

Supply circuit disconnecting means with rotary handles in compliance with NFPA 79 and UL 508A



Technical Paper
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– Fulfilling key requirements of relevant North American standards –

Abstract

Differences between IEC and North American standards already become apparent when discussing even the most basic of component accessories, such as the operating handle of a supply circuit disconnecting switch. For example, main disconnect switches equipped with door mounted rotary handles, and installed in industrial control panels for industrial machinery applications, essentially require the use of an additional internally mounted supplementary handle in order to meet all of the requirements found in the relevant North American standards dealing with this application. An important change in an earlier (2002) edition of the NFPA 79 standard for industrial machinery panels led to this significant development. It became an essential requirement of the standard at that time for an operating handle to maintain contact with the disconnect switch at all times, regardless of door position.

Furthermore, in cases where the main switch needed to be accessed internally and switched on by qualified persons, let's say for maintenance purposes, the standard already required, under its door interlocking provisions, that a deliberate action initially be performed by such persons before the disconnect switch could be engaged successfully, in order to enhance the inherent safety of personnel and of the assembly. Thus, an additional level of sophistication for the internal supplementary handle, combined with a door mounted rotary style handle, became necessary in order to meet all of the requirements of the relevant standards in this respect. Eaton Moeller now supplies such supplementary handles, which feature a deliberate action consisting of a travel of the handle to a certain position, followed by a simultaneous push and turn of the handle through to the ON position. The handle has all the necessary certifications, and is now part of the component program. This paper will address in more detail the ramifications of this development in North American standards as well as provide potential end-users with various solutions to meet the requirements.

Introduction

In the IEC world the rotary handle is the popular choice, and it's by far the most widely encountered type of operating handle for main disconnect switches in these various countries. In the US and Canada, the situation is markedly different, and the use of similar rotary handles for main disconnect switch applications is not nearly as prevalent, chiefly due to the fact that the conventionally door mounted operating handle separates from the switch when the door is opened, and this feature is considered less than desirable. Countless millions of rotary handles in IEC countries throughout the world are thus located on the outer door portion of a control panel when the door is open, and that is perceived as a problem in North America, since it is alleged to potentially invite the actuation of the switch mounted inside without the use of a proper handle. However, that was only a theoretical problem, since Eaton Moeller, for many years, had been offering a supplementary handle that mounted directly onto the extension shaft and the body of the switch inside the panel. The supplementary handles Type *NZM...XDZ* have always been available for the purpose of providing qualified persons with a means to actuate the switch from inside the control panel without the use of a tool. (**Photo 1**). The bar is, however, set even higher in these cases by current NFPA 79 [1] und UL 508A [2] standards because, in the event that the door of a control panel housing the main disconnect switch has been opened, the standards mandate that an additional and premeditated action (*Deliberate Action*¹) on the part of a qualified person be required in order to effect a change in the operational state of the switch from OFF to ON. Although this requirement of the NFPA 79 standard directly impacts significant design aspects of the operating handle of a supply circuit disconnecting means used in electrical control panels for industrial

machinery, particularly those involving IEC style door mounted rotary handles, its primary goal naturally is not to make component design more difficult, but rather to provide industry floor personnel with an extra measure of protection from electric shock through the use of suitable enclosures, specifically the need for adequate interlocking provisions with the supply disconnecting means whenever there is the potential for exposure to live equipment. The new supplementary handles Type *NZM...XHB-DA(R)-NA* from Eaton Moeller fulfill all of the more stringent North American standards requirements in this respect. They can also be used in all types of control panel applications extending beyond those solely related to industrial machinery. Their usage would, of course, also provide an additional measure of safety in start-up and maintenance situations for any installation in the IEC world using switches with door mounted rotary handles. The supplementary handles can be used on all *NZM* circuit breakers, (*P/N*) switch-disconnectors and *NS* molded case switches, whether or not these products are being used as a supply circuit disconnecting means in any given application.

IEC compliant solutions are not always sufficient to meet all requirements in North America

This author has dealt extensively with the topic of „Export of electrical components and systems to North America“ by giving comprehensive seminars and writing several detailed technical papers on the matter. (<http://www.moeller.net/de/company/news/publications/index.jsp>). One recurring theme in all of these endeavors has been that widely applied and accepted technical solutions rooted in comprehensive and well established IEC standards are often considered inadequate when going up against comparable North American requirements, specifically those from relevant NFPA installation standards such as the NEC² and

