



Roxtec Multi-Cable Transit Devices

Application and design practices within
onshore oil, gas and petrochemical facilities

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Abstract

This is an introduction to applications and an engineering design approach for the proper use of Roxtec multi-cable transit devices within onshore oil, gas and petrochemical facilities. This paper demonstrates improved safety and improved project delivery when cable transit devices are included into owner and EPC design scopes. International standards for cable transit devices and common safety demands are presented, including the use of Roxtec cable transit devices for vapor-tight barriers, blast-rated structures, fire walls, pressurized buildings, and simple ingress protection against environmental elements. Incorporating Roxtec transits into owner-level and engineering-level design standards, is demonstrated to provide project savings that include reducing contractor work-hours, detail design time, and reduced field maintenance time. Proper multi-cable transit design and installations are also shown to increase project safety and operational uptime.

Index Terms – Multi-cable transit, Cable Transit Device (CTD), Blast-rated wall, Vapor-tight barrier, Cable entry, Pressurized building, Cable termination, Earthing armored cable.

1. Introduction

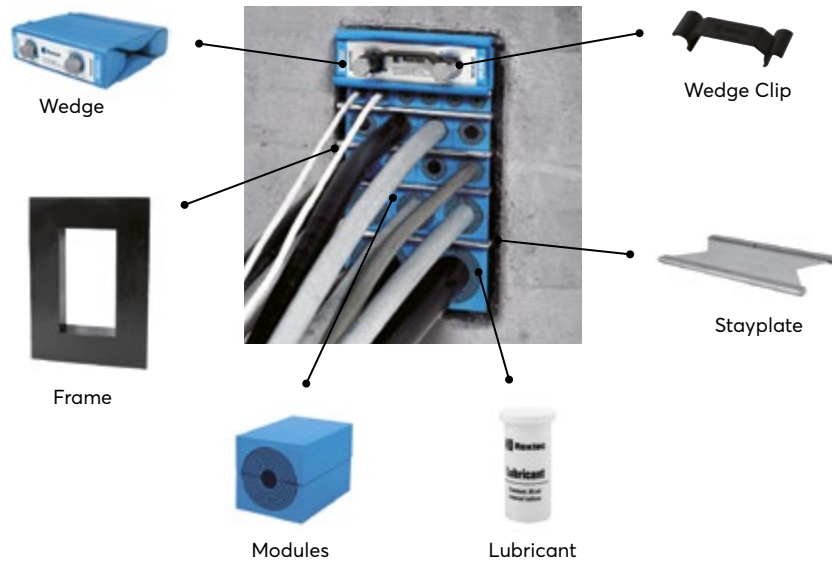
In the 1950's, design methods and products were developed to protect against the hazards of water, fire, blast and smoke for shipboard/marine applications. These products became known as multi-cable transits or MCT's. The early adopters for these technologies were primarily naval engineers that required improved methods for sealing cables and pipes that passed through bulkheads and decks of navy vessels. As multi-cable transits proved their benefits throughout naval fleets and commercial shipyards around the world, the offshore oil and gas industry also began to recognize the safety features and benefits of having a cable transit that can be opened to add, remove and maintain electrical and control system cabling.

Today, Roxtec transits for multiple cables and pipes are a standard design practice for many marine and offshore oil and gas projects. However, this same level of standardization for cable entries is lacking within many project designs for onshore projects. This paper focuses on introducing multi-cable transits to electrical, instrumentation and civil design teams working with onshore oil, gas, petrochemical and heavy industrial facilities, reviewing the critical components for design and installation, relevant international standards for use of Roxtec multi-cable transits and providing a recommended work process for proper designs of the transits.

2. Components and Assembly Overview for Multi-Cable Transit Devices

A. Components

Multi-cable transits have standardized designs and components. At minimum, each transit includes a frame, modular elastomeric blocks which are commonly called modules or insert blocks, stayplates and a mechanical compression unit, or compression wedge, all as shown in Fig. 1. Also, most Roxtec transit designs require the use of lubricant or assembly gel to aid with the installation of the modules as the design tolerances are very tight and the module materials create friction against themselves during installation.



B. Dimensions and Packing Space

The inside dimensions of each single window are most commonly standardized to 120mm width, with varying heights. The interior height range of each single window is variable from 60mm to 240mm. Together, these interior dimensions are known as "Packing Space". It should be noted that Packing Space does not include the space allocated to the mechanical compression wedge, only space where cables may be added.

