Carlon rigid nonmetallic conduit is a Schedule 40 polyvinyl chloride available in nominal Trade Sizes (Metric Designator) ½ (16) or ¾ (21) for wall assemblies and ½ (16) through 2 (53) sizes for floor-ceiling assemblies.

2.1.4. Liquidtight Flexible Nonmetallic Conduit Described
The Carlon Carflex® is a liquidtight flexible nonmetallic conduit available in Trade Sizes (Metric Designator) 3/8 (12) , ½ (16), ¾ (21) or 1 (27) for wall and floor-ceiling assemblies.

2.2. Wall Assembly

Specific wall assembly applications incorporating Carlon outlet boxes with the raceways described above are described in this report. For such uses, electrical outlet boxes shall consist of single-, two- three- and four-gang configurations with a maximum surface area of 26.5 square inches. The boxes are constructed from 3/32-inch-thick (2.4 mm) nominal PVC or modified phenylene oxide plastic material. They are used with listed cover plates in bearing or nonbearing wood or steel stud walls with fire-resistance ratings of up to two hours including stagger stud assemblies.

2.3. Floor-Ceiling Assembly

Specific floor-ceiling assembly applications incorporating Carlon ceiling or outlet boxes with the raceways described above are described in this report. For such uses, the electrical ceiling or outlet boxes shall be circular in shape with a maximum diameter of 4 inches (102 mm) and are constructed from the same material as described above. The maximum surface area of individual boxes shall not exceed 13 square inches (8387 mm2). The electrical ceiling or outlet boxes are designed to be used with light fixtures, ceiling fans or listed cover plates in combustible floor-ceiling assemblies with fire-resistance ratings of up to two hours. The assemblies shall consist of gypsum wallboard attached directly to solid-wood ceiling joists. When resilient channels are used in the assembly, they shall be installed between layers of gypsum wallboard.

3.0. INSTALLATION

This section provides detailed information describing how the fire resistive assemblies described – including the associated Carlon products - shall be assembled:

3.1. Boxes

In *all* cases - precautions shall be taken to ensure the wall openings are not oversized.

Clearance between cutouts and outlet boxes shall not exceed 1/8 inch (3.2 mm).

Any gaps between the box edges and the wall or ceiling openings shall be closed with wall taping compound or plaster spackling compound.

The electrical boxes shall be attached to the studs or joists using two nails, hangers or brackets.
Electrical outlet boxes installed, less than 24 inches apart, on opposite sides of staggered wood stud walls shall be separated by approved fire-stopping materials as specified in the applicable building code sections.

3.2. Two-hour Fire-Resistive Wall Assemblies

3.2.1. Two-Hour Fire-Resistive Nonload-Bearing Wall Assembly:
Installation of the tubing and conduit in the fire-resistive assembly described below shall comply with the applicable Electrical Code and is limited to a maximum of three runs in any 6 foot (1828.8 mm) length of wall, with a maximum of two tubes or conduits in any one stud cavity.

The tubing and conduit are installed within a noncombustible two-hour fire-resistive nonload-bearing partition consisting of the following: A base layer of 5/8 inch (15.88 mm) Type X gypsum wallboard or veneer base, applied parallel to minimum No. 25 gauge, 3-5/8 inch (92.08 mm) steel-studs spaced a maximum of 24 inches (609.6 mm) on center with 1-inch (25.4 mm) Type S gypsum wallboard screws spaced 8 inches (203.2 mm) on center along the edges and 12 inches (304.8 mm) on center to intermediate studs.

The face layer consists of a second layer of 5/8 inch (15.88 mm) plain or pre-decorated Type X gypsum wallboard base, applied parallel to the studs with 1 5/8 inch-long (41.28 mm) Type S gypsum wall board screws spaced a maximum of 16 inches (406.4 mm) on center. The vertical joints shall be staggered a minimum of 24 inches (609.6 mm) on center from the vertical joint in the first layer. The top and bottom tracks shall be fastened in place with recognized fasteners spaced a maximum of 24 inches (609.6 mm) on center to the top and bottom runners.

A uniform ¼ inch (6.35 mm) end clearance is maintained between the top and bottom tracks and each stud. Shims are used to attain the ¼ inch (6.35 mm) clearance and then removed after the wallboard is fastened to the studs and tracks. Studs need not be attached to the top and bottom runners.

