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主旨：請就本局編擬之CNS 14964(草-修1080471)「輪椅－應用指導綱要」1種國家標準草案惠提意見，如無意見亦請在空白意見書上註明無意見，並請於108年10月20日前惠復（或電子郵件寄jerrycr.wu@bsmi.gov.tw）本局第一組第四科吳啟瑞。

說明：檢附上開草案暨空白意見書各1份 。

正本：王委員淑芬、吳委員明美、吳委員煌榮、李委員淑貞、胡委員景灝、馬委員海霞、常委員挽瀾、張委員力山、張委員日聖、曾委員明基、蓋委員惠珍、趙委員福杉、鄭委員宗記、賴委員柏樺、衛生福利部、衛生福利部食品藥物管理署、衛生福利部社會及家庭署、衛生福利部社會及家庭署多功能輔具資源整合推廣中心、中華民國老人福利推動聯盟(請函轉會員)、中華民國老人福祉協會、財團法人中華民國消費者文教基金會、中華民國脊髓損傷者聯合會(請函轉會員)、台北市美國商會醫療器材委員會(請函轉會員)、台灣障礙者權益促進會(請函轉會員)、台灣醫療暨生技器材工業同業公會(請函轉會員)、社團法人中華民國身心障礙聯盟(請函轉會員)、財團法人自行車暨健康科技工業研究發展中心、財團法人車輛研究測試中心、財團法人金屬工業研究發展中心(北區)、臺灣輔具產業發展協會(請函轉會員)、經濟部標準檢驗局第三組、經濟部標準檢驗局第六組
副本：

經濟部標準檢驗局

裝 訂 線

ICS 11.180.10

中華民國國家標準

C N S

輪椅－應用指導綱要

Wheelchairs－Guidelines for the application

CNS 14964(草-修 1080471):2019
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Date of Amendment:　-　-

本標準非經經濟部標準檢驗局同意不得翻印

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前言

本標準係依標準法之規定，經國家標準審查委員會審定，由主管機關公布之中華民國國家標準。CNS 14964:2007 已經修訂並由本標準取代。

本標準係依標準法之規定，經國家標準審查委員會審定，由主管機關公布之中華民國國家標準。

依標準法第四條之規定，國家標準採自願性方式實施。但經各該目的事業主管機關引用全部或部分內容為法規者，從其規定。

本標準並未建議所有安全事項，使用本標準前應適當建立相關維護安全與健康作業，並且遵守相關法規之規定。

本標準之部分內容，可能涉及專利權、商標權與著作權，主管機關及標準專責機關不負責任何或所有此類專利權、商標權與著作權之鑑別。

1. 適用範圍

本指導綱要說明標準使用者如何利用 CNS 14964 系列的輪椅國家標準以選擇輪椅，由於此系列標準的內容非常專業，使用者初次閱讀，可能無法瞭解其中資訊如何運用在輪椅或代步車的選擇上，本標準目的在於協助標準使用者瞭解 CNS 14964 輪椅系列國家標準的用途與內容。

本指導綱要分成以下六個章節

(a) 如何使用本技術報告。

(b) 標準化測試和資訊宣告：提供輪椅標準化測試的背景資訊及討論輪椅如何測試與資訊如何宣告。

(c) 一般考量：討論選擇一台電動輪椅或手動輪椅的一般考量。

(d) 個人身體特徵：關於適合個人身體特徵的手動或電動輪椅。

(e) 手動輪椅：討論手動輪椅之測試程序。

(f) 電動輪椅：討論電動輪椅之測試程序；集中在三輪及四輪代步車和全尺度的電動輪椅。

在手動與電動輪椅的章節，測試程序分成三個範疇

－ 性能。

－ 安全性。

－ 尺度。

對每個測試程序，本指導綱要包括

－ 可能需要此一資訊的理由。

－ 簡述標準化測試之程序。

－ 如何於製造商的產品上以印刷來宣告測試結果。

－ 如何在自己的立場詮釋測試結果。

2. 引用標準

CNS 14964-1　輪椅－第 1 部：靜態穩定性之測定

CNS 14964-2　輪椅－第 2 部：動態穩定性之測定

CNS 14964-3　輪椅－第 3 部：煞車效率之測定

CNS 14964-4　輪椅－第 4 部：電動輪椅及代步車之耗能－理論行駛距離之測定

CNS 14964-5　輪椅－第 5 部：尺度、質量及操控空間之測定

CNS 14964-6　輪椅－第 6 部：電動輪椅最大速度、加速度與減速度之測定

CNS 14964-7　輪椅－第 7 部：座位與輪子尺度的量測

CNS 14964-8　輪椅－第 8 部：靜力、衝擊與疲勞強度之要求與測試方法

CNS 14964-9　輪椅－第 9 部：電動輪椅之耐候測試

CNS 14964-10　輪椅－第 10 部：電動輪椅越障能力試驗

CNS 14964-11　輪椅－第 11 部：測試用假人

CNS 14964-13　輪椅－第 13 部：測試表面摩擦係數之測定
CNS 14964-14　輪椅－第 14 部：電動輪椅之電力與控制系統測試方法與要求
CNS 14964-15　輪椅－第 15 部：資訊宣告、文件與標示之要求
CNS 14964-16　輪椅－第 16 部：座墊組件防火性之要求與測試方法
CNS 14964-19　輪椅－第 19 部：機動車輛使用之輪型移動裝置
CNS 14964-21　輪椅－第 21 部：電動輪椅及電動代步車之電磁相容性要求和測試方法
CNS 14964-22　輪椅－第 22 部：設定程序
CNS 14964-26　輪椅－第 26 部：詞彙
CNS 14964-28　輪椅－第 28 部：爬梯裝置之要求與測試方法

3. 如何使用本技術報告

如果有經驗的使用者，可能知道哪些性能、安全性和尺度等要素是重要的。對於新手，建議在選擇輪椅時，尋求相關專業知識的人來協助選擇。許多的復健專家對本系列標準的使用，有相當的經驗與訓練，他們可協助選擇適當的輪椅。

一個好的的輪椅選擇過程，是基於使用者的移動性與坐的需求，而設定其優先順序。設定優先順序可幫使用者判別哪些是最重要的，哪些是需要妥協的。例如若使用者住在小公寓裡，且需將輪椅放入汽車後行李箱中，則將需特別注意輪椅的全尺度、折收性和重量。另一方面，若為使用客貨車且車子容易到達公寓或住家，則可能不需要一台可折收的輪椅。

本指導綱要將協助使用者瞭解與重要性能的測試結果。有了這些資訊，將能正確比較產品而做出購買的測定。

4. 標準化測試和資訊宣告

4.1 通則

購買輪椅可能是一次痛苦的經驗，因有太多的選擇，要找到一台合適的輪椅看來似乎不可能。過去因製造商使用不同的標準和程序去測量及測試輪椅，因此比較其特性與性能是件很困難的事。如座位寬度，一個製造商測量座椅扶手外側，另一個製造商測量扶手內側，第三個製造商測量兩扶手板間距離。因此，如果使用者需要一台座位寬 450 mm 的輪椅，則座椅的扶手外側的真實距離，可能在 425 到 475 mm 範圍之間。下列測試程序的結果可提供使用者購買所需的資訊。

4.2 測試與標準的背景

本標準提供消費者有關輪椅特徵與性能之客觀資訊。制定委員會的成員包括復健工程師、輪椅製造商、政府機關代表、輪椅使用者和開立輪椅處方的人。

標準內容包括適用於所有輪椅和僅適用於電動輪椅(包括代步車)的測試程序，測試程序詳細的說明輪椅如何執行測試或測量，其中部分測試程序並建議耐久和安全的最小性能標準。由測試所獲得的資訊是為了可協助使用者在購買時比較不同製造商的輪椅，以做出較佳的選擇，而許多測試程序所設定的最小性能水準，也

有助於製造商生產較好的產品。

參見圖 1。

4.3 標準增加購買動力

CNS 或 ISO 標準是自願性的，法律並未要求製造商使用該測試程序。然而，若消費者開始根據這些結果作為選擇輪椅時，不使用這些標準的製造商可能會失去銷售商機。例如美國退伍軍人事務部(VA)是美國最大的輪椅買主，未來將採用這些標準來購買輪椅，市場壓力可能促使全部的廠商遵照這些標準。