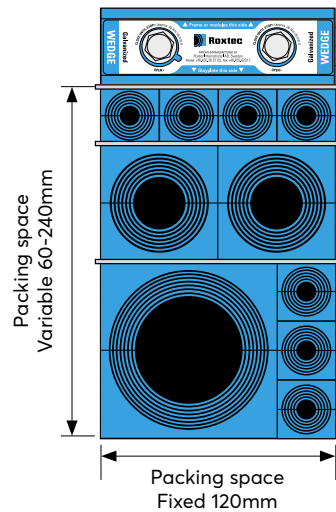


Fig. 2
Packing Space in a Roxeltec transit

C. Combination Frames

Roxtec transits are often designed as combination frames, where more than one packing window (120mm wide, x-height) are manufactured within the frame as a vertical addition, horizontal addition, or both, as shown in Figs. 3a-c.



Fig. 3a
Vertical Windows



Fig. 3b
Horizontal Windows

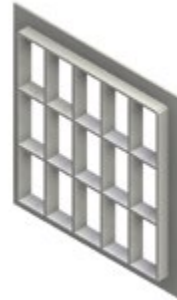


Fig. 3c
Combination Windows

D. Flanged and Non-flanged Frames

Manufacturer designs of Roxtec transits also provide the option to have a flange included with the frame to provide increased tolerance for the aperture or cut-out size in the wall or floor, and to enable installation by bolting. Most onshore project designs benefit from flanged frames, Fig. 4a; however in applications where the frame will be welded directly to a steel wall or floor structure, non-flanged frames may be specified, Fig. 4b.



Fig. 4a
Flanged Frame



Fig. 4b
Non-Flanged Frame

E. Frame and Component Materials

Selecting proper materials is a critical design element. Roxtec offers frames in different materials to meet specific demand or cost requirements. Some of the most common metallic material types and applications are suggested in TABLE 1, including stainless steel, galvanized and mild steel.

For applications without fire rating requirements and when a Roxtec transit will be placed in non-hazardous and non-blast rated applications, a designer may consider composite plastic materials for Roxtec frames to reduce both cost and weight.

F. Aperture Size

Most important in early design stages is to accurately size the aperture or cut-out that will be required in a wall or floor to properly install the Roxtec frame. This important dimension is shown as h_2 and w_2 in Fig. 5. Too often, the aperture dimension is sized incorrectly from the flange dimensions, H and W in Fig. 5. Missing this simple sizing detail has impacted many projects, requiring additional time and expenses to modify structures or to add additional flange plate to the frame to cover the over-sized cut-out. This mistake is easy to avoid by using manufacturer-generated drawings to assure accuracy and communicating early with civil design teams and building contractors.

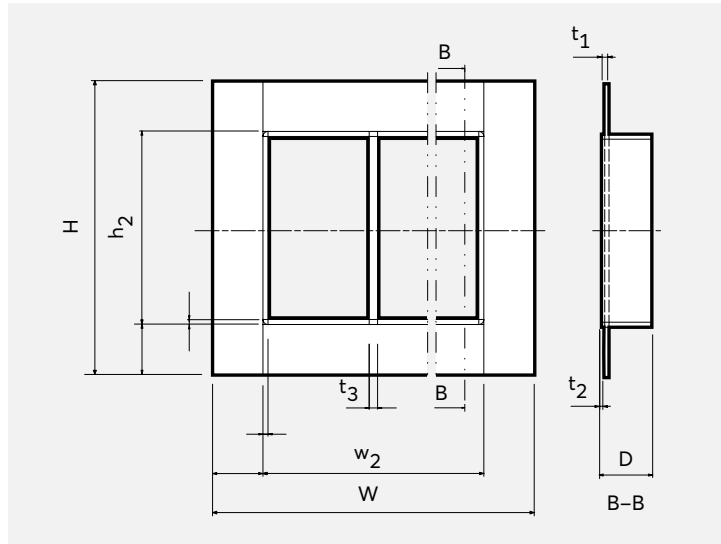


Fig. 5
Aperture sizing = h_2 and w_2

G. Sealing Modules

The modules within a Roxtec transit serve as the seal around the outside diameter, O.D., of the cables. Most modules are manufactured using a halogen-free rubber compound, Roxylon™, based on Ethylene-Propylene rubber (EPDM). The material allows for compression from the compression wedge to be applied universally to the modules, creating a mechanical seal around each cable in the transit. Like most onshore oil, gas & petrochemical facilities, which are designed to have an operating life >20 years, Roxtec modules have also proven to be a long-lifecycle product.

Roxtec modules consist of two halves which are placed on each side of the cable and then inserted into the frame.

Roxtec modules are available with removable layers and center core: one single Roxtec module can seal a cable or pipe over a span of several different diameters simply by peeling layers from the module halves. Typically 6 module sizes accommodate cable O.D. range from 3mm to 99mm. These modules with center core may be used as spare blocks for future cable additions, due to the fact that when under full mechanical compression, these modules serve as solid blocks. This type of module provides additional flexibility during both design and installations when cable schedules are known to change frequently.

H. Mechanical Compression Unit or Compression Wedge

It is important that the project design team for Roxtec transits be aware of the specific compression units to match the frame designs. Compression units are not interchangeable among manufacturers; some require additional components to fill voids in the packing space.

