

隔離設備相關法規之探討

■ 育駿企業有限公司

陳錫瑜 / 2961-5979

2009/12/24 攪成肉泥! 疑機器電源沒關, 工人慘死
苗栗頭份一家塑膠工廠...

2010/01/12 電梯夾死人 維修員頭部重創宣告不治
台北樹林發生一起電梯夾傷人...

2010/04/27 誤觸電扇開關? 維修工被絞死
台中市立焚化爐27日...

2010/05/17 機械突然轉動瞬間卡死維修工
南投市南崗工業區一家廢...

從許多因為誤送電而發生死亡工安事故層出不窮地發生, 造成許多悲劇的家庭, 造成社會問題, 也影響國家安定進步的力量。

筆者於多年前, 在新聞報導中, 因為誤送電的情況下造成慘痛的死亡工安事故, 於是致力發掘各國法規的條文, NEC, OSHA, 消防法規等等, 並且提出一些小小建議。

但是回顧現況, 就民國99年, 一年之中因為誤送電而發生死亡工安事故就多

到令人不敢回顧的地步。



綜合以上事故發生, 最主要原因是主電源在維修時無法確實防止誤送電。對於以往開關箱上鎖方式, 更是有檢討的必要。

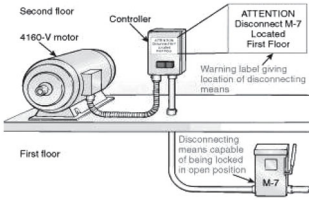
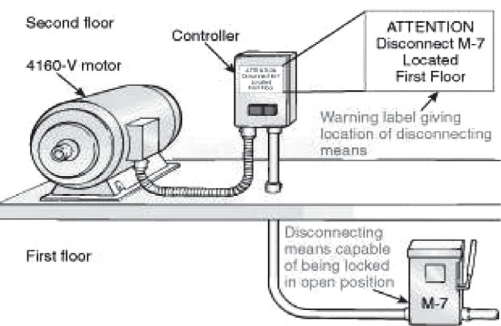
並且於實際狀況下, 隔離設備雖然裝設在電氣設備旁邊, 但是因為機器過於龐大或甚至在視覺死角問題, 而產生誤送電……等等狀況。

有鑑於此, 對於各界指教以及建議要求再補充一些資料說明, 如下以供參考。

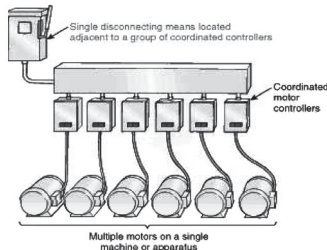
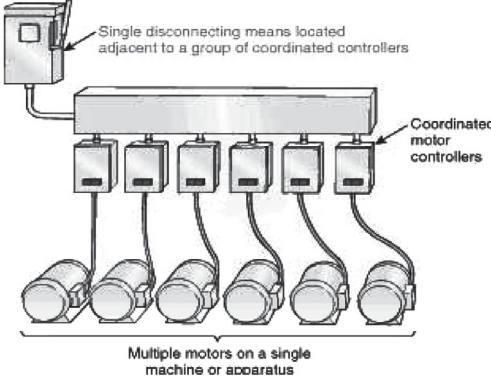
NEC 條文	內容
III Disconnecting Means	三、 隔離設備
422.30 General A means shall be provided to disconnect each appliance from all ungrounded conductors in accordance with the following sections of Part III. If an appliance is supplied by more than one source, the disconnecting means shall be grouped and identified.	第422.30條 (通則) 用電器具之電路應裝設隔離設備，以切斷供應用電器具電路之所有非被接地導線。如用電器具電源為一個以上時，其隔離設備應予分組並加以標示。
422.31 Disconnection of Permanently Connected Appliances (A) Rated at Not Over 300 Volt-Amperes or 1/8 Horsepower For permanently connected appliances rated at not over 300 volt-amperes or	第422.31條 (永久連接用電器具之隔離) 永久連接用電器具，其隔離設備之裝置應符合下列規定： (A) 額定在三〇〇伏安或八分之一馬力以下之永久連接用電器具，其分路過電流保護設備得作為隔離設備。
1/8 hp, the branch-circuit overcurrent device shall be permitted to serve as the disconnecting means. (B) Appliances Rated Over 300 Volt-Amperes or 1/8 Horsepower For permanently connected appliances rated over 300 volt-amperes or 1/8 hp, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means where the switch or circuit breaker is within sight from the appliance or is capable of being locked in the open position. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed. Section 422.31(B) has been expanded to increase safety to maintenance and service personnel working on electrical appliances. The requirement now provides detailed information pertaining to the method of providing the disconnection required by Article 422, Part III. A device that is attached to the circuit breaker handle by a set screw is not an acceptable means to serve as a safe method of locking the device in the off position. The device must have provisions for placement of a lock on it to secure the device in the off position. The lock-out device must be part of the disconnect assembly and must remain in place after the padlock is removed, whether it is a fused disconnect switch, a single circuit breaker, or a circuit breaker in a panelboard.	(B) 額定超過三〇〇伏安或八分之一馬力之永久連接用電器具，如其開關或斷路器係在用電器具可視及之範圍內或開路時可閉鎖者，則其開關或斷路器得作為隔離設備。作為隔離設備用之開關或斷路器應具有閉鎖裝置，其閉鎖裝置應置於適當位置。 本條第二款之規定，係加強維護及服務人員運轉作用電器具之安全。本條為隔離方法之詳細規定。以固定螺絲加裝於斷路器把手之裝置措施，並非為可接受作為閉鎖開關於開路位置之安全方法。此裝置必須具有可在其扣件上裝掛鎖之處，以穩固保持開關於開路位置。閉鎖裝置必須為整組隔離設備之一部分，且在掛鎖移去後，不論其係附裝熔線之隔離開關，單獨斷路器或配電箱內之斷路器，開關必須仍然保留在其原開閉位置。