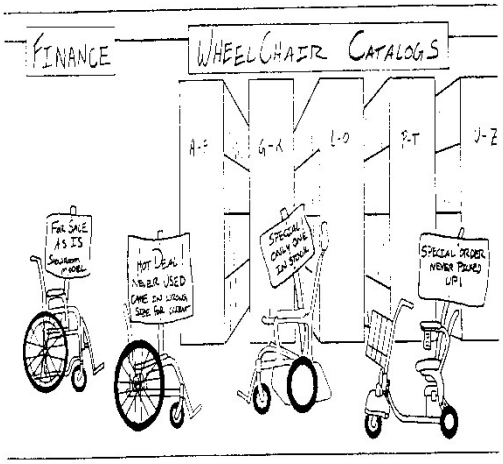

圖 1　在這麼多的選擇中，要找到合宜的輪椅似乎不可能

4.4 更多相關的國家標準

為了從標準化測試獲得最大利益，消費者和專家均須瞭解如何使用此資訊。

相關的 CNS 標準及其測試程序概述如下，下列適用於所有的輪椅。

CNS 14964-26　[輪椅－第 26 部：詞彙]。本標準建立測試程序中所使用之術語與定義。

CNS 14964-5　[輪椅－第 5 部：尺度、質量及操控空間之測定]。本標準建立輪椅建議最大尺度，使其他組織做為建築可接受度的指導綱要。

CNS 14964-1　[輪椅－第 1 部：靜態穩定性之測定]。本標準測定輪椅靜止於傾斜表面之穩定狀況。

CNS 14964-3　[輪椅－第 3 部：煞車效率之測定]。本標準說明如何適當地鎖住輪子(駐車剎車)以防止輪椅於傾斜表面上發生滾動，同時測定電動輪椅在最大速度下之最小煞停距離。

CNS 14964-5　[輪椅－第 5 部：全尺度、質量和迴轉空間之測定]。本標準指出輪椅的全長、全寬、全高、折收寬度、質量和迴轉空間。

CNS 14964-7　[輪椅－第 7 部：座位與輪子尺度的量測]。本標準指出座位需要配合乘坐者的尺度資訊。標準量測方法可消除因量測方法差

別所造成結果差異的問題。

CNS 14964-8　[輪椅－第 8 部：靜力、衝擊與疲勞強度之要求與測試方法]。本標準指出輪椅的強度和耐用性。

CNS 14964-11　[輪椅－第 11 部：測試用假人]。本標準指出執行測試所使用之測試用假人的尺度與質量(重量)。

CNS 14964-13　[輪椅－第 13 部：測試表面摩擦係數之測定]。本標準規定測試所使用表面的粗糙度或光滑度。

CNS 14964-15　[輪椅－第 15 部：資訊宣告、文件與標示之要求]。若製造商選擇遵守本標準，本標準說明製造商需要宣告什麼資訊和如何於其產品上以印刷方式來宣告。

CNS 14964-16　[輪椅－第 16 部：座墊組件防火性之要求與測試方法]。本測試說明座墊組件燃燒的程度與座墊組件如何延緩燃燒。

CNS 14964-19　[輪椅－第 19 部：機動車輛使用之輪型移動裝置]。本標準說明對於在機動車輛上作為座椅使用之輪椅的設計、性能要求和相關測試方法。

CNS 14964-22　[輪椅－第 22 部：設定程序]。本標準規定測試前輪椅配置與調整的程序。

CNS 14964-28　[輪椅－第 28 部：爬梯裝置之要求與測試方法]。本標準測定使用者操作之爬梯裝置的性能。

下列測試程序僅適用於電動輪椅

CNS 14964-2　[輪椅－第 2 部：動態穩定性之測定]。本標準敘述電動輪椅驅動至後退、前進和側向方向行駛時其如何穩定。

CNS 14964-4　[輪椅－第 4 部：電動輪椅及代步車之耗能－理論行駛距離之測定]。本標準測定電動輪椅在標準化跑道上的能源消耗。

CNS 14964-6　[輪椅－第 6 部：電動輪椅最大速度、加速度與減速度之測定]。本標準測定向前與倒退的最大速度；即測定從靜止到最大速度(加速度)與從最大速度到完全靜止(減速度)的最小時間。

CNS 14964-9　[輪椅－第 9 部：電動輪椅之耐候測試]。本標準測試雨和溫度變化對電動輪椅功能的影響。

CNS 14964-10　[輪椅－第 10 部：電動輪椅越障能力試驗]。本標準測試電動輪椅能跨越障礙的高度。

CNS 14964-14　[輪椅－第 14 部：電動輪椅之電力與控制系統測試方法與要求]。本標準說明如何安全而適當地操作安全煞車系統及做動控制所需力量與其他與電動輪椅相關的特別要求。

CNS 14964-21　[輪椅－第 21 部：電動輪椅及電動代步車之電磁相容性要求和測試方法]。本標準測定電動輪椅含代步車之電磁輻射和電磁免疫力。

4.5 輪椅如何測試

本標準說明輪椅測試之執行程序，部分測試程序規範最低性能要求，並以為合格或不合格的結果表示，包括耐燃性、耐候、靜力、衝擊強度和電動輪椅之電力與控制系統測試。這些測試是為了確保產品的最低性能和產品安全。參見圖 2。

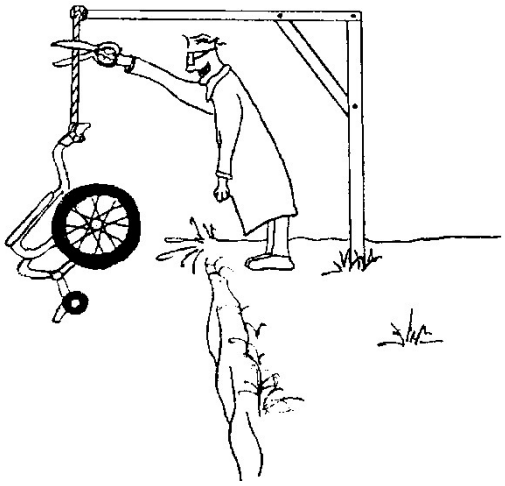

圖 2　近年來輪椅測試變得更複雜

大部分的測試程序是為了獲得輪椅的量化資訊而進行的性能測試，其結果僅作為資訊的比較，並不表示合格與不合格。因為製造商每次使用相同的測試，該結果的比較才有意義。目前仍有不同製造商使用不同用語來描述他們的輪椅。

多數的測試是從一個測試用假人放在輪椅上，來代表一個人的重量開始。在〝已負載〞條件下進行測試所得的結果會更接近真正使用時輪椅的性能，因為使用者之身體大小、比例與乘坐方式會影響輪椅使用時的合適度與性能。

可調組件之輪椅，在一特定測試程序中，製造商可調整輪椅配置與控制以獲得極限範圍的結果；例如後輪軸位置和其他可調整部位會影響輪椅的穩定性，此時，製造商可在後輪與其他可調整部位，以最小與最大穩定兩種配置來測試輪椅。測試結果可代表調整輪椅後輪與其他可調整部位傾倒角度範圍。電動輪椅若有可調控制器，製造商應宣告煞停距離的範圍以表示速度與減速度(減加速度)的調整。

4.6 資訊宣告

製造商必須遵循 CNS 14964-15 [輪椅－第 15 部：資訊宣告、文件和標示之要求]，該標準規定哪些測試結果必須於銷售前標示於產品印刷包裝中，其他需額外執行的測試項目列於附錄 A，製造商雖未沒被要求將這些結果於銷售前宣告於產品印刷包裝中，但消費者仍可要求這些資訊。參見圖 3。

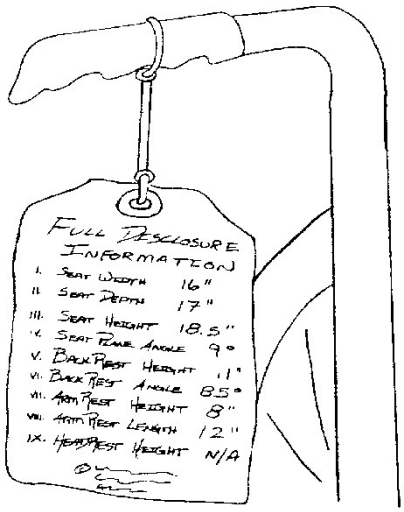

圖 3　依照 CNS 測試程序之標準，製造商須於銷售前於產品印刷包裝中宣告輪椅確實的資訊

特定程序之測試結果的宣告，起初對使用者可能意義不大，例如製造商宣告輪椅的後傾角度，卻缺乏最低性能值可供比較。此時，使用者可找出曾使用過輪椅的傾斜角或範圍，再比較其他輪椅的傾斜角，以評估這些輪椅與已知的輪椅。假設現有輪椅的後傾角為 4°，使用者可藉由考量中輪椅之後傾角大於或小於 4°，來推斷此輪椅比現有的輪椅穩定或不穩定。借輪椅的使用經驗進行比較，將使輪椅的資訊變得更有意義。

備考：性能之等級通常僅由一台輪椅測試而得。其宣告之結果代表測試未失敗之新輪椅的最大性能。使用者個人輪椅的性能會隨著使用者的身體尺寸與比例、體力、身體施力、乘坐技巧與習慣及環境條件而變化。