I. Stay Plates or Anchor Plates

The use of stay plates is common to nearly all Roxtec multi-cable transit applications. The metallic plates are installed between each row of modules. On both the front and back side of each stay plate is a raised lip that prevents modules from sliding forward or back within the frame. By design, stay plates provide a significant benefit to increase cable retention and improve integrity of multi-cable transits to withstand pressure from blasts and water. Stay plates also play an important role during horizontal or floor installations. With this raised lip on each side of the stay plates, modules have a place to rest, holding them in place before final compression.

3. Applications for Roxtec Cable Transit Devices in Onshore Facilities

A. Environmental Protection/Ingress Protection

In even the simplest applications, Roxtec devices provide excellent protection against the elements and hazards that may be caused by weather (rain, snow, wind, heat, humidity), splashing or hose-down water, sand and/or dust. Standard Roxtec designs have minimum watertight and dust-tight rating equivalent to an Ingress Protection (IP) rating for electrical enclosures of IP 54 as defined by IEC 60529. IP 54 provides protection against dust with limited ingress, with no harmful deposit and also protection against splashing from all directions – with only limited ingress permitted. Performing at higher levels, Roxtec provides standard products with IP 66 and IP 67 ratings. IP 66 rated products deliver total protection against dust and protection against powerful water jets without harmful effects. IP 67 ratings deliver total protection against dust and protection against immersion into water to a depth of 1 meter. In addition to IP ratings, it is important to understand the capacity of Roxtec devices to prevent the passage of corrosive or potentially explosive gases. Gas tightness is discussed in more detail in Section C – Vapor Tight Barrier.

Unfortunately, many system failures and safety risks have been created due to poor levels of protection against these routine environmental hazards. A basic Roxtec design and installation protects life, equipment and assets, yet in many projects, it is found that no cable sealing or barrier to the basic environment has been installed. In other cases, the method of sealing the cable entry is simply inadequate. As shown in Fig. 6, a hole remains after the cable sealing installation is complete, compared to Fig. 7, where proper cable sealing is provided in this floor application using a Roxtec seal.



Fig. 6
Incorrect cable sealing



Fig. 7
Correct cable sealing with Roxtec

B. Blast Rated Structures

Due to the potentially explosive environments of many onshore oil, gas and petrochemical facilities, people and operations are at risk of blasts. Many hours of engineering design are involved to correctly design blast rated walls and structures, but the openings where cables pass are not always considered. Most often this oversight is a result of communication breakdowns across project phases and between different engineering disciplines for the project. Roxtec transits should be included in early project designs, with civil and/or structural design teams confirming with Roxtec that the multi-cable transit design provides the required level of blast load protection.

Depending on application, Roxtec transits are commonly available to provide protection against blast load to >10 psi for > 60 milliseconds. The ratings for blast rated structures vary widely, but Roxtec can be consulted to provide test reports to the specific project demands.

C. Vapor Tight Barrier

During the identification and planning of the hazardous areas for a facility, design considerations must be given to properly separate hazardous areas from unclassified areas. During this hazardous location definition and planning phase, consideration should be given to designing cable entry methods to buildings within these hazardous zones.

An unclassified room or building may be installed adjacent to a classified area provided a vapor-tight barrier is placed between the hazardous location and the unclassified area. The design of the vapor barrier is such that it prevents the migration of fugitive emissions from the classified area to the unclassified area under normal ambient pressure conditions. Section 6 of API RP 500 and 505 discuss the use of classifying areas using vapor-tight barriers.

The industry currently has vague definition to the term "Vapor-Tight"; however the following standards are commonly referenced to address the requirements for vapor-tight:

- 1) IEC 60079-13 "Construction and Use of Buildings Protected by Pressurization,
- 2) NFPA 496 "Standard for Purged and Pressurized Enclosures for Electrical Equipment",
- 3) API RP 500 "Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Division 1 and Division 2", and
- 4) API RP 505 "Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, and Zone 2"

With proper specification, design and installations, Roxtec devices meet or exceed the

requirements for vapor-tight barriers. Due to the history of multi-cable transits in catastrophic pressure scenarios for harsh marine applications, Roxtec transits have been designed to provide gastight certifications to a pressure of 2.5 bar (~36 psi).

For land-based applications, the pressure requirements are much less, where most applications are required to prevent the passage of gases with pressure equal to 25 pa (0.1 inch WC or .00361 psi). The onshore project requirement is typically to maintain a pressure slightly positive to atmosphere. Roxtec transits are certainly fit for this purpose.

Other methods to create vapor-tight barriers in structures include using concrete or compounds to seal openings around cables. When these methods are used properly, they also provide protection against hazardous vapors. However, when maintenance or addition of cables is required, the effectiveness of these permanent barriers is violated when a new hole or entry is required to the structure. Depending on the structure and location where a new cable entry must be made into these mortar-type cable seals, most often an electrical tool is necessary. This typically requires a hot work permit in addition to partition barriers or operational shutdowns before work may begin.