¹ will be described in more detail in the paper

² NEC = NFPA 70 = National Electrical Code, USA

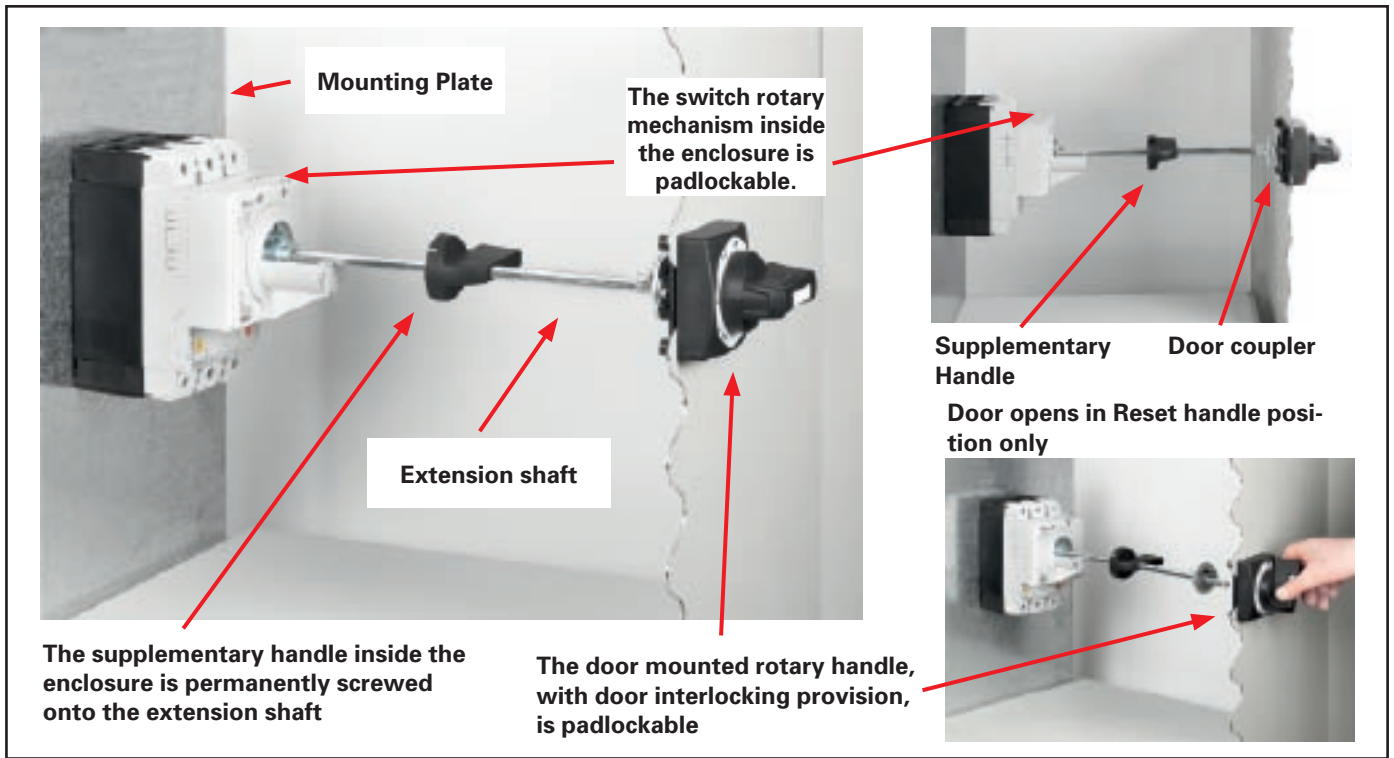


Photo 1: Former solution with older version supplementary handle, lockable rotary switch mechanism and lockable door mounted handle.

CEC³, as well as in various UL and CSA safety standards dealing with product and engineered assembly approvals. In many instances, these differences can cause conflicts and hardships to arise during local inspections of products at the end-user facility, or whenever power is required for the start-up and commissioning phases of a new project or refurbished installation.

This paper deals mainly with the operating handles of circuit breakers, switch-disconnectors and *Molded Case Switches* [3], which would be used as the supply circuit disconnecting means of electrical control panels for industrial machinery per the NFPA 79 standard. These switches are normally operated from the exterior of the control panel, with the panels doors closed. The switches themselves are mounted internally and their operating shafts extend through the door, all the while maintaining the necessary environmental rating of the outer handle and enclosure assembly. The operating handles are mounted on the door panel exterior. Eaton Moeller refers to this style of switch operator as a „door-mounted rotary handle“. A coupling piece enables the opening and closing of the control panel door, either with or without any dependence on the position of the main contacts. An elaborate offering of addi-

tional handles and accessory parts are available as well in order to fulfill a number of special application requirements. Standard operating handles come in black, with red-yellow versions for Emergency-OFF applications, as well as operating handles with or without defeating mechanisms (**Table 1**), and handles with environmental ratings to cover both IEC and UL/CSA type rated

requirements. IEC type operators are dual position (ON and OFF) handles and, if applicable, include a third position (Trip) as dictated by the type of switch. These models also have UL/CSA certification. Control panel doors equipped with IEC style door mounted rotary handles with a built-in door interlocking feature can be readily opened as soon as the switch is in the OFF position,

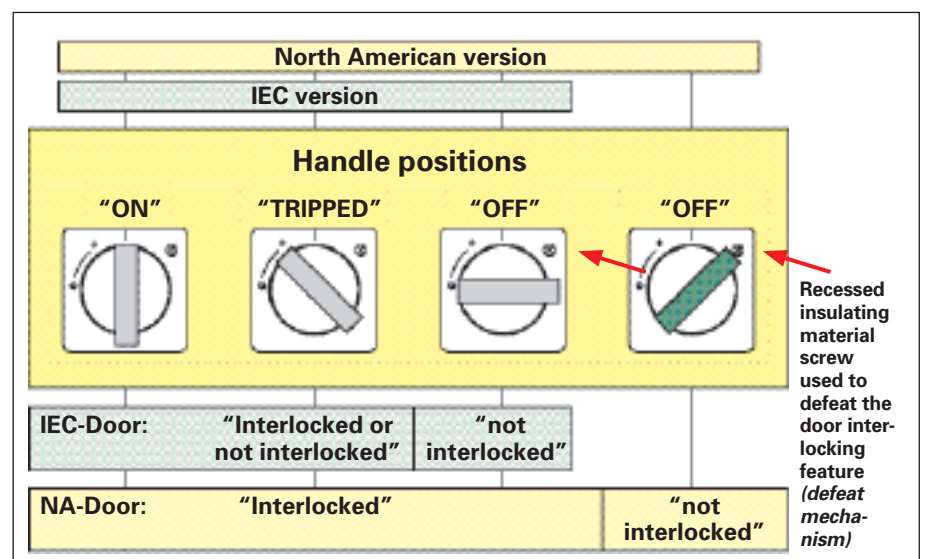


Photo 2: IEC style Door mounted rotary handles feature 3 switching positions whereas North American versions have 4. The North American versions allow the door to open when the handle is rotated through an overtravel, to a position slightly beyond OFF. The word „Reset“ is located at that position. The word „Reset“ further indicates that, after a trip, the handle needs to be first brought back to the OFF position before the switch can be re-closed.

³ CEC = Canadian Electrical Code, Kanada

Operating handle modification possibilities for molded case circuit breakers and switches Type NZM, N, NS, PN

Type	Door interlocking			Padlocking capability	
	is activated, when handle closes switch			Padlocking on handle only when door is closed. Padlocking on switch is possible also with door open.	
	Door opening in positions			Padlocking in positions	
	also in ON	only in OFF	only > OFF	ON + OFF	only in OFF
IEC-Door mounted rotary handles					
NZM...XTVDV(-60)(-0)	wT	+	-	mH	H + S
NZM...XTVDVR(-60)(-0)	wT	+	-	-	H + S
NA-Door mounted rotary handles					
NZM...XTVDV(-60)(-0)-NA	wT	-	+	-	H + S
NZM...XTVDVR(-60)(-0)-NA	wT	-	+	-	H + S

+ = normal - = not possible S = on Switch H = on Handle mH = modification on Handle possible wT = defeatable with the use of a Tool
Only > OFF = Door can be opened when handle is turned beyond the OFF position.