5. 一般考量

5.1 手動輪椅與電動輪椅

5.1.1 通則

過去復健計畫向來強調，若使用者能自行推動手動輪椅，就應那麼做。俗話說〝用進廢退〞，然而，多數稍有能力使用手動輪椅的使用者發現，他們耗盡全部力氣只為了到達想去的地方，一旦抵達該處，卻已無力可做想做的事。更糟的是，尚有 20 或 30 年使用手動輪椅經驗的人們意識，經過多年〝用進〝而非〝廢退〞的結果，他們的肩膀受損，健康的手動輪椅乘坐者是否該改花時間在電動輪椅上呢？要回答這個問題，首先必須自我省察，自問哪種移動性符合個人的需求，參見圖 4。

圖 4　某些環境，手動輪椅可能無法讓使用者留有餘力以達目的

5.1.2 選擇手動移動性的若干理由

使用者具有足夠的上半身強度及全程的耐力，可以整天推動輪椅。

減輕輪椅的重量或增加機動性，可提昇使用者的獨立性。

使用者的某些日常活動，以手動輪椅較容易進行。

手動輪椅較小型及輕巧，且保養及維修較不昂貴。

使用者的手臂或肩膀並無慣性疼痛。

5.1.3 選擇電動移動性(包括代步車)的理由

使用者無足夠耐力或體能可獨自推動手動輪椅。

使用者需在長途推動輪椅的期間保留體力以便工作或上學。

電動移動性可讓使用者在日常生活、工作及休閒娛樂等活動中更加獨立。

有通道可達個人或大眾交通工具，能讓全尺度的電動輪椅或代步車進行長途行進。

許多電動輪椅的乘坐者同時擁有手動輪椅，以能在電動輪椅不便時，經由他人協助使用手動輪椅而移動。部分使用者可於住家及工作時依靠手動輪椅，而於旅行及不工作時使用電動輪椅。電動輪椅尚可防止使用者過度使用肩膀肌肉，此外，由於電動輪椅比較昂貴，財務上的考量亦相當重要。無論使用者的首選是電動或手動輪椅，都該同時擁有一台備用的手動輪椅，以防主要輪椅發生故障。

5.2 非折收式與對折收式手動輪椅

如果使用者決定使用手動輪椅，第一個必須做的決定就是到底該選擇非折收式或是折收式。非折收式輪椅的固定車架比較堅固，而折收式輪椅的車架則具備較多的屈曲性，經過崎嶇的路面時，屈曲性將是優點，因為輪椅全部的輪子比較容易貼近地面，而在崎嶇的路面使用非折收式輪椅，常有一個輪子離開地面。然而，在堅硬的路面行進時，非折收式輪椅的避震性較佳，因為使用者施予的力量轉換為推進力而非輪椅車架的屈曲性。雖然兩者皆有輕量型及各種顏色，多數人還是比較喜歡非折收式車架的美觀(參見圖 5)，兩者優缺點列於表 1。

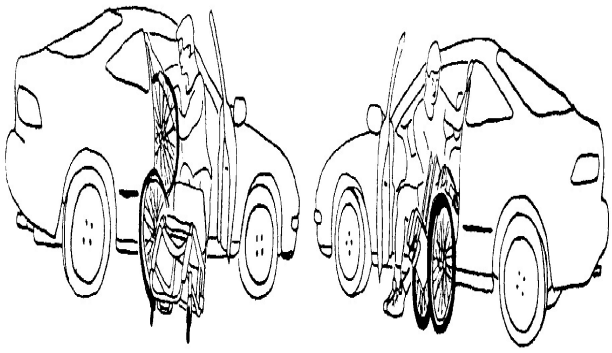

圖 5　折收式輪椅放入及取出車輛可能比非折收式車架的輪椅更為迅速

當然，多數乘坐者也比較喜愛非折收式車架的輪椅於堅硬地面行進的性能。

表 1　非折收式與對折收式輪椅

	優點	缺點
非折收式車架	● 車架設計所需的組件較少，因此在相同質量下具有較大的強度。 ● 一般比同類型同等配備的折收式輪椅更為輕巧。 ● 可移動的組件較少。 ● 必須符合國際輪椅籃球協會的規格。 ● 座位至背靠之角度，通常為可調式。	● 後輪需可迅速鬆開以移去，以利裝載於車內。 ● 在崎嶇的地面行進，可能會感到明顯的顛簸。 ● 無法折收於小型包裝中，以貯藏於汽車或飛機內。
折收式車架	● 可折收於小型包裝中，以貯藏於汽車或飛機內。 ● 其屈曲性可在行駛於崎嶇地表時，讓 4 個輪子均貼近地面。 ● 不需移動組件，即可折收及收藏。	● 可移開、調整及移動的組件較多。 ● 可能不適合乘坐者從事運動或休閒活動使用。 ● 座位至背靠角度通常不可調整。 ● 在屈曲或進行折收時，輪椅側向穩定性可能降低。

5.3 直接驅動式電動輪椅與傳動帶驅動式電動輪椅

馬達直接裝置於驅動輪，傳動裝置僅置於中間之系統稱之直接驅動系統。利用傳動帶將馬達連接至驅動輪，則稱為傳動帶驅動系統。多數輪椅為這兩種系統的其中一種。記住比較兩台代步車時，需考慮是直接驅動系統或傳動帶驅動系統。全尺度的電動輪椅，亦可能是直接驅動或傳動帶驅動系統。

與非折收式車架的手動輪椅相同，直接驅動系統無屈曲性或鬆弛性，驅動輪直接反應馬達的作動。傳動帶驅動系統的傳動帶，則可使馬達的作動與輪子之間，產生輕微的緩和作用。以身體的平衡而言，傳動帶驅動式輪椅的緩和作用可讓使用

者的乘坐更加舒適。

不幸的是，若未能適當調整或處於潮濕，傳動帶可能會滑動，後輪則無法即時依使用者需要而反應。使用者必須了解直接驅動與傳動帶驅動的優點，並依個人需求及環境條件做出最佳的選擇。參見圖 6。

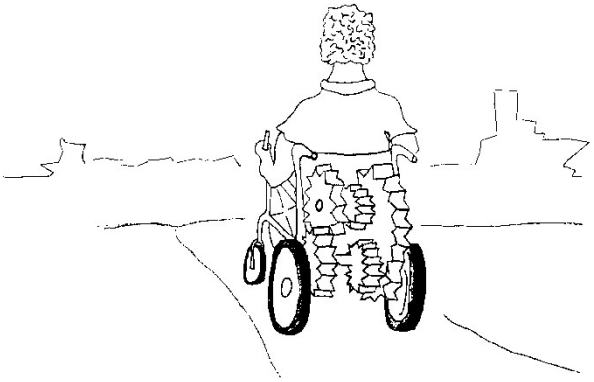

圖 6　許多使用者忽略部分缺點，選擇較少維修的直接驅動式輪椅

兩種驅動系統的優缺點列於表 2。

表 2　直接驅動式電動輪椅與傳動帶驅動式電動輪椅

	優點	缺點
直接驅動式	● 所需維修較少。 ● 無暴露於外的組件，不會因污物而磨損。	● 操作時可能會嘈雜。 ● 若未能適當地加以潤滑，齒輪會磨損。
傳動帶驅動式	● 傳動帶可輕易更換。 ● 一般而言，操作時安靜無聲。 ● 能提供平穩的乘坐。	● 若一條傳動帶斷裂，輪椅會繞著圈圈環行。 ● 傳動帶可能因潮濕而滑動，降低其控制性。 ● 一般而言較常需要維修。 ● 若溫度變化，可能需要調整。 ● 傳動帶啟動時可能有噪音。

5.4 成本

座椅與移動性的專家可針對使用者的需求、環境、尺度、性能強度、座椅與移動性限制，提供完整的臨床評估，以協助選擇適當的輪椅。此外，復健中心應該有各式各樣的輪椅，以展示〝最新與最佳的〝設計及組件。對相關組件取得正確的臨床評估及知識，可避免犯下嚴重錯誤。由於許多輪椅的使用者，在未能取得資訊下斷然決定，結果所選擇的輪椅並不適合或不符合自身機能需求。多數情況，復健中心會組裝並調整輪椅至適合消費者，而且與輪椅供應商同樣可提供訓練，

以協助使用者了解輪椅的性能特徵。

若使用者認為自己可以略過座椅及移動性的專家，因為本身具備足夠的專業知識，則可以透過郵購或直接向當地供應商購買輪椅以節省金錢。透過任何郵購的購買方式，必須放棄當地的支援，包括維修保證、組裝、設定及調整為適合自己的身體、能力及技巧之協助。當然，這種購買方式也不包括訓練，而新輪椅的性能特徵若與之前使用的輪椅大不相同，使用者則可能需要這些訓練。