Any nonmetallic electrical outlet boxes used in this assembly shall be those described Carlon's UL Classification for Fire Resistive Outlet Boxes R8326. Precautions shall be taken to assure that the wall openings are not oversized. Clearance between cutouts and outlet boxes shall not exceed 1/8 inch (3.18 mm). Any gaps between the box edges and the wall or ceiling openings shall be closed with wall taping compound or plaster spackling compound. The electrical boxes are attached to the studs or joists with two nails, hangers or brackets. Electrical outlet boxes installed on opposite sides of staggered wood stud walls shall be separated by fire-stopping materials as described in Section 721.0 of the **BOCA National Building Code/1999**, Sections 705.3 and 2305.1 of the **Standard Building Code,** Section 708 of the **Uniform Building Code** and Section 716 of the **2000 International Building Code**.

3.2.2. Two-Hour Fire-Resistive Limited Load-Bearing Wall Assembly: Installation of Carlon Flex-Plus® Blue® electrical nonmetallic tubing in fire-resistive assembly described below shall comply with the applicable Electrical Code and is limited to a maximum number of six tubes in any one stud cavity.

The tubing is installed within a two-hour fire-resistive load bearing partition consisting of the following: 2 by 4 inch (50.8 x 101.6 mm) nominal wood stud kiln dry number 2 Douglas-Fir lumber, cut into 9 foot - 7 ½ inch (2933.7 mm) lengths, and the three bearing plates cut into 10 foot -1 inch (3073.4 mm) lengths. The two lower bearing plates are nailed together with 16d steel nails 16 inches (406.4 mm) on center. The upper and lower bearing plates are to be secured to the top and bottom of the masonry opening, respectively, with ¼ -20 by 2 ½ inch (63.5 mm) long steel screws spaced 24 inches (609.6 mm) on center.

Each stud is toe-nailed to the upper bearing plate and the fop lower bearing plate with four 16d steel nails per stud end. The studs are positioned in two rows, with the studs within each row spaced 16 inches (406.4 mm) on center. Studs are to be staggered *8* inches (203.2 mm) on center between adjacent rows.

A UL- Classified 4 inch (101.6 mm) thick mineral wool batt insulation with a density of 2.54 pcf (40.69 kg/m^3) is cut to length and fitted into each of the stud cavities on both sides of the assembly.

A base layer of 5/8 inch (15.88 mm) thick Type X gypsum wallboard is applied parallel to nominal 2 by 4 inch (50.8 x 101.6 mm*)* wood with 6d nails spaced 6 inches (152.4 mm) on center.

A face layer consisting of a second layer of 5/8 inch (15.88 mm) thick Type X gypsum wallboard is applied parallel to the studs with 8d nails spaced 8 inches (203.2 mm) on centers.

Any nonmetallic electrical outlet boxes used in this assembly shall be those described Carlon's UL Classification for Fire Resistive Outlet Boxes R8326. Precautions shall be taken to assure that the wall openings are not oversized. Clearance between cutouts and outlet boxes shall not exceed 1/8 inch (3.18 mm). Any gaps between the box edges and the wall or ceiling openings shall be closed with wall taping compound or plaster spackling compound. The electrical boxes are attached to the studs or joists with two nails, hangers or brackets. Electrical outlet boxes installed on opposite sides of staggered wood stud walls shall be separated by firestopping materials as described in Section 721.0 of the **BOCA National Building Code/1999**, Sections 705.3 and 2305.1 of the **Standard Building Code,** Section 708 of the **Uniform Building Code**, and Section 716 of the **2000 International Building Code**.

The wood stud axial stress is limited to 0.78 F'_a and shall not exceed 0.78 F'_a at an *I/d* ratio of 33. The maximum load on the system described in this section of the report is 1,100 pounds (4950 N) per stud or 50% of the allowable axial stress. For purpose of design:

F = Allowable unit stress in compression parallel to the grain adjusted for l/d ratio.
l = Effective length of compression member, inches.
d = Least dimension, inches.

3.3 One-hour Fire-resistive Nonload-Bearing Wall Assembly:

Installation of ½ inch or ¾ inch (12.7 or 19.05 mm) trade size Carlon Flex-Plus® ENT tubing in the one-hour fire-resistive assembly described below shall comply with the applicable Electrical Code and is limited to a maximum of two tubes in any one stud cavity.