技術交流

NEC 條文	內容
<p>IX. Disconnecting Means</p>	<p>九、 隔離設備</p>
<p>430.101 General Part IX is intended to require disconnecting means capable of disconnecting motors and controllers from the circuit.</p>	<p>第430.101條 (通則) 電動機及控制器自電路切離之隔離設備，應符合本款之規定。</p>
<p>430.102 Location (A) Controller An individual disconnecting means shall be provided for each controller and shall disconnect the controller. The disconnecting means shall be located in sight from the controller location. The installation shown in Exhibit 430.18 is an example of compliance with the main requirement of 430.102(A).</p>	<p>第430.102條 (位置) 隔離設備之位置，應符合下列規定： 一、每一控制器應有可啓閉控制器之個別隔離設備。隔離設備應設於從控制器位置可視及之處。但有下列情形者，不在此限： 照片 430.18 裝置符合本條第一款規定。每一個控制器的隔離設備應裝設於從控制器位置可視及之處所。</p>
	
<p>Exhibit 430.18 The disconnecting means for each controller, which must be within sight of the controller location. (Courtesy of International Association of Electrical Inspectors) <i>Exception No. 1: For motor circuits over 600 volts, nominal, a controller disconnecting means capable of being locked in the open position shall be permitted to be out of sight of the controller, provided the controller is marked with a warning label giving the location of the disconnecting means.</i></p>	<p>照片 430.18 每一控制器之隔離設備裝設位置 (一)超過六〇〇伏特標稱電壓之電動機電路，其控制器之隔離設備在開放式位置可能被上鎖者，得置於控制器可見範圍外；該控制器則應設有警告標識，載明隔離設備之位置。</p>