6. 個人身體特徵

6.1 身體尺寸

僅知個人身高及體重，並不足以測出個人最合適的輪椅尺度。為達最佳合適性，尚需得知個人乘坐姿勢時身體的尺度。測量身體尺寸時，盡可能乘坐於一台尺寸接近真實使用的輪椅是有助的。若所訂購的輪椅具有吊腕帶墊，應該乘坐在一台具有吊腕帶墊的輪椅進行測量，若訂購的輪椅具有硬式座椅及背靠表面，則應該乘坐在一台具有硬式座椅及背靠的輪椅，或者至少具有類似特徵的表面進行測量。若會使用座墊，就應乘坐於用於新輪椅的同類型及尺寸座墊，且確認測量時，將座墊視為身體的一部分。若乘坐的座墊低於或高於用於新輪椅的座墊，則該量測將修正。

你將會使用到的量測為

- 座椅寬度。
- 座椅深度。
- 座椅表面高度。
- 背靠高度。
- 腳踏板至座椅的距離。

若使用扶手及/或頭靠，則需要知道

- 扶手高度。
- 扶手前端至背靠的距離。
- 扶手長度。
- 扶手結構的前端位置。
- 扶手之間的距離。
- 頭靠高度。

目前為止，計算適合於個人的輪椅尺度仍是個夢魘，因為缺乏標準的測量方法。每個製造商都有自己進行測量的方法。此外，所有製造商都是測量空的輪椅，儘管輪椅的尺寸可能因人體的乘坐而有所改變。如織布座椅及背靠墊有柔軟度，會將輪椅兩側拉靠在一起，因此改變其尺度。

CNS 標準之測試程序要求以秤過重量的測試用假人在〝已負載〞條件下進行輪椅的測量。測試用假人的尺寸代表預備乘坐者的尺寸及質量：大型成人 100 kg，成人 75 kg，小型成人 50 kg 及兒童 25 kg。以代表使用中輪椅的尺度進行測試時，

具體指出適合你的輪椅將會更加準確。雖然計算輪椅的尺度可能依然相當具有挑戰性，但你會發現測試程序提供更加準確的資訊，並且可以比較來自不同製造商的測量。

6.2 座椅

6.2.1 座椅寬度

一般而言，為了通行便利，輪椅的寬度應儘可能狹窄而不對乘坐者髖部造成應力。座椅寬度的增加通常會導致輪椅全寬的增加。若想要一台側向較為穩定的輪椅，可以選擇寬度較大的輪椅。

另一項考量是穿著的服裝類型。若通常穿著西裝或外套，可能需要稍微大一點的空間，以便將衣服塞進兩側。參見圖 7。

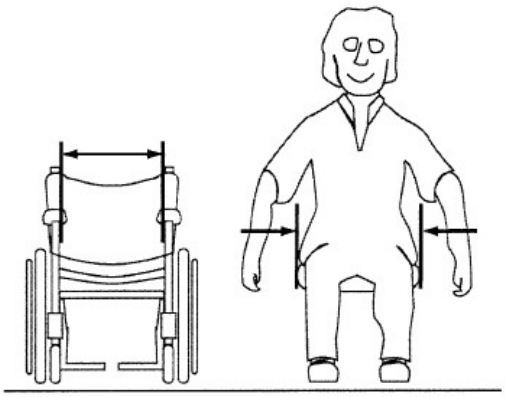

圖 7　座椅寬度

6.2.2 座椅深度

座椅的深度必須可提供腿部充分的支撐，而產生較佳的重量分佈。若腿部可以支撐重量，較深的座椅會將體重更加分散在大腿上。這表示你的身體凸出部位的總重量將會減少，因而降低壓瘡的風險，但若座椅過深，其前緣會絆住膝蓋背部。一台具有織布背靠的輪椅，其有效的座椅深度應該比一台具有硬式背靠支撐表面的輪椅更深。

若使用者以吊腕帶墊來增加輪椅硬式背靠的支撐，則輪椅的座椅深度可能會有所改變。在與所訂購類似的輪椅上安裝背靠支撐是個好主意，可測定座椅深度改變多少。參見圖 8。

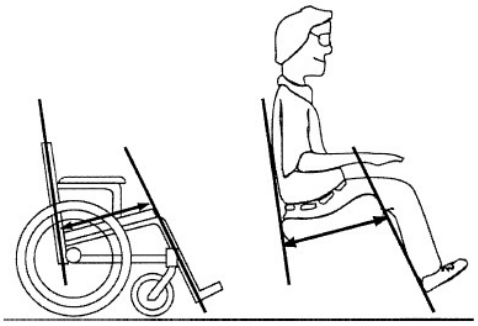

圖 8　座椅深度

當輪椅配備小腿支撐物的腳踏板時，座椅的深度將更增加。小腿支撐物可將腿部從座椅前緣向前托住。採購輪椅時若未考量此因素，則可能無法靠著背靠來容納髖部而導致坐姿塌陷。參見圖 9。

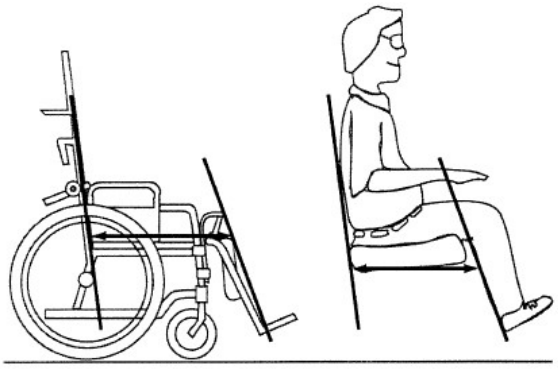

圖 9　小腿支撐物

6.2.3 座椅表面高度

輪椅的座椅必須有足夠的高度以符合腿長，但也必須夠低，讓腿部能舒適擺放。某些使用者喜歡坐得高一點，以便與坐著或站於他們身邊的人目光交會。

若輪椅具有織布座椅，其座椅表面高度的測量需比具有硬式座椅表面的輪椅稍微低一些。製造商所宣告的距離並不包括座墊的高度，若使用椅墊，則需坐在椅墊上以測定適當的座椅高度；即坐在類似的輪椅上，並測量至椅墊的底部。參見圖 10。

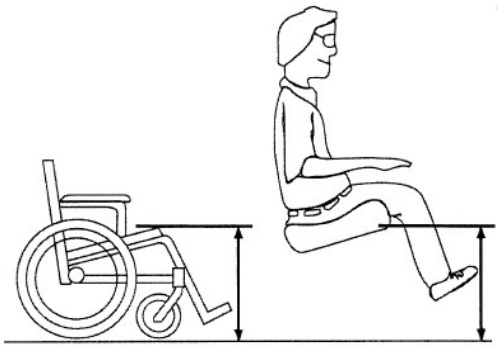

圖 10　座椅前緣的表面高度

若座椅高度太低而使用腳踏板，則腳踏板可能因為與地面缺乏足夠的間隙，而被陡坡的邊石或地面刮到。過高的座椅會讓輪椅轉入及轉出時更加困難。手動輪椅的使用者應該記住，改變座椅高度也會改變身體與驅動輪的關係，而影響輪椅推動的能力。較高的座椅比較不容易握到推進輪圈，而較低的座椅則容易握到推進輪圈。

座椅高度對於半身不遂或其他用腳來推動輪椅的人而言極為重要。

若用腳來推動輪椅，則可能需要較低的座椅。

6.2.4 背靠高度

背靠高度取決於乘坐者。某些輪椅乘坐者想要低的背靠，以增加上半身的活動性，或因為喜歡輪椅的外貌。較高的背靠有助於支撐上半身缺乏平衡的乘坐者。姑且不論背靠高度，須確認背靠支柱或推進握把不會推動輪椅時妨礙手臂的活動。

製造商所宣告的背靠高度，並不包括椅墊的厚度，背靠高度是從輪椅的座椅表面測量。測定背靠高度時，先確認坐在預備使用的椅墊上，從椅墊的表面進行測量。參見圖 11。由於是從椅墊表面進行此測量，因此具有吊腕帶墊的輪椅所測量的背靠高度，會比具有硬式座椅的輪椅稍微高一些。