When a properly-specified Roxtec multi-cable transit is used, a simple 13mm wrench provides access to the transit, allowing easy addition or maintenance of cables without the related permitting and downtime required with concrete or compounds as barriers.

Recent project reports have also indicated that leakage of corrosive gases into electrical or instrumentation buildings and equipment is a contributing risk to operational reliability and increasing operating costs. Roxtec devices, when specified with non-corrosive components, should be considered for cable entries into buildings and/or equipment in these potentially corrosive environments.

D. Earthing, Bonding and EMC

Many project designs are using armored cable types for power and control systems, and Roxtec has also improved product designs to meet the requirements specific to these cable types. International and local electrical codes require either bonding or earthing of the armor jacket component in these cable types. Some devices have recently been approved to meet the requirements for bonding or earthing. These Roxtec designs typically include a tin plated copper earthing strap that is embedded into the module, as shown in Fig. 8. Roxtec solutions are also approved to provide equipotential bonding as well as electrical safety protection against lightning strikes, as identified by IEC-62305.



Fig. 8
Roxtec module with earthing strap embedded for use with armored cables

Protection against electromagnetic interference (EMI) is also becoming a more frequent discussion for new industrial project designs. The requirements to meet Federal Communications Commission (FCC) regulations in North America and global EMC directives and IEC product standards regarding immunity and emissions are important design criteria. Proper designs to protect against EMI are known to increase uptime reliability and avoid equipment damages caused by electromagnetic Interference. Specific Roxtec devices are approved and fit for these purposes.

As interfering signals propagate along cable armor or screens, traditional grounding methods may not provide the most effective ground path for HF signals. Examples of interferences can be surges from lightning strikes, induced currents from variable frequency drives (VFD's) and switched devices.

With the Roxtec module design shown in Fig. 8, the electrical safety requirements, and also the industry demands for improved HF grounding methods are considered, giving excellent protection for disturbances conducted by the armor or screen. Other Roxtec module designs are also readily available for shielding purposes giving protection up to 40GHz and more for radiated interference.

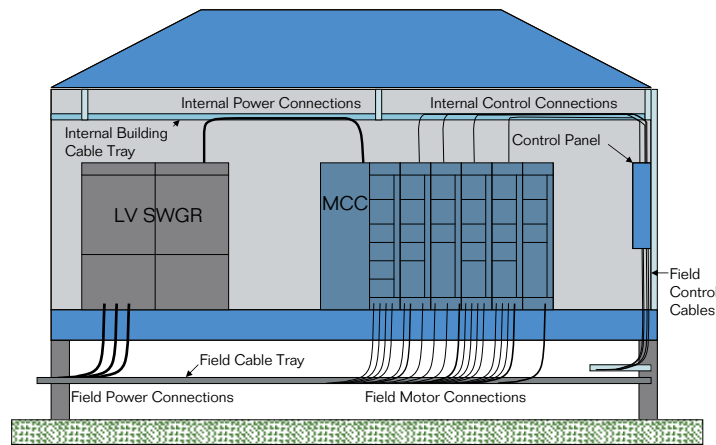
From an electrical and EMC perspective, Roxtec transits by design, promote good engineering practice in that cables are routed through a single entry plate and not spread around an enclosure or building. This single entry point minimizes the risk of circulating ground currents as all cables are earthed in the same point where the Roxtec frame serves as the bus bar (earthing bar) that encloses all cables. The combination frames discussed in section II.C provide a natural design method for cable segregation where e.g. power cables and sensitive instrumentation cables can be routed through separate openings further reducing the risk for crosstalk and interference.

E. Hazardous Locations

In addition to using multi-cable transit devices for cable entries to buildings, Roxtec has also developed approved products that meet the major international electrical schemes (IEC, ATEX and AEX) for use of multi-cable transit devices to seal cables entering electrical equipment or enclosures within designated hazardous or classified areas. In these applications, the multi-cable transit device must be an approved device or component to the equipment or enclosure. Where multi-cable transit devices may be installed directly to electrical equipment or enclosures, it may be necessary that a cable entry scheme be certified to a hazardous location standard, e.g. ATEX, IEC 60079-0 or to an accepted engineering practice such as API RP 500/505. These applications must be identified early in the project to ensure that the transit device(s) are properly specified, designed and installed. Roxtec offers hazardous location approved solutions that are labeled for easy visibility and identification by inspector. Including Roxtec early into your project designs can prevent costly inquiries and delays during inspections.