Table 1: The table shows door interlocking and padlocking capabilities of handles and switches as they are supplied from the factory, along with various field modification possibilities.

whereas special North American versions of the same style handles require a slightly extended travel beyond OFF in order to release the mechanism and allow the door to open. (Photo 2). North American standards are very much application based. Thus, it's always a good idea to keep the application in mind when considering a particular design or solution to any particular engineering task. As such, there may not always be a need to consider the special requirements of a "supply circuit

disconnecting means" to a panel. This paper deals mostly with electrical apparatus for industrial machinery, which is considered to be a specific use application per the standards. Article 670 of the NEC (NFPA 70) defers the details of this application to the specialized standard NFPA 79 „Electrical Standard for Industrial Machinery“ (Photo 3). There is also the predominant UL standard to consider for the design and building of "listed" (3rd party certified) industrial control panels, i.e. UL 508A. The UL

508A standard, accordingly, differentiates between "General Use Industrial Control Panels" in Part 1, and " Specific Use Industrial Control Panels" in Part 2. The electrical controls for machines (Industrial Machinery) are covered as Specific Use Industrial Control Panels in sections 65 through 67 of the UL 508A standard. The standard acts more or less as a supplement in this regard to the NFPA 79 standard, which describes all the critical and relevant requirements for machine control in much greater detail. The following main themes covered in this paper:

- Switches with rotary operating handles,
- Door interlocking provisions,
- Padlocking capabilities,
- Actuation of the switch independent of the door position, and finally:
- „Deliberate Action“

are essentially concepts which are more relevant and appropriate when discussing the requirements of a supply circuit disconnecting means for industrial machinery, and are not necessarily applicable to the topic of main disconnect switches for general applications. The special features of the Type NZM...-XTVDV-DZV6 supplementary handle, to be described in greater detail later in the paper, also lend themselves well to both IEC and North American applications extending beyond the requirements of any specific usage standard. There are, furthermore, „General Use“ and additional „Specific Use“ industrial control panels per UL 508A for which the concept of a deliberate action, as it relates to interlocking provisions for

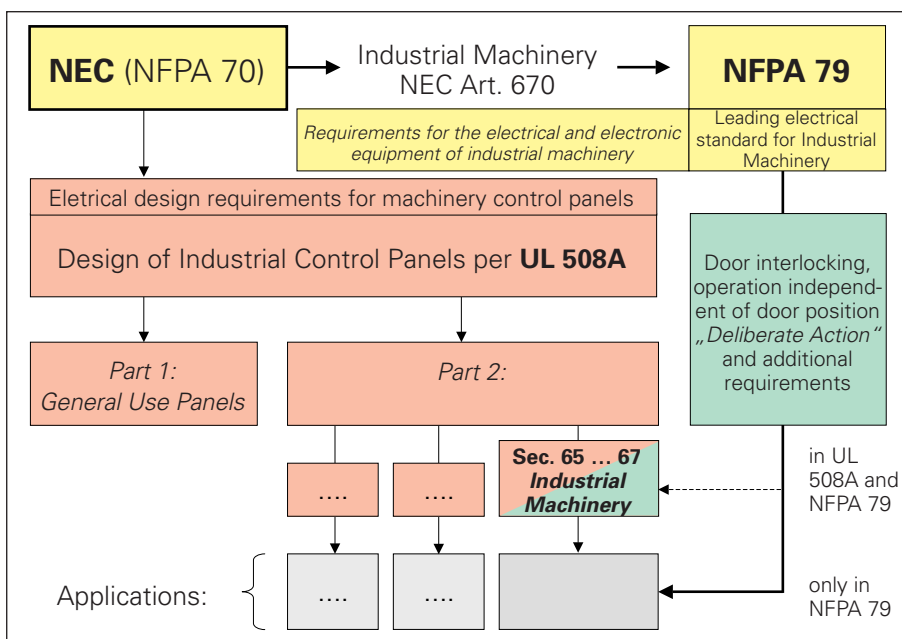


Photo 3: The main disconnect switch requirements described in this paper deal primarily with electrical control panels suitable for industrial machinery applications per UL 508A and NFPA 79. Of course, these features can also be incorporated in any other type of industrial control panel assembly.

IEC and UL/CSA (NEMA) operating handle environmental ratings for molded case circuit breakers and switches Type NZM, N, NS, PN

Type	Environmental Rating IEC / EN - UL / CSA	Handle color	Characteristics
IEC- Door mounted rotary handles			Door interlocking possible only in yellow marked fields *) in ON, the door interlock can be defeated with the use of a tool The door interlock cannot be defeated, if the handle is padlocked off. Door opens in OFF- Position *)
NZM..XTVDV(-60)(-0)	IP 66 UL / CSA Type 12 + 4X	black	
NZM..XTVDVR(-60)(-0)	IP 66 UL / CSA Type 12 + 4X	red	Padlockable on handle and switch.
NA- Door mounted rotary handles			Door opens only when handle is turned beyond the OFF-position *) Padlockable on handle and switch. Padlockable on handle and switch.
NZM..XTVDV(-60)(-0)-NA	IP 66 UL / CSA Type 12 + 4X	black	
NZM..XTVDVR(-60)(-0)-NA	IP 66 UL / CSA Type 12 + 4X	red	

Table 2: Operating handle variations with their corresponding North American environmental ratings. Particular attention to door interlocking and padlocking requirements in North America for operating handles is warranted. All operating handles are UL listed and CSA certified. The NA versions of the door mounted rotary handles are the preferred choice for North American applications. The IEC versions of the door mounted rotary handles in the NA market place are tolerated for the most part.

industrial machinery, is not specifically mentioned as a requirement. (Table 2). One could, therefore, legitimately and with good conscience, make use of other well proven operator accessories for these applications, such as the side and rear operated handles (Photo 4) for circuit breakers and molded case switches. Even though, as part of their basic design aspects, these handles do not separate and always maintain contact with the switch, they would not, on their own, be suitable for industrial machinery applications, since they do

not inherently provide for the required "deliberate action" which is part of the interlocking provision requirements for this application. In these cases, one should at least plan to include an electrical interlock as part of the design.