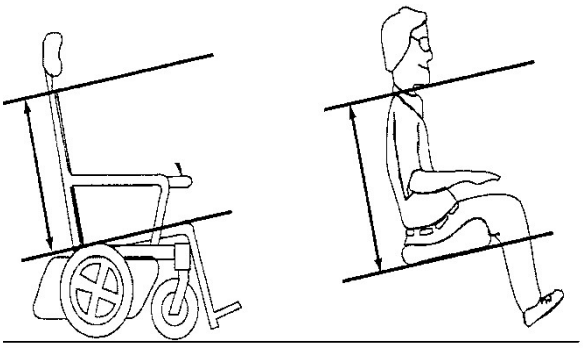

圖 11　背靠高度

6.2.5 腳踏板至座椅的距離

製造商會在不含椅墊，而輪椅已負載的條件下，測量並報告腳踏板至座椅的距離。要測定輪椅是否能容納使用者的腳長，首先坐在具類似座椅表面之輪椅的靠墊上。通常由鞋子底部至靠墊下方(座椅表面)的前緣進行測量。參見圖 12。若腳踏板的長度為可調式，製造商會註明特定輪椅及腳踏板的可用範圍。若該範圍不符合使用者的需求，記住腳踏板通常具有各種型式；不同的腳踏板可提供不同的調整範圍以容納腳長。

有時只改變腳踏板是不夠的，若使用者的腿部很長或很短，可能需要尋找不同的車架型式。對於比例較高或較矮的人而言，可選購某些高大或短小的車架型式。要容納較長的腿部，可能還需要較高的座椅或較大的座椅至腿部的角度。

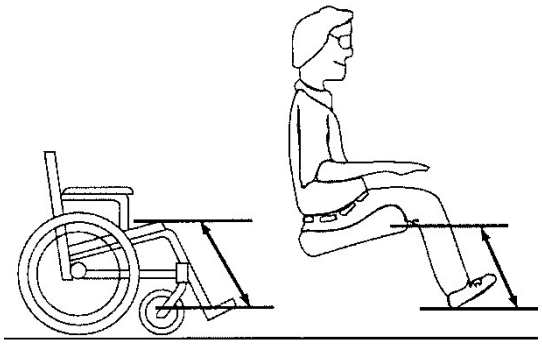

圖 12　腳踏板至座椅的距離

一旦要調整腳踏板，記住腳踏板下方應該至少預留 500 mm 的間隙，以免腳踏板被陡坡的邊石或地面碰撞。在選擇座椅高度之前，必須考量腳踏板間隙及使用者腿長。

腳踏板有各種不同的型式，可根據使用者的尺寸、需求及喜好加以選擇。表 3 所列的腳踏板特性可向製造商取得。

表 3　腳踏板特性

腳踏板	說明
可調式長度	● 通常為標準特性。 ● 可容納腿長的範圍。
擺動，可拆卸式	● 某些乘坐者所需，可方便轉位或將輪椅放入車內。
翻轉式	● 折收式輪椅所需。 ● 有助於某些轉位類型。
折收式腳踏板	● 非翻轉式。 ● 可折收以便收藏。
衝擊防護器	● 腳踏板前緣外側的硬式塑膠製輪型緩衝器。 ● 可用來推開門板。 ● 防止腳踏板撞擊障礙物，例如陡坡的邊石及門板，並防止戳入地板表面。
抬升	● 通常為可選擇之特性。 ● 通常一次可抬升一隻腿。
90°−90°平台	● 可容納較短的腿長。 ● 通常用於兒童。
硬式單一裝置	● 通常可見於硬式車架的輪椅。 ● 一般較堅固。
小腿支撐帶	● 防止足部往後掉落於輪椅下方。
小腿支撐物	● 通常會配備可抬升的腿墊。 ● 防止腿部往後滑落於輪椅下方。

6.2.6 扶手與頭靠

6.2.6.1 通則

若使用扶手，測試程序中的下列量測項目，可能會令人感興趣：包括扶手高度、扶手前端至背靠的距離及扶手長度。

6.2.6.2 扶手高度

扶手高度是必須考量的重要尺度。製造商報告的距離是指扶手頂部至已負載輪椅之椅面底部。具吊腕帶墊的輪椅，測量會異於具硬式椅面的輪椅。測定使用者需要的扶手高度，首先乘坐在類似與所選購輪椅之椅墊上，將手臂垂放在身旁，手肘彎曲 90°，測量手肘底部至椅墊下方之輪椅椅面的距離。參見圖 13。

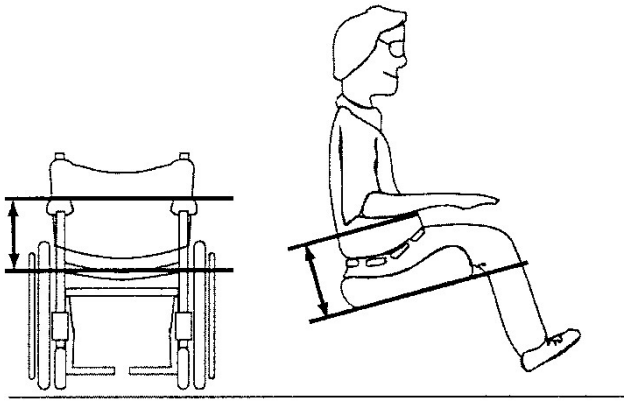

圖 13　扶手高度

固定式扶手的輪椅其扶手高度為單一數值，可調式扶手高度的輪椅，須註明高度範圍。部分可調式扶手，在一定的範圍內有無限的可調性，有些則為設定之有限高度可調性。

過高的扶手會造成使用者肩膀向上抬；太低的扶手會導致肩膀肌肉不夠健全的乘坐者坐姿塌陷或甚至肩膀脫臼，故必須確認扶手高度適中，以防止因坐姿不良造成肩膀問題及進一步的併發症。

若使用扶手，下列的量測將是有益的。

6.2.6.3 扶手前端至背靠的距離

若使用扶手以轉入或轉出輪椅，則背靠至扶手前端的距離將是重要的。若扶手不能充分向前延伸，則可能無法提供所需要的支撐。若扶手過度向前延伸，則可能無法接近書桌或桌子。參見圖 14。針對具有吊腕帶墊的輪椅，該測量結果會稍微長一些。

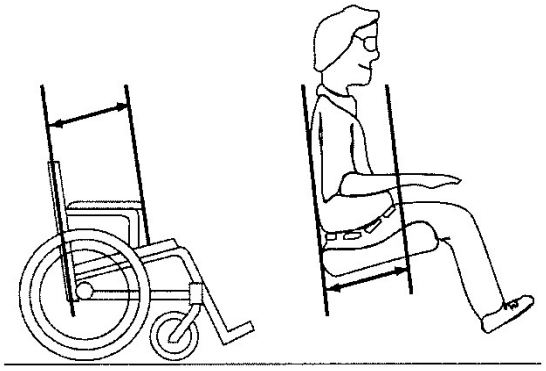

圖 14　扶手前端至背靠的距離

5.2.6.4 扶手長度

扶手長度指扶手裝有襯墊的部分。參見圖 15。使用者在輪椅上往後坐時，扶手襯墊必須能從背靠充分往前延伸，以在舒適狀態下支撐手臂。若使用膝上托盤，則扶手的長度必須能提供托盤足夠的支撐。

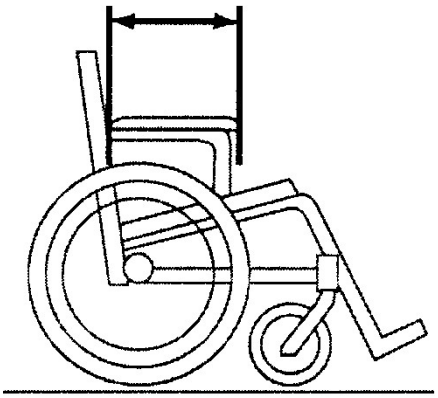

圖 15　扶手長度

6.2.7 扶手結構的前端位置

扶手結構的前端位置指背靠至扶手最前端的距離，參見圖 16。這段距離是從離地約 675 mm 的高度進行測量，用來表示如何向上接近書桌或桌子。書桌型式扶手，其背靠至扶手前端位置的距離較短，此特殊設計可讓使用者容易向上接近書桌、寫字台面或桌子。