F. Cable Terminations

With the increase in modular building packages for substations, control centers and analyzer buildings, Roxtec devices are becoming more common in designs with floor entries for cables to enter directly below electrical equipment. In these cases, the Roxtec frame is either welded or bolted to the floor at strategic locations to the cable termination in the equipment. The cables are then pulled through the Roxtec frame, sealed with the modules and compressed. The Roxtec device provides cable retention in addition to an approved barrier against environment, fire, gases, blast, and rodents. With proper component selection, Roxtec devices also provide earthing and bonding safety as well as protection against EMI as discussed in section III.D.



Using Roxtec devices as the cable entry method into substations, control rooms and analyzer buildings offers several advantages including the following:

1. Efficiency: A Roxtec multi-cable transit device allows multiple cables to be pulled at the same time into the opening. The design of Roxtec transits provides for a high quantity and high density of cables to be installed within a very small footprint, making a very time and cost-efficient installation.
2. Integrity: The frame of the Roxtec multi-cable transit maintains the structural and environmental integrity of the floor or structure. In contrast, when foams and other alternatives for cable sealing are used, the integrity of the structure is most often compromised.
3. Future Expansion: By design, Roxtec devices are easily opened to maintain or add new cables. As discussed in more detail later, it is important that the design includes spare capacity of modules.
4. Cable Bend Radius: Using Roxtec devices for cable entries to floors provides additional room below the building floor and equipment. The standard depth for Roxtec devices is 60mm, but the manufacturer can provide deeper extension frames that are designed to a depth equal to or less than the height of the structural steel. This additional working space assists with the restrictive bend radius of larger armored cables and allows for proper alignment of cables with equipment configurations.
5. Single entry point for earthing to minimize risks of circulating ground currents as discussed in section III.D.

G. Cable Retention and Pull Force

The design and materials of Roxtec devices provide high levels of cable retention for both vertical installations (walls) and horizontal installations (floors). The latest Roxtec designs are tested for cable retention to perform to the same requirements as traditional metallic cable glands, as defined in EN 50262 for Type B cable glands, IEC 62444, and also as stated as the minimum "Pull Force" in UL 514B, Table 27. As an example, for 50mm O.D. cables, Roxtec devices have tested to provide cable retention >2000 NM (~450 pound-force).

In general, multi-cable transit devices used within hazardous areas should comply with IEC 60079-0, where it is stated to secure cables for fixed installations without slippage with a force applied to the cable equal to 5 times the value in millimeters of the cable diameter in Newtons (1 Newton = 0.224 lbs.-force) for round cables. Roxtec can be consulted to provide documentation for cable

retention requirements for the project demands or to comply with the applicable standard. In most multi-cable transit applications, including cable entries into floors (horizontal frame installation), the system delivers approved cable retention and cable support. See Section 8.L.1 for additional information about cable support requirements.

H. Fire Barrier

Roxtec devices have a long and proven history of providing protection against fire. One of the most efficient applications for Roxtec multi-cable transit devices is when a design must provide fire protection, but also has demand(s) to provide protection against water, smoke, blast, rodents or other hazards. Stated in another way, if the only design concern is fire, there may be less sophisticated and lower cost methods to provide fire-only protection. However, when a complete risk assessment is included with project design, most often the risk of fire is compounded with the risks of casualty or damage from the hazards of smoke, water, or blast that are directly or indirectly related to the fire. In these cases where risks beyond fire-only are present, Roxtec devices should be considered by project owners, engineers and operators.

I. Rodent and Insect Barrier

Although often overlooked, rodent and insect infestations have caused operational upsets to many onshore processing plants. From the arctic conditions of the Canadian oil sands to the hot and harsh conditions of Saudi Arabian deserts, rodents and insects search for nesting, breeding and eating locations within the most favorable conditions. Typically, these locations are buildings or cabinets that shelter electrical and control equipment. Unfortunately, when these pests seek refuge within electrical or control equipment, they often destroy the sensitive cables, connections or wiring within the buildings and cabinets, causing downtime and costly repairs or replacement of equipment. Preventing entry of these pests can be aided by using Roxtec devices where cables enter/exit buildings. Roxtec can provide you with test reports that demonstrate their system ability to serve as a barrier to these pests.

J. Extreme Environments

Many of today's largest projects are being constructed in the most harsh and hazardous environments that our world has to offer. These projects are demanded to perform at the same or higher levels of safety when compared to projects in the more mild climates. The history of Roxtec multi-cable transit devices through the hazards and harsh environments of shipboard and offshore oil and gas applications has proven the ability of the system to endure to these extreme conditions.

When designing for such extreme environments, temperature and variations of temperatures are a primary consideration. Roxtec devices are available to perform with an operating temperature range from -40°C to +80°C with standard materials, and some solutions are certified for arctic conditions with temperature ratings to -60°C. Roxtec should be consulted to confirm the tested performance of the specified multi-cable transit device.