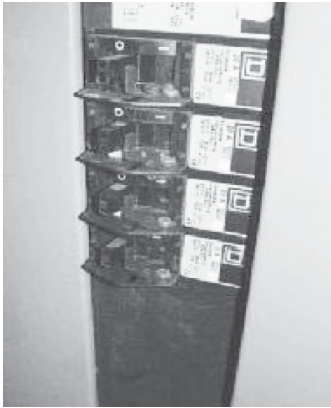

NEC 條文	內容
<p><i>Exception No. 2: A single disconnecting means shall be permitted for a group of coordinated controllers that drive several parts of a single machine or piece of apparatus. The disconnecting means shall be located in sight from the controllers, and both the disconnecting means and the controllers shall be located in sight from the machine or apparatus.</i></p> <p>(B) Motor A disconnecting means shall be located in sight from the motor location and the driven machinery location.</p> <p><i>Exception: The disconnecting means shall not be required to be in sight from the motor and the driven machinery location under either condition (a) or (b), provided the disconnecting means required in accordance with 430.102(A) is individually capable of being locked in the open position. The provision for locking or adding a lock to the disconnecting means shall be installed on or at the switch or circuit breaker used as the disconnecting means and shall remain in place with or without the lock installed.</i></p> <p><i>(a) Where such a location of the disconnecting means is impracticable or introduces additional or increased hazards to persons or property</i></p> <p><i>(b) In industrial installations, with written</i></p>	<p>(二)單一機器或設備由數具可協調控制之群組驅動者，其控制器得使用單一隔離設備，並應裝設在控制器可視及之範圍內，且隔離設備及控制器應裝設在機器或設備之可視及之範圍內。</p> <p>二、隔離設備應設於自電動機及被驅動機器設備處可視及之範圍內。但如符合前款所規定之隔離設備，在啓開位置可個別上鎖時，則該隔離設備有下列之情況之一者，得不設置在電動機及被驅動機械設備之可視及之範圍內。隔離設備之鎖件或外加掛鎖，應設在開關或斷路器操作處。</p> <p>(一)如隔離設備裝設位置不可行或安裝後對人員或財產將增加危險者。</p> <p>(二)隔離設備裝設於工廠，且已訂有安全操作</p>
<p><i>safety procedures, where conditions of maintenance and supervision ensure that only qualified persons service the equipment</i></p> <p>The main rules of 430.102(A) and 430.102(B) require that the disconnecting means be in sight of the controller, the motor location, and the driven-machinery location For motors over 600 volts, the controller disconnecting means may be out of sight of the controller, as illustrated in Exhibit 430.19, provided that the controller has a warning label indicating the location and identification of the disconnecting means, which must be capable of being locked in the open position.</p>  <p>Exhibit 430.19 A motor installation over600 volts, where the motor controller is not located within sight of its disconnecting means.</p> <p>A single disconnecting means may be located</p>	<p>程序書，在維護及監管條件確保僅由合格人員檢修設備下，可對設備處理者。</p> <p>本條第一款與第二款主要規定要求隔離設備必須在控制器、電動機位置及被驅動機械位置可視及之處所。對於電壓超過600伏特之電動機，控制器之隔離設備可裝設在控制器位置不能視及之處所，如圖4-313.2所示，其控制器應有警告標識，標明隔離設備之位置與識別，且隔離設備必須在開路位置時，能予以閉鎖。</p>  <p>圖430.19A 超過600伏特電動機控制器裝設於不可視及之處所 如控制器裝設在由數具電動機帶動持續運轉之機器旁，單一隔離設備可裝設於一組能協調之控制器</p>

技術交流

NEC 條文	內容
<p>adjacent to a group of coordinated controllers, as illustrated in Exhibit 430.20, where the controllers are mounted on a multimotor continuous process machine. The exception to 430.102(B) was revised for the 2002 Code. The disconnecting means may only be out of sight of the motor, as illustrated in Exhibit 430.21, if the disconnecting means complying with 430.102(A) is individually capable of being locked in the open position and meets the criteria of either (a) or (b) in the exception. If locating the disconnecting means close to the motor location and driven machinery is impracticable due to the type of machinery, the type of facility, the lack of space for locating large equipment such as disconnecting means rated over 600 volts, or any increased hazard to persons or property, then the disconnecting means is permitted to be located remotely. Industrial facilities that comply with OSHA, CFR 1910.147, <i>The Control of Hazardous Energy (Lockout/Tagout)</i>, are permitted to have the disconnecting means located remotely. Section 430.102 clearly requires that individual disconnect switches or circuit breakers must be capable of being locked insight of its disconnecting means. A single disconnecting means may be located</p>	<p>旁，單一隔離設備可裝設於一組能協調之控制器旁，如圖430.20A所示。</p> <p>如隔離設備符合本條第一款規定，能夠單獨於開路位置可以閉鎖，且符合第一款第一目或第二目之例外情形，則隔離設備可以設置在看不到的地方。如因機器型式、用電設備型式放置大型設備之空間不夠，例如超過600伏特之隔離設備，或安裝後對人員或財產將增加危險等原因而無法使隔離設備位置鄰近電動機位置與驅動機器時，則隔離設備可以設置在遠處。</p> <p>本條清楚地規定，單獨的隔離開關或斷路器必須能夠在開路位置可以閉鎖。隔離開關或斷路器僅裝設於配電箱已上鎖門後或在已上鎖之屋內，並不符合本條之規定。</p>
<p>the open position. Disconnect switches or circuit breakers that are only located behind the locked door of a panelboard or located within locked rooms do not comply with the requirements of 430.102. The provision for locking or attaching a lock to the disconnecting means must be part of the disconnect and a permanent component of the switch or circuit breaker.</p>  <p>Exhibit 430.20 A single disconnecting means located adjacent to a group of coordinated controllers mounted on a multimotor continuous process machine.</p>	<p>本規則規定要上鎖或在隔離設備上加鎖，必須是開關或斷路器之啓斷的部分且必須是開關或斷路器之一個永久組件。</p>  <p>圖430.20A 數具電動機可協調控制器由鄰近單一隔離設備控制之示意圖</p>