Switch operation per North American conventions

A particular aspect of North American style main disconnect switches is that the switch operating means or handle

always remains in physical contact with the switch, independent of any door position. Although this had been the convention throughout many years, it took on added significance when it became part of the requirement outlined in the main electrical standard for industrial machinery (NFPA 79) in 2002. It became apparent that the new requirement clearly posed potentially serious acceptability problems for typical door mounted rotary handles commonly seen and used in IEC style applications worldwide. The standards don't spell out any specific solution. One of the main requirements simply states that the supply circuit disconnecting means must remain operable at all times to qualified persons, independent of the door position⁴, without the use of a special acces-

⁴ UL 508A: Par. 66.6.3; NFPA 79: Parts 5.3.3.1.5, 5.3.4.2.1, 5.3.4.2.3

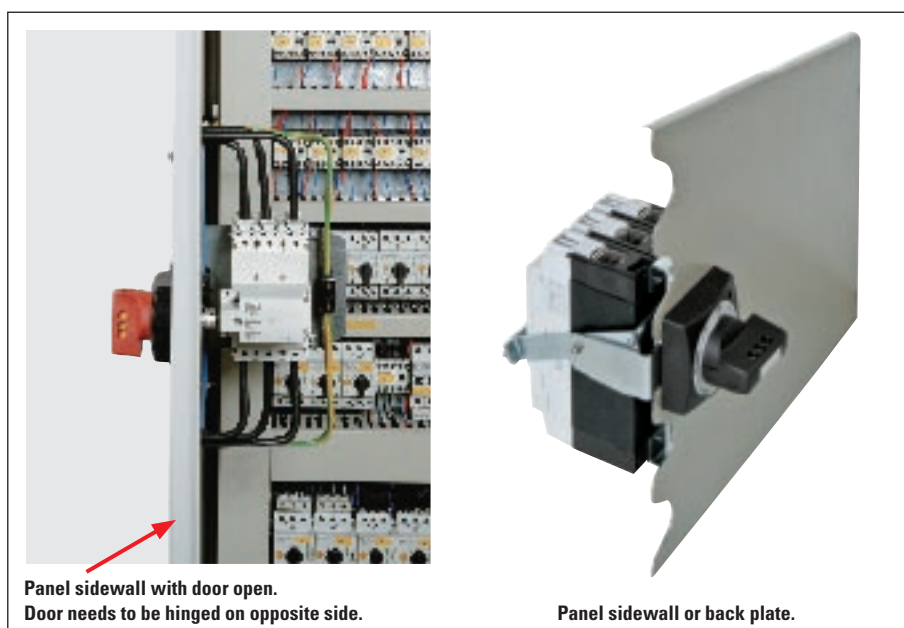


Photo 4: Switches with side mounted rotary mechanisms (left) or with rear operation (right) are suitable in this form for all types of Industrial Control Panels per UL 508A, but not specifically for industrial machinery on their own. Depending on the application, additional electrical interlocking circuitry could be necessary to fulfill all requirements.

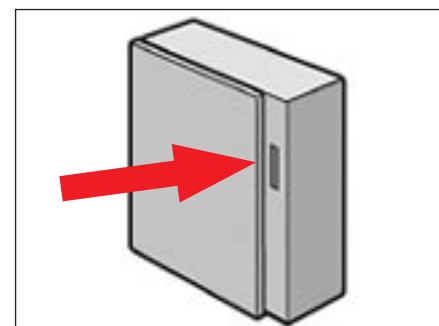


Photo 5: Typical North American enclosure with a flange mount and opening on the side to allow for "vertical motion" handles.

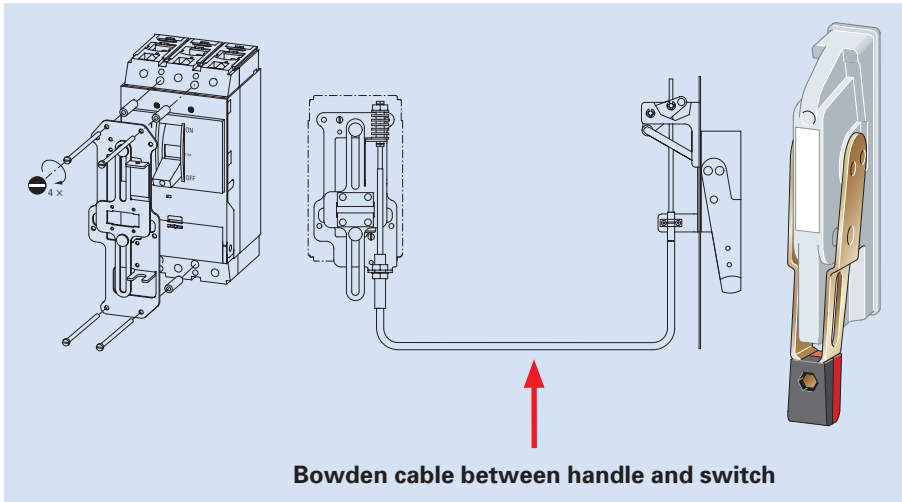


Photo 6: The vertical motion handle (right) depicts the typical North American main disconnect switch handle which, independent of the door position, remains in contact with the switch. The use of flexible, Bowden cable solutions is more often encountered in control panel applications. The handle and enclosure also combine to mechanically interlock with the door.

sory tools or devices. This convention peculiar to North America is partly realized through the use of specially designed enclosures featuring a flange portion on the front sidewall surface of the enclosure (Photo 5), which is designed to accommodate or link with typical North American side-mounted vertical motion or “flange mounted” handles (Photo 6). These types of handles are not very well known in Europe and are considered rather unconventional there as well as in other IEC countries. As mentioned, they feature a vertical operational motion. These relatively large and mechanically robust handles are either mechanically linked directly with the switch or come attached to the switch via a flexible Bowden type cable assembly tied to a sliding mechanism designed to actuate the switch toggle operator. This latter solution allows more flexibility in terms of positioning the switch inside a panel assembly whereas the direct mechanical link of the former would require the switch to be placed more closely to the flange opening side of the enclosure. Regardless of whether the control panel door is open or closed, operational access to the switch for ON and OFF operations is theoretically maintained at all times, and that’s the main purpose of the design.