The tubing is installed within a noncombustible one-hour fire-resistive nonload-bearing partition consisting of the following: A single layer of 5/8 Inch (15.88 mm) thick Type X gypsum wallboard is applied to each side of No. 20 gauge steel studs, 3 3/8 inches (85.73 mm) wide by 1 3/8 inches (34.93 mm) deep, having 5/16 inch (7.94 mm) folded-back return-flange legs, with No. 6 by 1 1/8 inch-long (28.58 mm), buglehead drywall screws spaced 8 inches (203.2 mm) on center along the perimeter of the board and intermediate studs. The wallboards are applied with long dimension parallel to the studs. Joints of the boards and screw heads are covered with paper tape and wall compound. Top and bottom tracks are fastened with approved fasteners spaced a maximum 24 inches (609.6 mm) on center.

A uniform ¼ inch (6.35 mm) end clearance is maintained between the top and bottom tracks and each stud. Shims are used to attain the ¼ inch (6.35 mm) clearance and removed after the wallboard is fastened to the studs and tracks. Studs need not be attached to the top and bottom runners.

The tubing is surrounded with a 6 inch-wide strip of Owens-Corning Fiberglass All Service Faced Duct Wrap insulation, Type 75, 1 ½ inches (38.1 mm) thick and with a ¾ pcf (12.01 kg/m3) density, wrapped with faced surface outwards and stapled with standard ½ inch (12.7 mm) office staples, ¼ inch long (6.35 mm), spaced 3 inches (76.2 mm) of center. At the duct wrap section joints, a minimum of 3 inches (76.2 mm) of overlap is used. A 24 inch by 24 inch by 3 inch (609.6 x 609.6 x 76.2 mm) thick mineral fiber unfaced-batt insulation blanket is placed behind each electrical outlet box and a 2 inch by 3 inch by 24 inch (50.8 x 76.2 x 609.6 mm) piece of the same mineral fiber insulation is stuffed into the open side of the stud supporting the outlet box on the exposed side of the wall. The mineral fiber insulation is Thermafiber Sound Attenuation Fire Blanket manufactured by U S . Gypsum Company.

Any nonmetallic electrical outlet boxes used in this assembly shall be those described in Carlon's UL Classification for Fire Resistive Outlet Boxes R8326 and in Section 3.1 of this report.

3.4. Fire-resistive Floor-Ceiling Assembly

The Carlon Schedule 40 rigid nonmetallic conduit, Carlon Flex-Plus® Blue™ ENT electrical nonmetallic tubing and Carlon Carflex® liquidtight flexible nonmetallic conduit with necessary fittings and boxes are permitted to be installed in fire-resistive-rated floor-ceiling assemblies with a rating of three hours or less, without affecting the rating, with the following limitations and requirements:

3.4.1. The total volume of rigid nonmetallic conduit, electrical nonmetallic tubing and liquidtight flexible nonmetallic conduit shall not exceed 380 cubic inches (6227.08 cm3) per 100 square feet (9.29 m2) of ceiling area. This value also takes into account the amount of fittings and junction boxes necessary for installation. Table 1 gives the volume per linear foot and maximum linear feel per 100 square feet (9.29 m2) of ceiling area for various sizes of raceways.

3.4.2. All raceways shall he installed with metallic fasteners or hangers at a spacing in compliance with the spacing requirements of the applicable Electrical Code.

3.4.3. The conduits shall not penetrate the dropped ceiling membrane.

3.4.4. The raceway systems shall he installed in compliance with the applicable Electrical Code.

3.4.5. The distance from the top of the ceiling membrane to the bottom of the floor or roof deck above shall not be less than 16-3/8 inches (4 15.93 mm).

3.5. Use of Floor and Ceiling Boxes with Carlon and other approved Raceways and wiring methods in Floor/Ceiling Assemblies

Carlon Floor Boxes with necessary fittings and raceways have been successfully tested and are permitted in 2 hour fire resistive horizontal slabs using either normal density concrete [minimum slab thickness - 4-1/2" or lightweight concrete installed on a fluted metal deck [minimum slab thickness - 3-1/2" installed on a 2" deep fluted metal deck] with a minimum cover for boxes of 1-1/2".

Carlon Ceiling Boxes with necessary fittings and raceways have been successfully tested and are permitted in 2 hour fire resistive horizontal slabs using normal density concrete with minimum slab thickness - 5" with intumescent pads installed above boxes and minimum slab thickness – 6" without intumescent pads installed above boxes.

In addition, Carlon non-metallic electrical outlet boxes with a variety of joist attachment methods have been successfully tested as components of a two hour fire endurance rated wood framed floor ceiling assembly of 12" nominal thickness. The tested assembly included a lower membrane consisting of 2 layers of 5/8" Type X generic gypsum wallboard mounted to resilient channels, 2" x 10" nominal wood joists and an upper membrane composed of a ¾" thick layer of plywood sub-flooring and a ¾" thick layer of plywood flooring.