NEC 條文	內容
ARTICLE 440 Air-Conditioning and Refrigerating Equipment	440節 空調與冷凍設備
440.14 Location Disconnecting means shall be located within sight from and readily accessible from the air-conditioning or refrigerating equipment. The disconnecting means shall be permitted to be installed on or within the air-conditioning or refrigerating equipment. The disconnecting means shall not be located on panels that are designed to allow access to the air-conditioning or refrigeration equipment. <i>Exception No. 1: Where the disconnecting</i>	第440.14條 (位置) 隔離設備應位於空調或冷凍設備可視及之範圍與輕易可及之處。隔離設備得裝置於空調或冷凍設備之內或之上。隔離設備與分電箱分開設置時，隔離設備應裝置接近於空調或冷凍設備之處。但符合下列規定者，不在此限： 一、如隔離設備符合第430.102條第一款規定，能在開路位置上鎖，及冷凍或空調設備符合工
<i>means provided in accordance with 430.102(A) is capable of being locked in the open position, and the refrigerating or air-conditioning equipment is essential to an industrial process in a facility with written safety procedures, and where the conditions of maintenance and supervision ensure that only qualified persons service the equipment, a disconnecting means within sight from the equipment shall not be required. The provision for locking or adding a lock to the disconnecting means shall be permanently installed on or at the switch or circuit breaker used as the disconnecting means.</i> Exception No. 1 accommodates special conditions associated with process refrigeration equipment. Typically, this equipment is very large, so rated disconnects may not be available. Additionally, this equipment may be in hazardous locations, and locating disconnecting means within sight of the motor may introduce additional hazards. The provision for locking or attaching a lock to the disconnecting means must be part of the disconnect and a permanent component of the switch or circuit breaker. The term <i>permanent component</i> is used to preclude portable or transferrable-type lock-out devices from	在開路位置上鎖，及冷凍或空調設備符合工業程序依安全製程，及在維修及監管條件確保僅由合格人員檢修設備者，則其隔離設備得免設置於可視及之範圍內。隔離設備應有上鎖或加鎖裝置於開關或斷路器之處或之上。 本條但書第一款適用於有關冷凍設備特殊情況。典型之冷凍設備為非常大的設備，故無適當額定值之隔離設備。另外，此冷凍設備可能位於危險場所，且將隔離設備裝設在電動機位置可視及之範圍，可能導致更加危險。隔離設備規定上鎖或加鎖，必須屬隔離之部分及開關或斷路器之永久組件。所謂「永久組件」就是不能使用可攜式或可轉換型之閉鎖設備，「永久組件」作為開關或斷路器在開路(啓斷)時，有能力予以閉鎖的方法。「永久組件型式」之鎖扣，如圖440.1所示。

技術交流

NEC 條文	內容
<p>transferrable-type lock-out devices from being used as the method to provide the ability to lock the switch or circuit breaker in the open (off) position. An example of ``permanent-type" locking hardware is shown in Exhibit 440.1.</p>  <p>Exhibit 440.1 Four circuit breakers equipped with locking hardware that is not readily removable or transferable.(Courtesy of International Association of Electrical Inspectors)</p> <p><i>Exception No. 2: Where an attachment plug and receptacle serve as the disconnecting means in accordance with 440.13, their location shall be accessible but shall not be required to be readily accessible.</i></p>	 <p>圖440.1 4只斷路器附加不易移除或轉換之鎖件裝置</p>

對於現場已裝設配置之配電設施，箱（盤）體內因為原設計中沒有規劃裝置隔離設備閉鎖裝置，以致內部空間無法容納，甚至因為盤體內銅排配置關係或者因電纜間的排序等等，在實際上有其執行上的困難，以上狀況，筆者建議可以在控制迴路上的斷路器做閉鎖裝置，可以使電磁開關等因閉鎖狀況下，無法驅動電動機運轉，而使得維修人員不會因為誤送電的狀況而發生感電工安事故。降低職災案件。

又對於業主而言，在隔離設備上能有維修補助接點的功能，一則設備於盤體上有明確的指示功能，不用因維修時必須掛牌或者必須人員監視的困擾。二則容易做

整體的管理，無論是在維護管理上以及責任歸屬上，絕對清楚並且得到應有的保障！

由於國外法規比較完善，而且誤送電之工安事故確實少有耳聞，所以一定有些優點可以提供各位先進參閱之功能。

希望藉由各位先進大德，在設計規劃時能夠多方考慮，以便使用電的環境更加安全與舒適，如是，筆者甚幸！

參考資料：

1. 「屋內線路裝置規則」修正草案技術手冊第四章一般使用器具部分條文
2. 民視新聞 2010/04/24
3. TVBS 新聞 2009/12/24.2010/01/12
4. 中國時報 2010/05/17