The *Vertical Motion Handles* additionally provide a mechanical interlocking feature with a single or multi-door control panel, either directly or with the use of additional mechanical enclosure provisions. **As a general rule, incoming supply circuit disconnect switches should only be able to be switched ON once all control panel doors have**

been closed, and door interlocking provisions have been activated.

US and Canadian standards allow qualified persons to temporarily bypass the door interlocking feature of a control panel by actuating, with the use of a prescribed tool, a manufacturer supplied defeat mechanism normally provided on the operating handles of switches used as the supply circuit disconnecting means. A condition for this, however, is that the defeat mechanism is fully deactivated and the interlocking provision becomes automatically re-instated once all of the control panel doors have been reclosed⁵. The handles must also have a padlocking feature to be in full compliance with the NEC and OSHA standards. Per UL 508A Section 30.4.4 and NFPA 79 section 5.3.3.1.3⁶ the operating handle of the disconnecting means must be capable of being locked in the „OFF” or open position.

As previously described, it is allowed for qualified persons, with the use of a proper tool, to gain access to the inside of a panel with the main switch in the ON position and thus under live conditions. An appropriate tool to use for the defeater mechanism could be, for example, a particular screwdriver identified by the manufacturer as being suitable for the purpose. The ability to work without removing power has many practical advantages such as troubleshooting a faulty circuit and making necessary adjustments to protective devices. It will

later be described in greater detail how qualified persons, by undertaking a deliberate action, are also able to close a main disconnect switch with the control panel door open in order to re-establish power in a panel.

Comprehensive testing of vertical motion handles, Bowden cables and switches from various brands have demonstrated that their usage in the IEC world would not be permitted, for the mere fact that a successful outcome of critical performance testing of the actuator mechanism on present designs per the IEC standard (IEC/EN 60 947 [4]) could not be verified. Eaton Moeller does offer this style of operator because of their strategic importance on the North American market, but only under condition that they be installed in North America only. The handles do not bear the CE mark⁷. Technical information in catalogs and accompanying documentation also refer to these application constraints. A re-import into the IEC world would not be permissible. In the aforementioned test per IEC/EN 60 947 to verify the operational performance of the actuator mechanism, the main contacts of a switch are purposely welded closed and under these conditions, it is strictly forbidden for the operating mechanism of the switch to be physically brought into the OFF or OPEN position and allow the installation of a padlock. The reasoning behind the IEC standard makes perfect sense from a safety point of view. If a padlock were to be installed in the OFF position of the operator under these conditions, an unsuspecting user could be easily be fooled into concluding that the circuit on the load side of the welded switch would be open, when it is in effect live. A comparable performance test in North American standards to verify the suitability of an actuating mechanism in this respect is not currently in place. Machine manufacturers and panel builders, who normally work in accordance with IEC and EN standards, also have misgivings about incorporating vertical motion handles into their assemblies, and would normally only do so under the expressed wishes of their North American customers. Panel builders who deal in export markets look towards the implementation of solutions which would ideally have global conformity. Under this pre-requisite, it’s not realistically possible to unify a design based on the use of a vertical motion handle.

⁵ UL 508A: Par. 66.1.5.1; NFPA 79: Par. 6.2.3.2

⁶ For brevity purposes, the paper references the US norms only.

⁷ Conformité Européenne, the CE mark allows products so marked unimpeded access to markets within the European Union.

Industrial Control Panels in accordance with UL 508A					
Features/Characteristics /Requirements	Part 1	Part 2			
	General Use Panels	Industrial Machinery	Crane Control	Elevator Control	... Additional Types
	General Use	(in coordination with NFPA 79)			
NEC compliance	X	X			
Suitable enclosure environmental rating	X	X			
Ambient temperature considerations	X	X			
Main Disconnect switch	- / O *)	X			
Door interlocking	- / O	X			
Main Disconnect switch / padlockable door	- / O **)	X			
Main Disconnect switch supplementary handle with Deliberate Action	- / O	X ***)			
Door interlock defeat mechanism	- / O	O			
Automatic re-activation of door interlock	- / O	X	Refer to UL 508A for additional Specific Use type Panels		
Deliberate Action	- / O	X			
Control circuit transformer	- / O	X			
Enclosure lighting provisions up to 150V, on load or line side of Main Disconnect	- / O	O			
Panel rating label	X	X			
Panel rating label designation: „Industrial Control Panel for industrial Machinery“, largest heating load	-	X			
Label (e.g. from UL) to conform with NEC	X	X			
... additional requirements					
Construction in accordance with UL 508A, Section.....	1 - 61	65 - 67	68 - 72	80	Refer to Standard
		62 - 64			
		1 - 61			

X = Required O = Optional - = not a requirement, not applicable

*) Refer to UL 508A, 30.3 / 60.1 **) Refer to UL 508A, 30.4 ***) Applicable to door mounted rotary handles

Table 3: The requirements for various types of industrial control panels per UL 508A are not always completely identical. The most comprehensive requirements are generally associated to industrial control panels for industrial machinery, which are in line with NFPA 79, the US national electrical standard for industrial machinery.

Even the North American automotive industry, arguably the most prominent user of this type of handle historically, has already started giving signals that it may be seriously re-considering the use of this relatively expensive operator in their own future installations in favor of a more globally accepted and modern approach. Their reasoning relates as well to the overall theme of enhanced safety in the workplace and the influence of a union based workforce, which is still an integral part of this industry in North America.

Fulfilling North American requirements with rotary handle equipped disconnect switches

There really isn't much chance in the foreseeable future to expect a unified approach in the North American market place with respect to the selection of either vertical motion or rotary handles for use with main disconnect switches. The UL 508A standard for industrial control panels does allow both designs in all applications as long as they meet applicable requirements and follow proper conventions with respect to OFF and ON handle positions.