3.6 Placement of PVC Electrical Raceways in Concrete Slabs

Determination of safe depths for placement of PVC electrical raceways and conduits when they are used in suspended, reinforced concrete slabs - such as those found in parking structures - is important.

In doing so, it is important to be aware that the model building codes [eg IBC Section 1906 and its predecessor sections such as **Uniform Building Code** 1906.3] do *not* require that conduit be placed at mid-depth of a slab. Those sections require that conduit *diameter* not exceed 1/3 of the slab depth, but do *not* prescribe placement of the conduit in terms of slab depth. Nonetheless, "typical" details provided as part of structural specifications frequently do direct that conduit be placed at or near the centerline of the slab depth[1].

In some cases, placement of a conduit atop the lower reinforcement mat results in its being placed very close to the center of the slab. If, for example, in a 5 in. thick slab with #4 reinforcement bars laid in each direction over ¾ in. of bottom cover, the centerline of a ¾ in. nominal diameter conduit (1.05 in. true outside diameter), will be 2.3 in. above the bottom of the slab. This is within 0.2 in. of the slab centerline, and hence in general conformance with a project requirement that conduit be placed at the slab center. If, on the other hand, the slab is 8 in. in thickness and has bottom #4 reinforcement is only in one direction, the centerline of the ¾ in. nominal conduit will be 1.8 in. above the bottom of the slab – well below the slab centerline located 4 in. above the bottom. Such a slab would require supplementary chairing of the conduit to place it at the higher elevation and create a consequent susceptibility to damage as well.

A slab under vertical load experiences internal stresses that vary from maximum tension at one face of the concrete to maximum compression at the opposite face. Typically, tension occurs on the top of the slab near the slab supports and on the bottom of the slab near the center of the span (see Figure 1). Because concrete is much stronger in compression than in tension, and because slab cracking results in the total loss of concrete tensile strength at a cracked location, it in generally assumed that such concrete has, in fact, cracked, and that resistance to tensile stresses is provided by the reinforcement alone. As a result, the loss of concrete cross-sectional area due to conduit placement in the "tension zone" of the concrete slab has no significant affect on the strength of the slab.

Because the tension zone is at the bottom of the slab near mid-span, conduit placed near the slab bottom in the mid span area will not affect slab strength, and the discussion that follows is applicable where the bottom of the slab is in

[1] Experience from the field – referring to *all* electrical conduits, whether metallic or non-metallic – suggests that these are susceptible to damage when placed at the mid-point of slab depth. This occurrence is the result of large downward deflections that may occur when workers step on conduits placed in this manner.

compression, typically near the supports. In order to determine whether or not placement of the conduit directly atop the bottom reinforcement will have an impact on the structural integrity of the slab, analyses have been conducted to determine the extent of the slab compression block in a range of possible configurations, ranging from thin (4 in.) to thick (8 in.) slabs.[2] Illustrations of points addressed in such an analysis can be seen in the accompanying figures. Results show that such conduit will not fall within the compression block in thin (4 in.) reinforced concrete slabs, regardless of reinforcement ratio. In thick (8 in.) slabs, the conduit does not fall within the compression block in lightly reinforced slabs although it falls partially within it where the slab is reinforced to the *maximum* level permitted by code where the adverse impact of the conduit yields a strength reduction of only 1.0%.

Based on this analysis, including worst case situations, conduits can be placed in reinforced concrete slabs 4 in. to 8 in. thick directly atop reinforcement including those having a double mat of bottom reinforcements at all reinforcement ratios permitted by code without creating adverse significant effects in slab bending resistance.[3]

3.7 Use of Carlon Boxes with necessary fittings and raceways in generic fire resistance rated walls and floor – ceiling assemblies.

Literally hundreds of combinations of membranes and framing systems - with and without a variety of approved thermal -insulations have been fire endurance tested for applications in fire resistance rated walls and floor – ceiling assemblies. Reports on such testing can be found in the various Tables associated with fire resistive construction assemblies in the model building code chapters addressing fire resistance rated constructions.[4]

Thru today, it has been a fundamental assumption in the building codes that use of a variety of raceway materials, cable types as well as boxes of metal and more recently of plastic can when used according to listing instructions be used without compromising the fire endurance rating of the assemblies in which they are installed. This statement is supported by results of exemplar fire testing (insert test references).