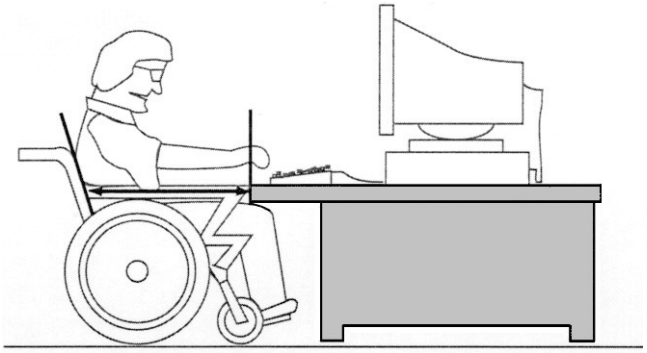

圖 16　扶手結構的前端位置

6.2.8

扶手間距指兩側扶手間最內緣的距離，本測量僅對具固定式扶手的輪椅進行。參見圖 17。直接熔接於輪椅車架的扶手，會因支撐襯墊的寬度，扶手襯墊的厚度將限制座椅寬度。

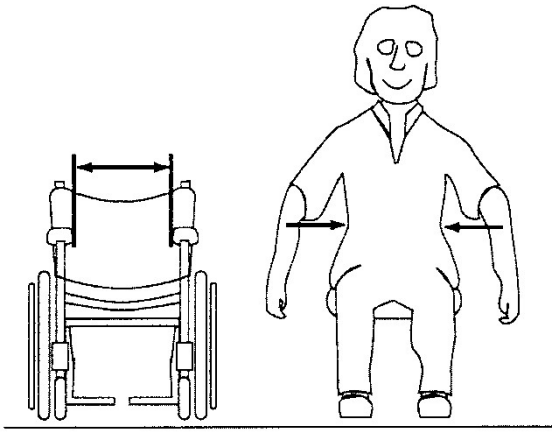

圖 17　扶手間距

扶手具有多種型式及尺寸，齊方式測量可能不同，若使用者改變輪椅的扶手型式。使用者最適合的扶手型式，取決於個人的尺寸、需求及喜好。表 4 所列的扶手特性可向製造商取得。

表 4　扶手特性

扶手	說明
可調式高度	● 扶手高度可視個人需求設定。 ● 不同高度有助於轉位。
衣物防護器	● 防止衣物及身體與輪子接觸。 ● 有織布及硬式兩種型式。
書桌型式	● 較短的扶手可接近書桌、寫字台面或桌子。
固定式	● 不可從輪椅上移除。
全長	● 從背靠向前延伸的長度相同。
轉動	● 可轉動至另一位置(通常為背靠支柱後方)。 ● 可轉開以便轉位。
可移動式	● 可移動以助於轉位。
傾斜	● 朝向輪椅前端傾斜。 ● 縮小輪廓以便靠近書桌、寫字台面或桌子。
環繞式	● 經常產生較窄的輪椅全寬，但不致嚴重地減少兩扶手間的寬度。 ● 扶手的後鎖可能遠在輪椅後方，而難以握到。

6.2.9 頭靠高度

若輪椅具頭靠，CNS 要求製造商宣告頭靠的中心點位於椅墊上方之高度。若頭靠為可調式，測試結果須指出可放置的高度範圍。測定頭靠高度，首先乘坐在類似個人所選購輪椅之椅墊上，測量頭部後方往下到靠墊下方的椅面的距離。參見圖 18。

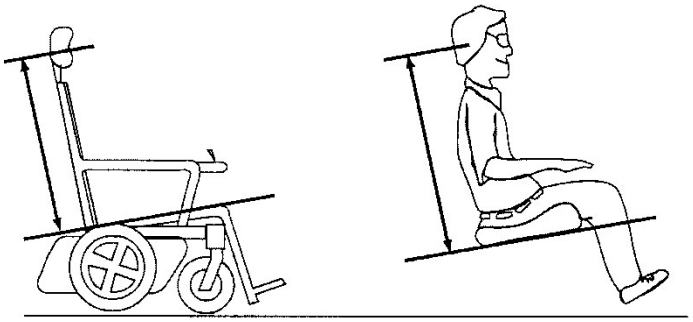

圖 18　頭靠墊高度

另一項令人感興趣的測量是頭靠到背靠前方的距離。

雖然並未要求製造商銷售前，必須在產品包裝中以印刷方式宣告，但消費者可以要求該資訊。由該測量結果可得知頭靠是直接在背靠上、置於背靠前方或是置於後方。它可能為單一數值，但頭靠若為可調式，則是一範圍之數值。

6.3 關節柔軟度

6.3.1 通則

除了個人尺寸，關節柔軟度(手臂及腿部彎曲及挺直的程度)也會影響與輪椅的合適性，另外保持坐姿平衡的能力也是選擇時該考量的。

髖部的柔軟度與所需座椅至背靠的角度有關。CNS 中，座椅平面的角度也代表座椅的傾斜度。某些乘坐者已經發現，楔形或擠壓式的車架(座椅可向後傾斜的輪椅)穩定性較佳，有助於平衡。若背靠保持豎直(非後仰)，在座椅後傾斜度增加時，使用者必需更加彎曲髖部以適合輪椅。若髖部沒有良好的彎曲性，過多的擠壓可能造成應力問題，因為身體將無法充分彎曲以適合輪椅。

若使用者柔軟度不佳，則可能需要一台具可調式背靠角度的輪椅，以便在背靠後傾時，座椅與背靠間的角度能更密合，以符合大腿與軀幹間的角度。

某些型式的電動輪椅具有電動後傾的特性。，若使用者必須獨自變換重心及姿勢，以增加乘坐耐力，卻自己無法變換重心時，該選擇將是需要的。。電動後傾的特性，也可減少使用者必須轉移到床上休息或插入導尿管的需要，此外姿勢迅速的變換亦有助於降低痙攣性、身體對低血壓的調解反應及反射障礙。

了解使用者膝蓋及踝關節的柔軟度也相當重要。多數製造商提供的輪椅在座椅前緣處附有腳踏板。為減少輪椅全長，這些〝較為緊貼的〝相當靠近使用者，

而要適合這些緊貼的腳踏板，使用者的膝蓋必須有良好的屈曲性。

6.3.2 小腿至座椅表面的角度

小腿至座椅表面的角度愈小，膝蓋將需要愈大的屈曲性或彎曲性，若使用者膝蓋的活動性有限，則必須找出最為符合大腿及小腿部間的角度。參見圖 19。

備考：許多輪椅製造商向來採用不同方法來測量該角度，他們並非如圖 19 般的測量小腿至椅面的角度，角度若正確地測量，一般都大於 90°。

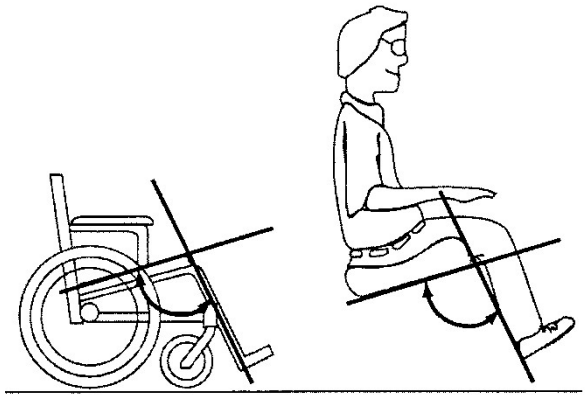

圖 19　小腿至座椅表面的角度

6.3.3 座椅平面的角度

座椅平面的角度可能是正數、負數或零，座椅平面角度為零，表示座椅是水平的。座椅平面角度為正數，表示座椅向下傾斜至後方，而座椅的前緣高於後緣該輪椅的使用者需有良好的髖部屈曲性。座椅平面角度為負數，表示座椅向前傾斜而座椅的前緣低於後緣，該輪椅使用者則需有良好的軀幹平衡能力。參見圖 20。

部分輪椅的使用者乘坐時，習慣將膝蓋蹺高於楔子上，以提高軀幹穩定性，這麼做雖然暫時可以提高軀幹穩定性，但長期下來則容易讓脊椎變形，而導致背部疼痛。

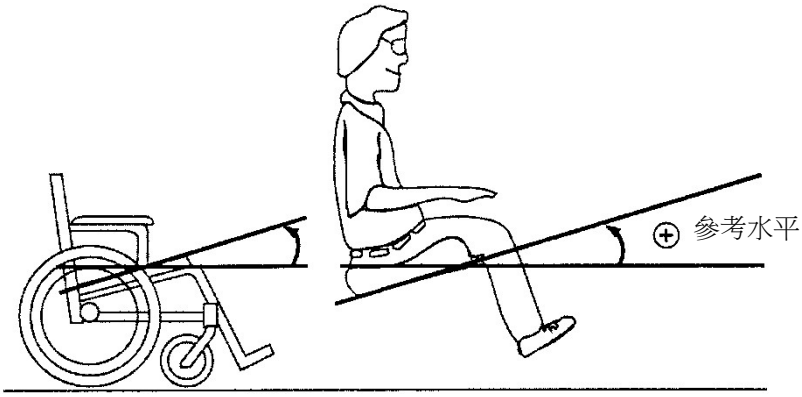

圖 20　座椅平面的角度

6.3.4 背靠角度

背靠角度是零，表示背靠為直立或垂直。背靠角度是正數，表示背靠為後傾。參見圖 21。可大幅度後傾的背靠正數角度愈大，代表輪椅在使用時時愈可能後傾，後傾的姿勢可使髖部屈曲性不良的使用者比較舒適。前傾姿勢的背靠其背靠角度是負數，使用者需要較大的髖部屈曲性。背靠角度愈垂直，使用者在輪椅上將坐得愈挺直，部分輪椅使用者較喜歡乘坐具有負數背靠角度的輪椅。