For applications which demand operating performance requirements beyond the standard Roxtec product range, higher performing materials are available. However, it should be noted that when non-standard products are required, that either an engineering judgment and/or additional product testing may be required to confirm other certifications that are represented with standard materials. This can impact delivery timing and costs, so it is most important to have these discussions with Roxtec very early in project design.

K. Vibration and noise dampening

The components of Roxtec devices which are in direct contact with and around cables are made of elastomeric polymers which provide vibration and noise dampening performance. Owners and operators of skid mounted turbine equipment, generators, motors, mining equipment and cranes commonly specify Roxtec devices, with vibration and noise dampening often cited as one of the benefits to protect their systems.

L. Retrofit for Existing Cables

Many existing, or brownfield, facilities are operating today with either no original attempt to seal cable entries into buildings or have attempted to seal these entries using sub-standard methods. Roxtec devices are available with bolt-together frames that can be installed around existing cables. These retrofit solutions provide brownfield projects with the possibility to improve safety and reliability by installing Roxtec transit devices to properly seal existing openings into buildings and equipment. The potential risks and costs associated with water, gases, rodents or blast entering control rooms or substations should be considered. Is it recommended to leave a fire or blast-rated door open in an operating facility? No. Is it wise to leave a window open with blowing rain? No. In fact, most project owners and EPC firms have adopted specification standards and safety requirements for fire and blast rated doors. Yet in many of these same buildings, the opening for cable entries remains open. These instances can be solved with Roxtec retrofit frames.

4. Work Process and Design Approach for Roxtec Devices

Taking a very early and very clear decision path in all project designs is important. Selecting an overall project design method for cable entries should be no different. Today it is most common in the marine and offshore oil/gas industries that project owners make the design decision related to cable entry methods for decks and bulkheads. However, for onshore projects, this decision has most often been left to an electrical contractor on the job site. With lack of standardization, many unapproved methods have been deployed at the last minute to attempt to seal openings for cable entries, or the cable entries are never sealed.

To improve project designs for safety, delivery timing, maintenance and costs, project owners should consider taking a decision to standardize their methods for sealing cable entries and push this engineering decision forward to all stages of engineering design and construction throughout a project. Although the overall costs to properly seal cable entries is nominal within the scope of project budgets, when this decision is not taken as a design method or standard practice, then the related costs and delays begin to rise quickly near the completion stage of a project. As an example, if civil designs do not properly size apertures in concrete walls, or worse, omit openings for cable entries, the cost to customize product sizing or to modify the opening sizes not only adds costs, but also creates project delays. The following section will provide a simple and effective design method for project owners, engineering and construction firms to approach cable entry designs.

A. Owner level

Owner-level decision to adopt and standardize on a proper method for sealing cable entries is critical to improve project safety, reduce design risks and costs, and to simplify long-term maintenance and expansions for cabling. Regardless of the design method chosen for cable

entries, it is critical that this decision be clearly and routinely included in the related project documents and communications.

B. Front End Engineering Design (FEED)

Owner-level decisions to standardize on multi-cable transit devices for cable entries should be communicated to the FEED stage of a project and the selected device manufacturer should be consulted for the best methods and early design recommendations. At this stage, Roxtec will be able to provide preliminary drawings and budgetary quotes based on the earliest cable schedule data. At this stage the combined requirements such as area classification, tightness, fire, blast, and the earthing strategy should be assessed as this will drive some of the requirements for wall or floor design, and cable and multi-cable transit system type selection.

C. Project Management Contractor (PMC)

At the time the PMC is selected by the owner, the PMC becomes responsible for communicating owner-level design standards, and cable entry methods should be included. To optimize project standardization and efficiency, the same design method for cable entries should be employed across the full scope of the project. This standardization certainly improves design and construction efficiencies, but more importantly for the lifecycle of the project, it provides the operating owner and/or maintenance teams with a standardized platform to simplify maintenance which reduces total cost of ownership.

D. Detail Design

For electrical and controls teams – during this project stage, the first requirement is to accurately size the aperture for all multi-cable transit devices. This can be easily completed by providing Roxtec with preliminary cable schedules. Roxtec is able to provide the design service for all multi-cable transit devices, and even cable transit design software which the project team may elect to utilize. This software system provides significant time savings when designing multi-cable transits when compared with traditional CAD designs.

To properly size apertures, only basic cable data is required as follows. Roxtec can provide a template to provide this information.

- 1) Cable O.D. for each cable
- 2) Cable type (power, control, telecom, etc.)
- 3) Spare capacity – as a percentage (%), it is important to factor in design changes to add equipment and technology to the project scope as well as consideration for future expansions or upgrades that may require additional cables to be added to the transit. A minimum 30% spare capacity within a multi-cable transit design is recommended, and many projects will add 100% spare capacity, as they have learned that Roxtec transits which are properly designed and installed during original construction reduce costs when compared to installing additional transit devices within an operating facility.