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[2] Code limited extremes of both light reinforcement (0.18% of the total slab cross sectional area and heavy reinforcement (2.14% of effective slab area from the compression face to the center of the tension reinforcement) have also been considered.

[3] The above discussion addresses only reinforced concrete slabs that have not been post-tensioned. Post-tensioning of a slab causes it to be pre-compressed in a manner that offsets the tension that a portion of the slab cross section experiences under load and requires additional analyses.

[4] Additionally, references such as the Gypsum Association Manual, the UL Fire Resistance Directory [Directory of Listed Building Products and Accessories, Omega Point Laboratories and ETL Verified Product Directory, Intertek Laboratories] include information describing tested designs.

However, it is impractical from both cost and convenience perspectives to test *each and every possible combination of claddings, structural elements, insulations and wiring methods used in fire resistive construction designs*. For that reason, generalizations – arrived at either formally or informally – about the overall, expected behavior of fire resistance rated assemblies are frequently relied upon in the field to review designs.

A formalized, peer-reviewed presentation of such generalizations can be found in and article entitled the "Ten Rules of Fire Endurance Ratings" compiled by fire scientist Tibor Harmathy (1965). These guidelines have proven useful for over two decades when considering and predicting the probable fire performance of assemblies as built in the field. They have been referenced in various model codes and associated standards during that time including most recently the **2003 ICC International Existing Buildings Code** ("Resource A") [IEBC], as well as earlier model building codes addressing the treatment of existing buildings. They have also been included in their entirety in NFPA Standard 909 [addressing Museums, Libraries and Places of Worship] and NFPA Standard 914 [addressing historic buildings] and in part in a variety of other reference documents including HUD's NARRP (1997).

By combining fire endurance testing results for generic wall and floor/ceiling assemblies in which electrical components had been installed, guidance from the "Ten Rules" approaches can be conservatively applied to field use of the Carlon boxes and necessary fittings and raceways addressed in this report with generic walls and floor ceilings.

These Rules – as found in the IEBC ("Resource A") as well as the NFPA 914 and 909 and the NARRP prepared by HUD specifically reference the comments and methodologies found in "Ten Rules of Fire Endurance Rating" compiled by fire scientist T. Harmathy (1965) cited above. These have proven useful in considering and predicting the probable fire performance of such assemblies as built in the field as referenced in various model codes and associated standards documents (refs – ICBC, HUD, NFPA, ETC.).

Building on these concepts and based on specific fire endurance testing results with generic wall and floor/ceiling assemblies containing electrical components the Harmathy methodologies can be applied to generic walls and floor/ceilings which include the Carlon boxes and necessary fittings and raceways addressed in this report.

Applicable assemblies include the following:

3.7.1 Generic walls and floor-ceiling assemblies successfully tested at a specific; given thickness for fire endurance can be built and utilized at thicknesses greater than the minimum thickness as exemplified by the tested assembly. Thickness increases may come in the form of additional slab thickness, deeper framing members or the addition of thicker layers of the cladding materials tested examples include studs, joists and claddings which may all be thicker or deeper – but NOT more shallow or thinner - than the tested materials.

3.7.2 Generic walls and floor-ceiling assemblies successfully tested at a specific; given thickness for fire endurance without thermal insulations can be safely built with thermal insulations at equal or greater thickness than the tested assembly.

> Since thermal insulations add to the thermal resistance of assemblies, addition of such insulations to assemblies originally tested without insulation is permissible and can be expected to increase fire resistance.

3.7.3 Specific claddings and combinations of claddings on generic walls and floor-ceiling assemblies successfully tested for fire endurance may be replaced by multiple thinner individual layers of the same material of equal or greater total thickness. Such assemblies will have the same or greater fire endurance than the originally tested assembly.

> Thus, if a single 5/8" layer of gypsum wallboard is used in the tested assembly, two layers totaling 5/8" or greater in thickness can also be used as well. The latter version will provide significantly enhanced fire endurance as opposed to the version with a single layer.

3.7.4 Openings in such assemblies must be treated with care. They must not be oversized and they must be carefully firestopped. Use of multiple or large or repetitive openings shall only take place if supported by appropriate analysis and/or test results.

4.0. IDENTIFICATION

The electrical boxes, tubing and conduit shall be identified by Carlon name and trademark, the listing mark which includes the name and/or symbol of Nationally Recognized Testing Laboratories (NRTL) together with words "Listed", or Classified..