若背靠角度為可調式，製造商將訂出該角度範圍。

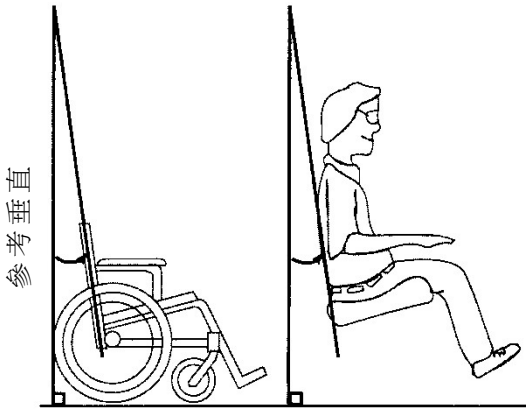

圖 21　背靠角度

6.4 推進技巧

6.5.1 通則

輪椅的手輪圈通常裝設於後輪。使用者握到手輪圈的容易度，將大大影響其推動輪椅的能力。下列三項標準之測量，有助於判斷是否可順利推動輪椅。

－　推進輪直徑。

－　手輪圈直徑。

後輪軸的水平位置。

6.5.2 推進輪直徑

多數輪椅具有直徑 610 mm 的推進輪及稍微小一點的手輪圈(手推輪圈)；通常直徑為(500～530) mm，推進輪及手輪圈頂部放則位於推進的最佳位置。然而，若想在輪椅上坐較高或較低的位置，除非有比較長或短的手臂，不然可能需要比較小或較大的輪子。小的輪子比較有效率，若使用者的手臂比較長，則不必太過彎曲手肘及肩膀就可握到手輪圈頂部。

相反地，若使用者手臂短小或在輪椅上需要坐得較高(如為了腳踏板下方與地面有適當的間隙)，則較大的輪子(直徑 660 mm 或 710 mm)可較為靠近使用者的手。若使用者手臂的活動性有限，手輪圈較靠近手臂將有所助益。

6.5.3 手輪圈直徑

許多運用輪椅參加競賽的使用者已經發現，直徑較小的手輪圈(手推輪圈)其每一推的效率會增加。在每一推的推進階段中，當使用者手臂向下推動及向後收靠時，均維持與手輪圈的接觸，以完整的連續動作給予長遠的一推，可使速度增加至最大。這在每天的推進中可能不實用，但可以較小的手輪圈進行實驗，以測定符合推進所需要的手輪圈直徑。

日常活動中，較小的手輪圈可能會增加使用者受傷的風險，而且需要較大的施力以推進輪椅。輕微地推動手輪圈，輪椅就會移動很遠，就像在腳踏車上使用高速檔一樣。此外，要握到較小的手輪圈必須坐得很低，對日常生活而言可能不實用。

6.5.4 軸線的水平位置

除了推進輪的尺寸之外，輪子的前後(水平)位置也會影響是否可以輕易握到手輪圈。軸線水平位置與使用者的關係請參見圖 22。正值表示輪子裝設於背靠與座椅平面交叉點的前方，負值表示後輪軸位於交叉點的後方，數值範圍表示輪子可於該範圍內移動。調整輪軸的位置通常需要工具，以拔出溝槽的螺栓，並插入可迅速鬆開的輪軸。

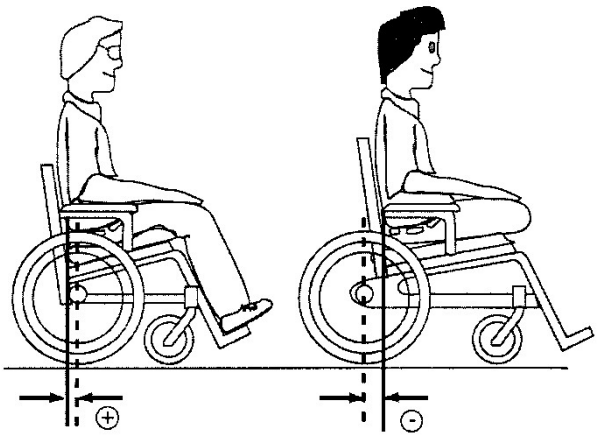

圖 22　輪軸的水平位置

6.5.5 不同輪子定位的優點與缺點

裝設於前方的輪子可能比較容易握到，但使用者需要較佳的輪椅移動技巧，因為輪椅易於向後傾斜，前輪也比較容易懸空，而單靠後輪平衡。裝設於前方的輪子另一項優點是軸距減小，容許使用者可在狹小範圍內四處移動，此外，輪椅比較不容易在側邊斜面上轉向下坡，另外，後輪會具有較大的摩擦力，因為使用者大部分的重量落在後輪。

若輪軸的水平位置置於後方，則軸距長度會增加，而較難握到輪子。然而，輪椅後部的穩定性會提高，較穩定的輪椅比較不容易前輪懸空，而單靠後輪平衡，

但比較不能向後傾，此外，輪椅比較行進於側邊斜面時容易轉向下坡，另外，後輪的摩擦力較小，也會降低煞停性能。裝設於後方的輪子可能也有前傾的問題，許多輪椅的意外事故都與向前傾斜有關。

對截肢者而言，具有置於後方的驅動輪是不可或缺的，因為輪椅之前方重量較輕時，可能會非常不穩定。

由於許多輪椅具有可調式的後輪軸位置，因此當使用者對輪椅的操作更為熟練時，可將輪軸向前移動。

7. 手動輪椅

7.1 性能

7.1.1 通則

目前市面上有數百款手動輪椅，開始進行比較選購的程序時，使用者應知道輪椅究竟如何的正確運作，CNS 輪椅標準指出影響輪椅性能的四個因素如下。

(a) 質量(重量)。

(b) 穩定性。

(c) 耐用性—疲勞強度。

(d) 機動性。

針對上述性能測試，製造商會提出一特定數值之測試結果，但沒有最小的性能數值，因此並無輪椅未通過上述測試。若輪椅於斜面上僅向後傾斜 1°，那就是報告的數值。輪椅的性能是否符合使用者能力、生活方式及環境，均由使用者自行決定。

必須了解上述性能數值所代表的意義，使用特殊輪椅的經驗，才能幫助使用者明白其它的輪椅如何運作。藉由測試結果之比較，與你目前所使用的輪椅相較之下，其它的輪椅如何運作。上述測試所提供的資訊，有助於在眾多輪椅中作出確實的比較，因為每一台輪椅都會以相同的方式進行測試。

7.1.2 質量(重量)

7.1.2.1 輪椅有多重呢？

無論使用者喜歡坦克型或超輕量型輪椅，應該會想要知道並比較輪椅的重量。在需要開車收藏在汽車後面，或協助使用者的人需要將輪椅抬進及抬出後行李箱時，輪椅的重量將是重要的。

參見圖 23。

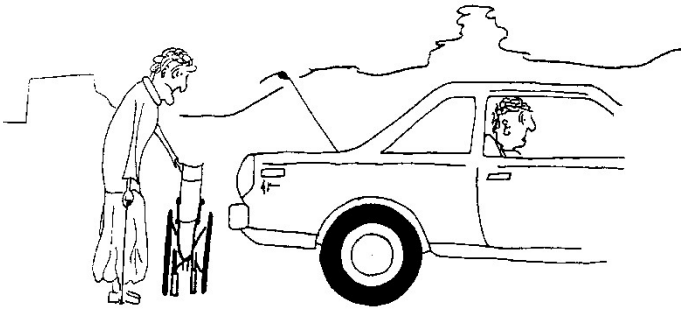

圖 23　對使用者而言，輪椅的重量並非僅是個人的問題

7.1.2.2 質量之測定

質量之測試程序請參考 CNS 14964-5 [輪椅－總尺度、質量及迴轉空間之測定]，量測配備包括標準扶手、小腿靠、輪子及萬向輪的輪椅總質量。

宣告格式(如製造商所報告)

測試名稱　測試結果

具有配件的輪椅總質量　　___kg

未被要求於產品印刷包裝中宣告的資訊：

輪椅每一個可移動組件的質量　　___kg

7.1.2.3 結果之詮釋—質量

本測試結果有助於不同廠牌輪椅的比較，運用這些結果，可判別出輕量型與重量型。重要的是，可選擇出期待重量範圍內的輪椅，此資訊指出輪椅如何運作以及使用者或其協助者是否能將它裝載於車內。