In the introduction we touched upon the Eaton Moeller supplementary handle Type NZM...XDZ, which fits onto the switch extension shaft inside the panel and has been available for many years now. This time proven accessory, as well as the more recent version Type NZM...XTVDV-DZV6-NA to be described next, need to be permanently attached onto the extension shaft in order to meet the provisions of the UL 508A (par. 66.6.3) and NFPA 79 (sect. 5.3.3.1.5) which require the operating mechanism to be readily operable⁸ without the use of accessory tools or devices, i.e. articles which could otherwise normally be part of tool kits carried by qualified persons performing maintenance duties. Both of these solutions from Eaton Moeller, therefore, took into consideration the need under this context for the main disconnect switch to be operable using two separate handles. The primary handle is mounted on the panel door exterior and provides the required functionality with the panel door closed, whereas the supplementary handle, which is mounted on the switch extension shaft, is accessible to operate the switch whenever the door is open. Whether the older or more

⁸ UL 508A, Pkt. 66.6.3.A, NFPA 79, Punkte 5.3.3.1.3, 5.3.3.1.5

recent version of the supplementary handle is used, Eaton Moeller still equips the rotary mechanism of the switch itself, which is part of the switch housing inside the panel, with a padlocking feature. This provides the switch with a permanent means to be locked in the OFF position, independent of the door position, and thus fulfills an important requirement of the NFPA 79 standard (sect. 5.3.3.1.3) with respect to devices suitable for use as the supply circuit disconnecting means. The feature effectively helps to safeguard against inadvertent closing of the main disconnect switch when the control panel is open. As mentioned, the padlockable switch rotary mechanism mounts on the switch housing inside the panel. In order to simplify ordering procedures, this rotary mechanism is bundled together with the extension shaft and supplementary handle as part of a kit, which is made available under one part number. The rotary mechanism also features a clearly visible means to indicate switch position when the control panel door is open, which is also part of the requirements. The three main aspects combining both features and requirements, i.e.:

- Operational capability,
- Switch position indication, and
- Padlocking feature

can be achieved in both sets of handles when all parts and switch combinations are selected appropriately, and thus fulfill an important premise of the standard that the main disconnect be readily accessible at all times to qualified persons, *independent of the door position*. As long as a control panel is equipped with a single door only, the interlocking provisions of the UL 508A and NFPA 79 standards can be easily fulfilled mechanically with various configurations of door mounted rotary handles (Table 3). All UL/CSA certified IEC style models of door mounted rotary handles, also those for use with IEC version of circuit breakers and molded case switches, feature 3 distinct switch position indications:

- ON
- TRIP and
- OFF.

In the ON position the handle mechanically interlocks with the door and in the OFF position allows the door to open. As previously mentioned, the North American version of the handle, with the suffix „-NA“, features an additional 4th position (Photo 2). In order to reach this position, the handle has to be

rotated through a slight overtravel beyond the OFF position. Only in this position does the handle completely release the interlock and allow the door to open. Both IEC and NA versions have a *defeat mechanism* feature to permit qualified persons the ability to bypass the interlock.

In the case of a larger control panel with multiple doors, an electrical door monitoring circuit⁹ must be incorporated in addition to the mechanical interlocking feature of the primary door mounted rotary disconnect in order for the position of all doors to be properly monitored. Dual door panels are normally equipped with two positioning (limit) switches in order to insure that both doors are closed before power can be restored. In the machine tool industry the use of more sophisticated positioning switches (safety limit switches) equipped with a mechanical door latching feature is considered more advantageous. On those auxiliary control switches the design is such that the mechanical latch feature is released electrically, in similar fashion to the monitoring circuitry used for protective grids in modern machinery. These solutions introduce, therefore, more than just a straight mechanical interlocking feature into the overall picture. Rather, they reliably establish both a mechanical and electrical linkage between the door

position and the position of the main disconnect switch contacts. On dual panel doors, the door with the locking mechanism is normally equipped with the positioning switch featuring the mechanical latch whereas the other door can get by with just the simpler conventional limit switch (Photo 7). The electrical portion of the door monitoring circuit works in conjunction with shunt or undervoltage trip accessories mounted in the disconnect switch or switches. These accessories help to both trip the disconnect switch open, or prevent its closing when a control panel door is open. The monitoring circuit is also provided with a defeating feature which would enable qualified persons to open doors and gain panel access without tripping the main disconnect switch open, or the ability to close the disconnect switch through deliberate action for maintenance and troubleshooting purposes. The circuit has to be set up in such a way that the defeating feature automatically disables itself once the last remaining door has been re-closed in order to re-engage the interlock. Following that, the defeating mechanism needs to remain active to be ready for the next time a maintenance procedure would require the defeater to be re-engaged. The combined interlocking features of both the door mounted rotary handle and a positioning switch with a mechanical latching feature certainly provide a clearly evident and sufficient deterrence against efforts to open panel doors

⁹ Allowable per NFPA 79 Sect. 6.2.3.1

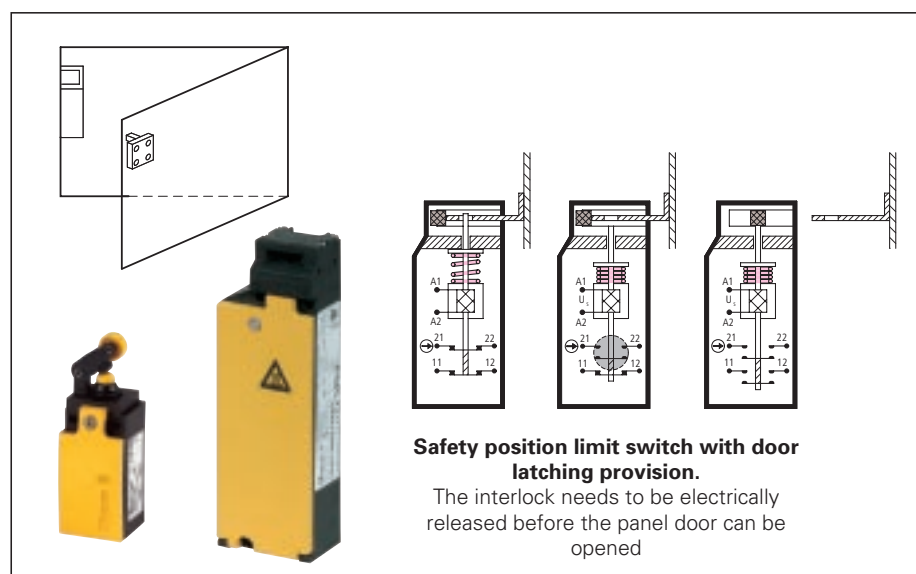


Photo 7: Simple positioning (limit) switches or switches with additional door latching features are used for monitoring purposes in control panels with multiple doors, or with doors installed on both the back and front of a panel. The electrical interlock works directly on the main disconnect switch or switches. Normally a defeat mechanism is designed in, so that panel doors can be opened under live conditions for maintenance or troubleshooting purposes.

under live and potentially hazardous conditions. These protective measures could, however, become disabled through a deliberate use of sufficient force based on malicious intent. One could make the presence of an interlocking provision even more apparent in these cases by the use of indicating lights mounted in the door to display an „interlocked“ status. This would provide an effective way to visually indicate that damage to the protective measures in place had occurred. Another alternative would be to use one indicating light to display the interlocked status and an additional light to provide indication that the doors are safe to be opened.