5.0 CONDITIONS OF USE

When used consistent with the descriptions and specifications in this report, noncombustible and combustible, fire-resistance-rated wall and fire- resistance-rated floor-ceiling assemblies are intended to comply with the **2003 International Building Code** provided that those installations are in accordance with the content of this report and the applicable Electrical Code.

Consistent with the preceding comments, it is our opinion that the Carton nonmetallic electrical outlet boxes described in this report meets all requirements for acceptance as alternative products to those specified in the **International Building Code** for fire-resistance rated wall and floor-ceiling assemblies with fire-resistance ratings up to two hours, subject to the following conditions:

5.1 Boxes and raceways are installed in accordance with this report.

5.2 No more than two wall boxes are located in each stud space on the same side of fire-resistance rated walls.

5.3 The electrical outlet boxes may be installed on opposite sides of wall assemblies having a fire-resistance rating of two hours or less, as described below:

5.3.1 Boxes installed on opposite sides of load-bearing and non load-bearing wood stud assemblies and non load-bearing steel-stud assemblies, without the use of mineral wool ban insulation, shall be separated by a horizontal separation distance of at least 24 inches (610 mm).

5.3.2 Boxes installed on opposite sides of a non load-bearing fire-resistive wall assembly that contains 3 1/2-inch-thick (89 mm) mineral wool batt insulation having a density of 2.5 pcf (40 kg/m3) between the boxes are permitted when the horizontal separation distance is at least 7 inches (178 mm) and the insulation is continuous for the entire width of the fire resistance rated assembly.

5.3.3. ENT boxes installed with ENT on opposite sides of a load-bearing fire-resistive wall assembly containing a minimum of 4-inch-thick (102 mm) mineral wool batt insulation having a minimum density of 2.5 pcf (40 kg/m3) between the boxes are permitted when the horizontal separation distance is 24 inches (610 mm) and the insulation is continuous for the entire width of the fire-resistance rated assembly.

5.4 Cover plates, other covers and Canopies complying with Section 314.25 of the National Electrical Code, when used with ceiling boxes. With wall boxes listed plastic cover plates, complying with UL Standard No. 514C, or listed steel cover plates, complying with Section 314.25 of the National Electrical Code are required.

5.5 The surface area of the wall and ceiling outlet boxes are limited to a maximum of 21.2 and 13 square inches (13,677 and 8,387 mm2), respectively.

5.6 Ceiling boxes are separated from each other by a minimum of 4.5 feet (1,372 mm).

5.7 Aggregate surface area of the outlet boxes in walls or ceilings on one face of the fire-resistance rated assembly do not exceed 100 square inches (64,516 mm2) or 31 square inches (20,000 mm2) for any 100 square feet (9.29 m2) of wall or ceiling area, respectively.

6.0. Reference Materials:

Test data, References and other source materials upon which these findings are based are as follows:

Carlon correspondence, 1984 by H.F. Van der Vort, Vice-President Industry Affairs. Descriptive details under the cover of a letter, dated January 30, 1984

Fire Cause Analysis correspondence, 2004. Letter to Dean Shipcott of Berg Electric from Craig G. Huntington S.E. of Fire Cause Analysis re: Installation of PVC Raceway and Conduit in Concrete Slabs. May 10, 2004

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IFT Technical Services Inc., 1990. Engineering report on fire-resistive floor-ceiling assemblies with Carlon tubing and conduit, dated April 1990, signed by Joseph B. Zicherman. Ph.D.

International Building Code for Existing Buildings, 2003. International Code Council, Country Club Hills, Illinois.

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Omega Point Laboratories, 1992. Report No. 1149-92509, dated January 27.1992 from Omega Point Laboratories on fire tests conducted on a one-hour wall assembly using Carlon ENT tubing.

Product brochures and descriptive details under the cover of a letter, dated July 1984, prepared by M.B. Crawford, P.E., consultant.

Underwriters Laboratories Inc., 2002. Letter to David Kendall of Carlon, Lamson & Sessions regarding Small-Scale Fire Test Investigation on Floor Outlet Box Model B121BFB for Hourly Ratings up to 2 H. August 24, 2002.

Underwriters Laboratories Inc., 1994. Fact finding report on load-bearing wall assembly with nonmetallic outlet boxes and tubing, File No. R8326, Project No. 94NK17350, dated November 21, 1994, Test was conducted in accordance with ANSIlUL265, ASTM E 119, NFPA 252.

Underwriters Laboratories Inc., 1994. Report of fire tests, File R8326, Project 93NK19678, dated November 8,1994, conducted in accordance with ASTM E 11 9.

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