Modifications to cable schedules are ongoing with all projects, and cable transit designs should be frequently updated throughout the project design, as often as cable schedules are updated. With the Roxtec Transit Designer software and consultation, these modifications are relatively simple and quick, and provide updated engineering drawings, bill of materials, delivery timings and budgetary quotes. Again, all involved engineering disciplines should be included in these updates.

E. Civil Engineering

Civil design teams should be included at this time, if not earlier. Before any doorways or window openings are finalized, cut or cast into a building, it is critical to have accurate sizing. Aperture sizing for multi-cable transit devices is no different. To provide the most cost-effective and the safest solutions using multi-cable transits aperture sizing for them should be precise, just as other openings in buildings. As frames should be connected to an earthing system, proper methods to connect the frame to earth must to be established. This is especially important for frames cast into concrete structures where it can be difficult to arrange for such earthing arrangements after casting is complete. Roxtec has specific earth stud arrangements on their frames to simplify this.

F. Construction Contractors (Buildings)

As early as possible, contractors for building construction should receive engineering detail drawings produced by Roxtec, but controlled and communicated by the PMC or EPC teams. At the same time that the construction contractor is sizing doorways and windows, they should also be sizing multi-cable transit apertures.

G. Electrical Contractors

In many projects, it is often several months between the time that civil construction is complete with Roxtec frames installed and the time when cabling is pulled into buildings and equipment. It is important that the onsite electrical contractor team has received training to properly use Roxtec devices to seal cables and cable entries using the owner and manufacturer-approved cable transit design.

It is most important that the Installation Detail Drawings for multi-cable transit devices include a note requiring that the onsite electrical contractor contact the manufacturer for training. Roxtec provides onsite, hands-on training, and web-based or video training is also available. A proper installation of Roxtec transit devices is not complicated, but it is different for many contractors, and training should be defined within the work process.

H. Maintenance Teams

Onsite electrical and instrumentation maintenance teams should also be included as early as possible in the communications and training for Roxtec multi-cable transit devices. These teams will be responsible for safely and cost-effectively maintaining facilities for the extended life cycle.

5. Details Required for Proper Specification of Roxtec Devices

To accurately and efficiently specify, design, install and maintain Roxtec devices, the following details should be considered early in the project and carried forward in routine communications throughout the project:

A. Environmental Demands

- 1) IP requirements
- 2) Vapor-tight requirements

B. Blast Load Demands

- 1) Peak overpressure requirements (mbar or psi)
- 2) Duration (ms)

C. Operating Temperature Demands

D. Cable Retention or Pull Force Demands

E. Material Requirements for Frame and Hardware

Proper selection of frame materials is a required engineering specification, as is the material specification for the hardware and components within a multi-cable transit. TABLE 1 provides a general selection guide for frame materials. For hardware and metallic multi-cable transit components, stainless steel should be specified when stainless frames are specified. When other frame materials are specified, galvanized hardware and metallic components are generally fit for purpose.

TABLE 1

Material Selection Guide for Roxtec Frames

	Post-painted 316L SS	316L, 316, or 304 SS	Galvanized Mild Steel	Mild Steel - Painted
Continuous exposure to corrosive atmosphere	X			
Potential or occasional exposure to corrosive atmosphere		X	X	
Indoor and/or non-corrosive atmosphere			X	X
Fire rating				
Blast rating	X	X	X	X
Hazardous Area (EXe)	X	X	X	X
For use with earthing armored cables ¹	X ²	X	X	X ²

¹ Requires approved Roxtec components (modules and compression) for use with armored cables.

² Interior of frame must not be painted, to provide direct contact with earthing strap for modules used with armored cables.

F. Surface Treatments

- 1) Hot dip galvanized
- 2) Paint or coating specification

G. Method of Installation

- 1) Bolting
- 2) Casting
- 3) Welding

H. Structure Material – thickness of material should be stated with the material type

- 1) Concrete – block
- 2) Concrete – poured
- 3) Steel
- 4) Gypsum
- 5) Brick – masonry
- 6) Insulated panel or sandwich construction

I. Fire Demands

Unlike many other electrical and building standards, fire ratings are typically more regionalized or sometimes even localized, and the authority having jurisdiction should always be recognized. The following fire demands are common for onshore facilities; however it is most important that the project design team specifies the fire rating requirements for each wall, floor or rooftop where Roxtec devices will be installed.

1. ≤ 30 minutes
2. ≤ 1 hour
3. ≤ 2 hours
4. ≤ 3 hours
5. ≤ 4 hours

Further, the prevailing fire code or fire standards should be communicated in the specification and must be communicated with Roxtec, i.e. UL 1479, 1 hour rating for poured concrete wall.

J. Cable Type

To properly specify and design Roxtec devices, it is critical to identify the cable type that will pass through the Roxtec device. The following basic categories will typically provide sufficient information to Roxtec to assist with proper specification of the multi-cable transit system.