For export purposes it's also recommended to avoid the use of enclosures featuring a common two-way key release in favor of those with latches that accommodate real padlocks, the keys to which would be made available only to qualified persons¹⁰.

The often mentioned UL 508A document is a UL safety standard dealing with all design and construction aspects of various types of UL listed industrial control panels, including those specifically geared towards industrial machinery applications in accordance with the NFPA 79 standard. NFPA 79 is the widely recognized official standard in the US for electrical and electronic apparatus and systems for industrial machinery. The standard is analogous in its scope with the European Machinery Directive standard IEC/EN 60 204-1 [5]. In fact, many aspects of its content have already been harmonized with that standard. Both standards play very crucial roles in the booming machinery export trade to North America from European and Asian countries and thus indirectly contribute to Eaton Moeller's large indirect export business. The impact to electrical components in UL listed assemblies from the changes in the industrial machinery standard described herein are now part of the 1st edition of UL 508A, first published in April of 2001, which includes extensive revisions from September 2005. A large share of these first became effective in the UL standard in March of 2007. The standard now more clearly reinforces, for UL listed assemblies, the requirement in NFPA 79 that an intent to close a disconnect switch when a control panel is open must first be prevented through an interlocking provision, which can then only be bypassed through



Photo 8a: The new supplementary handle for Frame size 2 switches. The well-established door mounted rotary handle, which operates the switch with the door in the closed position, appears in the foreground.

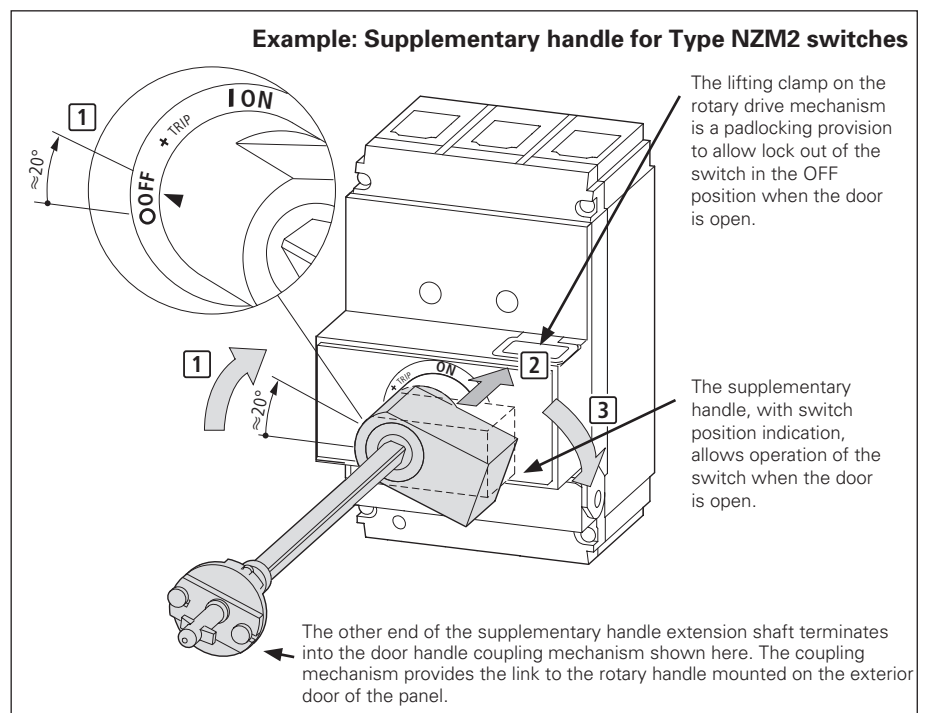


Photo 8b: The new supplementary handles NZM...-XHB-DA(R)-NA requires a deliberate action (by qualified persons) before they can be engaged to operate the switch to the ON position, should the control panel door be open (e.g. for maintenance purposes). The deliberate action consists of the following 3 operational movements:

- 1. The handle must first be turned clockwise appr. 20°.**
- 2. At this 20° position the handle is pushed in to engage the shaft.**
- 3. From this pushed-in position the handle can be turned all the way to ON to operate the switch.**

From the ON position, the switch can be turned back to OFF directly, without any intermediary manipulation. The switch can be locked in the OFF position with up to 3 padlocks using the padlocking provision on the switch housing. If the handle is not turned and pushed in simultaneously during an attempted operation, it simply rotates unengaged up to the point at which its travel perceptibly reaches a preset stop point. The switch is not being operated in this case.

¹⁰ NFPA 79 Sect. 6.2.4.1



Photo 9: A larger version is necessary to adequately handle the greater forces required to switch the larger frame sizes NZM 3 and 4. An identical „deliberate action“ feature consisting of an initial travel followed by simultaneous pushing and turning motion applies to this handle as well.

deliberate action. Main disconnect switches equipped with door mounted rotary handles have the peculiar design aspect that, with an open control panel door, there no longer is a mechanical linkage established between switch and door. This made it necessary to incorporate the deliberate action feature into the supplementary handle mounted inside the panel, in order to fully meet the intent of the standard. Eaton Moeller enjoys a relatively high share of the market for main disconnect switches and is presumably the first European manufacturer to now offer new supplementary handles (**Photo 8, Photo 9**) to meet these stricter requirements now in effect in both the UL 508A and NFPA 79 standards. The goal of the design sought to establish an actuation method which went beyond a simple ON and OFF operation, by introducing a non-instinctive and deliberate procedure to fully engage the handle. The principle is not unlike the safety guards found on the opening covers of medicinal and prescription drug bottles. The solution involves a motion implemented in multiple steps. The first consists of turning the supplementary handle clockwise approximately 20° towards the ON position. At that stage, the handle reaches a point at which it can be pushed in, and then rotated through to the ON position to engage the switch. Two models of the handle, varying in size, were introduced in order to adequately transfer the proper amount of force necessary to actuate the switch mechanism within different frame sizes of the circuit breaker and molded case switch family. The larger one features a more prominent, lever type grip design. If the handles, after reaching the 20°

position, are not simultaneously pushed in and turned, they cannot engage the shaft and simply rotate through unlatched to an end-stop position. The handles feature a clear positional marking dial on the switch housing to help identify their position relative to the switch. The handle and shaft form a single unit which is supplied factory assembled. The length of the extension shaft can be modified by the panel builder as a function of the panel depth and then installed into the final assembly (factory assembly¹¹). The certification also allows the handle to be field installed¹². The supplementary handle fulfills a safety function and is thus not allowed to be removed from the panel once installed. That is a requirement which is deemed necessary, and which UL feels particularly strong about.

An additional warning marking is placed on the supplementary handle to both alert people to the potential dangers arising from restoring power to a panel with the door open and to re-emphasize that the operation must only be undertaken by qualified persons. The chances for a negligent operation to occur can be further diminished by padlocking the rotary switch mechanism in the OFF position with one or more locks. In that way, multiple individuals, independent of each other, can protect themselves against shock hazards and the danger of unintentional machine starts. In accordance with North American practices per the requirements of OSHA (Safety and

¹¹ Factory Assembling = Assembled in a certified manufacturing location

¹² Factory Assembling = Suitably certified for installation

Health), switches with a disconnect function are normally also tagged with a warning stipulating that work is being performed on the machinery or assembly, and that an operation during that time period is not allowed (*LOTO, Lock-out/Tagout*).

For additional safety reasons, and in order to make the procedure even more „deliberate“, a description of the deliberate action operation itself was also purposely left off of the supplementary handle. Qualified persons can learn about the proper way to actuate the handle from instructions provided as part of the machinery documentation, which normally ends up in the possession of the end-user or operator of the assembly. The installation instructions also include detailed and descriptive text in English, which is more desirable in North America than a document with pictorial information only.

Unlike in the IEC world, it's unfortunately not possible in North America to seek a special mark to emphasize conformity with safety relevant aspects of standards and specifications, such as the „GS“ mark in Germany, or the similar TUV and BG markings recognized throughout the EU. However, the new supplementary handles were evaluated by *Underwriters Laboratories Inc. (UL America)*, the most widely known and recognized 3rd party certification laboratory in the US (*NRTL*¹³). The successful evaluation of the handles as recognized components (or listed components) confirm its full compliance with the relevant requirements in North American standards.

Comment from the author:

The possibility of operating a switch through deliberate action with an open control panel door is certainly a safety issue to be considered more likely in control panels of 1 to 2 meters in width, in which the disconnect switch can be accessed more easily. The idea of a main disconnect switch being easily accessible in larger panel assemblies, i.e. panels that are, say, 5 meters in width, is questionable, regardless of whether the handle in question is a *vertical motion* design or a door mounted rotary style. For larger control panels it would thus be worth considering the idea of providing each section with an

¹³ NRTL = Nationally Recognized Testing Laboratories

Emergency-Off control switch in order to provide the capability, should a hazard arise, to trip open the disconnect from each section of the panel. Generally speaking, however, one should always make a point of carefully evaluating whether or not an abrupt disconnection of the main disconnect does indeed lead to a safe condition in the overall picture. Increasingly, more specialized and elaborate safety provisions are becoming necessary, like for example the need for a controlled stop to power down or reverse a dangerous drive. Whether power is removed abruptly via the main disconnect, or in controlled fashion using Emergency-OFF or Stop controlled devices, the final goal is obviously the safe removal of hazardous conditions in all possible cases. [6].

Summary:

The popular and proven door mounted rotary style handle for circuit breakers, switch-disconnectors and molded case switches can still be used in North America in complete conformity with the standards. In control panel assemblies with multiple doors, an electrical interlocking provision, with the capability to automatically re-instate itself after being deliberately defeated by qualified persons, is considered a necessary element of a sound engineering design. New styles of supplementary handles, which are mounted inside the panel onto the

switch extension shaft, make possible the safe and reliable operation of disconnect switches¹⁴ by qualified persons for maintenance purposes, should the control panel door be open. A proper switch closing operation is performed either with the handle mounted on the door, or with the supplementary handle mounted inside the panel, independent of the door position. The required „deliberate action“ is realized by an initial travel to a point at which the handle can be simultaneously pushed in and rotated through to the ON position. The use of the supplementary handle would also be considered a plus for IEC style control panels. Its application in the IEC world would represent a further step in achieving a unified and globally accepted control panel design. Eaton Moeller includes equipment in its product offering to satisfy the needs of both camps, i.e. those who still favor the North American vertical motion handle, and those who would prefer the more IEC leaning door mounted style rotary handle.

Bibliography:

- [1] “NFPA 79 Electrical Standard for Industrial Machinery 2007 Edition” NFPA, 1 Batterymarch, Quincy,

MA 02169-7471
<http://www.nfpa.org>

- [2] “UL 508A Industrial Control Panels”, September 1, 2005” ISBN 0-7629-0398-8 Underwriters Laboratories Inc. (UL) 333 Pfingsten Road Northbrook, IL 60062-2096
- [3] Wolfgang Esser “Safe Isolation of Main Circuits with Switch-Disconnectors *N* or with Molded Case Switches *NS*” Eaton Industries GmbH, 2005, VER1230-950GB, Article No.: 105224 Download: Quicklink ID: 950en at www.moeller.net
- [4] IEC/EN 60 947, „Low Voltage switching and control gear“ – Various sections
- [5] IEC/EN 60 204-1, „Safety of Machines – Electrical equipment of machines - Part 1: General Requirements (IEC 60204-1:2005, modified); German version EN 60204-1:2006”
- [6] Wolfgang Esser „Not-Aus-Betätigung darf Sicherheitsfunktionen nicht beeinträchtigen“ MM Maschinenmarkt, Nr. 32, August 1997 Würzburg, 103 (1997) 32

¹⁴ The proper term used today is : Supply Circuit Disconnecting Means

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