1. Armored Cable
 - i. Steel wire armor (SWA)
 - ii. Metal clad (MC), including TECK cable
 - iii. Braided, (Copper, Steel, ...)
2. Non-armored cable or Tray Cable
3. Circular or non-circular cable

Armored cable types may require the use of a Roxtec transit that is approved to provide bonding, earthing or grounding of the cable armor, depending on the application and electrical code of the authority having jurisdiction. If the project design is using cables that are non-circular, Roxtec should be consulted in detail to review systems approved for the non-circular cables with the specified demands.

K. Bonding, Grounding, and EMC Requirements

Does the location, surrounding environment or nearby electrical, instrumentation or other potentially sensitive equipment require protection from electromagnetic interference (EMI)? Will your project use armored cables which must have the armor earthed? Either way, Roxtec should be consulted to provide recommendations to meet your EMC demands. The following general information should be provided.

1. Type of protection required
 - a. Bonding & Grounding
 - b. Conducted interference
 - c. Radiated interference
 - d. Both conducted and radiated interference
2. Relative details of environment or equipment to be protected
 - a. Frequency range
 - b. Required protection levels

L. Installation Details

1. Cable Fixing Point - While a Roxtec device provides robust cable support and a defined fixing point, industry standards require that cables should be supported in additional methods when the cable runs vertical, or is "not laid on top of horizontal cable trays or supports", according to Offshore Standard DNV-OS-D201, April 2011. Additionally, BS 7671, EC60364-series and other standards require "the intervals between cable supports to be such that cables do not suffer mechanical damage or strain", and provide the guide as shown in TABLE 2.
2. 90° Entry – all cables should be installed to enter a multi-cable transit frame at a 90° angle.
3. Cable length should be measured to the termination point and enough slack or surplus should be left to allow for lifting and placement of the cable into the multi-cable transit frame and modules.

TABLE 2

BS 7671 – Armored Cable Maximum Support Spacing

Cable O.D (mm)	Horizontal (mm)	Vertical (mm)
>9, but ≤ 15	350	450
>15, but ≤ 20	400	550
>20, but ≤ 40	450	600

6. Conclusions

Roxtec multi-cable transit devices are innovative technologies that have proven their safety record throughout some of the harshest conditions within offshore oil/gas and marine projects. As onshore projects strive for improved safety, increased efficiency for project deliveries, and lower total costs of ownership, Roxtec devices should be considered for inclusion into owner-level approvals, standards and specifications for cable entries.

Taking a decision to standardize on a cable entry method is not complicated or time consuming. However, it is proven across many mega-projects, that by not taking a formal decision at the project owner level, that creative and non-approved methods are commonly utilized, and in too many cases, no cable sealing method is applied.

Roxtec devices are standardized in the design. The standard width of each window within a

frame is 120mm and the standard depth is 60mm, although many other sizing options and configurations are available for both frames and components. Roxtec frames can be designed in small single windows, or larger combination frames with multiple windows with different orientations to meet differing project demands. Although Roxtec frames and apertures sizing are mostly standardized, the specialized components, e.g. earthing armored cables, and the product certifications for fire, blast and operating temperatures can vary. It is important to be in close communication on these details early in project scopes.

Complete multi-cable transit engineering design services, onsite installation training and project support are also provided by Roxtec. Since multi-cable transits are a relatively new technology to many onshore designers and installers, it is important to select a provider that is resourced to support the project requirements with the most efficiency, from FEED through long-term project maintenance.

Specifying Roxtec devices is simple when a design team includes the vendor early in project discussions. To obtain the highest levels of safety and reduced project risks (design, installation, and maintenance) Roxtec devices should be considered by project owners to be included within company engineering standards for the electrical, control and civil disciplines.

When people and assets require protection from the risks of weather, harmful gases, blast, fire, rodents and/or EMI, Roxtec multi-cable transits are a proven, certified and cost-effective solution.

7. References

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10. BS 7671 "Requirements for Electrical Installations"
11. API RP 505 "Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, and Zone 2"
12. IEC 60364 "Low Voltage Electrical Installations", Section 522.8.4

8. Vita

Allen Gibson is a graduate of Oklahoma State University and since 1990, has worked for international oil and gas companies in both technical and commercial roles, and served as President/CEO of a US-based LPG company. He is a member of the IEEE Industrial Applications Society and a member of the PCIC Middle East Local Committee. Since 2007 he has worked for Roxtec Group and serves as the Global Segment Manager for Process Industries.
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Roxtec is the world leader in modular-based cable and pipe penetration seals. Roxtec transits are used worldwide in a wide range of projects and industries to ensure safety, efficiency and operational reliability. The Roxtec sealing system protects against, for example, fire, gas and water, and includes solutions for electrical safety.



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