了解輪椅的每一個可移動組件的重量，可能有助於選擇過程。當完整配備的輪椅(具有標準扶手、小腿靠、輪子及萬向輪)太笨重而不合適時，可根據最重組件的重量(通常為車架)，來選擇輪椅。本資訊雖未被要求於產品印刷包裝中宣告，但經要求可向製造商取得。運用輪椅及每一個組件的重量，可以計算出所喜歡配備的輪椅重量。

造成輪椅重量顯著改變的組件為主驅動輪。無論是輻絲或鎂合金輪兩種都是標準的，一般而言，輻絲輪較輕但需要較常維修，因為煞車容易鬆脫或碎裂，鎂合金輪較重但不常需要維修。所選擇的輪胎也可能造成重量有所不同，具細薄內胎的輕量型功夫龍強化輪胎，可能遠輕於具厚壁內胎的重型橡膠輪胎。而使用者本身的體重在輪椅與使用者者的總重量中佔很大的比例，雖然，減少部分的輪椅重量，並不會讓輪椅的性能產生明顯的變化，但如果必須裝載於車內，則是相當需要。

7.1.3 穩定性

7.1.3.1 輪椅如何傾斜？

讓我們面對它吧!地球不是平的。斜坡、坡道、陡坡的邊石及具有側邊斜面的

人行道，這些只是輪椅傾斜的幾個原因。輪椅靜止不動的穩定性，不僅代表輪椅靜止時的傾斜程度；更能反應輪椅移動時的穩定性。若使用者的乘坐經驗豐富或非常活潑好動，可能會較喜歡，只要稍微轉換重心即可向後傾斜，而呈前輪懸空單靠後輪平衡姿勢的輪椅，若缺乏經驗或上半身移動性不佳，則可能想要較穩定且較不傾斜的輪椅。

7.1.3.2 穩定性之測定

穩定性之測試程序請參考 CNS 14964-1 [輪椅－第 1 部：靜態穩定性之測定]。首先將輪椅置於標準測試表面上，再將秤過重量的測試用假人放置於輪椅上，此時測試表面呈傾斜，而輪椅面對上坡、下坡及人行道。記錄輪椅的輪子抬離測試表面的角度。參見圖 24。

宣告格式(如製造商所報告)

測試名稱 測試結果

面對下坡/煞車啟動狀態　　於斜面___度時傾斜

面對上坡/煞車啟動狀態　　於斜面___度時傾斜

面對人行道/煞車啟動狀態　於斜面___度時傾斜

其它關鍵方向/煞車啟動狀態　於斜面___度時傾斜

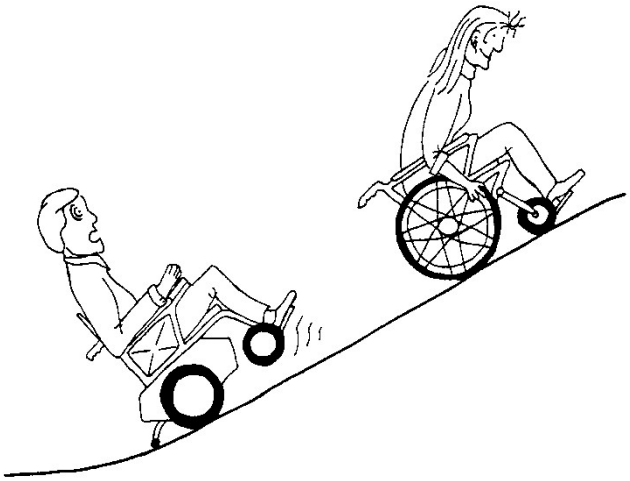

圖 24　在輪椅上向前傾身，可讓使用者順利通過較陡峭的坡道

7.1.3.3 結果之詮釋—穩定性

測試期間，使輪鎖處於使用狀態，測試人員模擬輪椅乘坐者，屈身握住手輪圈。測試期間要產生相同效果的最佳方式為運用輪鎖。

上坡傾斜角度越小，表示輪椅愈容易傾斜，也代表平台輕微傾斜時，輪椅就會開始傾斜。容易傾斜的輪椅其調整之操作較機動，比較不易於側邊斜面轉向下坡。由於使用者較大比重的體重落在後輪，因此輪椅會有較佳的摩擦力。然而上坡時，輪椅比較不穩定而可能往後傾倒，除非使用者能向前傾身以調

整身體重心。當身體重心超過輪椅的主驅動輪，輪椅容易傾斜。當身體重心向前轉換(無論是藉由向前傾身或將主驅動輪向後移動)，可讓輪椅較不傾斜。相反地，上坡傾斜角越大表示輪椅的輪子抬離平台前，可以有更大的傾斜。具有較大傾斜角度的輪椅比比較不會傾斜、較難以機動的操作，而比較容易於由側邊斜面轉向下坡。後輪所分配的重量較少，在屈身向下時可能導致後輪滑動。

具有較小下坡傾斜角的輪椅，向前時較不穩定。在測試期間平台呈傾斜而抬起輪椅的後端，模擬輪椅面對下坡。當下行坡道及遇到陡坡的邊石時，可能需要在輪椅上向後傾身以防止輪椅向前傾斜。除非使用者有良好的平衡力及低背靠的輪椅，否則可能無法在輪椅上向後傾身。若你無法在輪椅上向後傾身，則應該考慮一台在向前的方向上較為穩定的輪椅；其具有較大的下坡傾斜角。

若製造商報告有註明傾斜角的範圍，表示後輪位置、前萬向輪及/或其它特性為可調式。某些輪椅只有不同的垂直及/或水平的位置以設置主驅動輪，其它輪椅則提供無數的水平軸線位置。

將後輪向前調整會減少軸距，而降低輪椅在向後方向上的穩定性。將後輪向後移動會增加軸距，而提高輪椅在向後方向的穩定性。改變後輪的垂直位置，會改變座椅高度及角度，而可能提高或降低穩定性，這取決於系統質量中心點的位置。若調整萬向輪的前後，會改變軸距長度。軸距長度越小，輪椅在向前或向後的方向上越傾斜。許多使用者改用較易傾斜的輪椅，以獲取豐富的乘坐經驗。

具有較小人行道傾斜角的輪椅，其側邊至側邊較不穩定，當使用者行進通過具有陡峭交叉斜坡的表面或向輪椅的側邊傾身時，比較可能在人行道上傾倒。人行道傾斜角範圍通常表示其曲弧度為可調式。曲弧度為主驅動輪的角度在輪椅底部外側移動。某些製造商容許使用者訂製他們的輪椅藉以改變曲弧度。增加曲弧度會使輪椅的側邊至側邊較為穩定，但也會增加輪椅的全寬而難以通過狹窄的門口。曲弧度也會將手輪圈較為移靠主驅動輪的頂部，這讓使用者可容易於握到手輪圈並可以在通過門口時，真正防止碰撞到手指。參見圖 25。

請記住傾斜角並不代表輪椅的品質，而是個人的喜好問題。

在此提供一項可能在公共場所遇到的斜坡角度數據，依據美國殘障法案通行性指南(ADAAG)，可通行環境不可有斜坡大於 1：12 (5.8°)。因此，上坡傾斜角度大於 5°的輪椅或許不會在跨越公用坡道時向後傾斜，尤其是如果使用者可以在輪椅上向前傾身。然而，若下坡傾斜角度接近 5°，當使用者試圖下行坡道時可能終究會以翻筋斗收場，除非使用者可以藉由向後傾身以轉換身體重心。

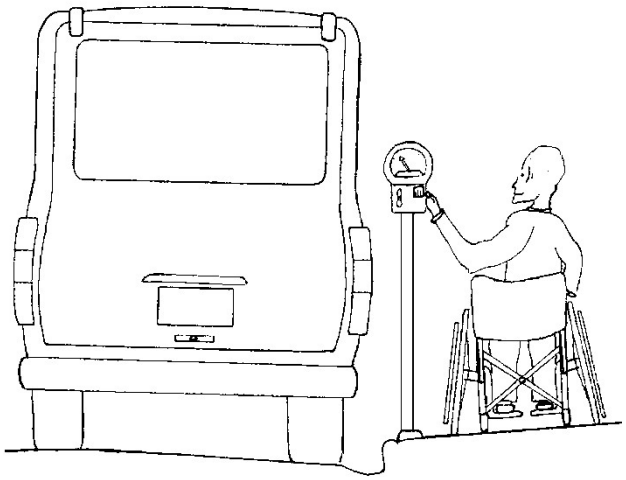

圖 25　額外的曲弧度讓輪椅在交叉斜坡上稍微穩定一些，並將手輪圈稍微移靠側邊。

被宣告的測試結果僅適用於製造商所測試的輪椅，如果想要改裝不同的主驅動輪或萬向輪，則輪椅的穩定性可能會改變。例如，較小的後輪直徑或較大的前萬向輪會讓輪椅傾斜至後方，並可能降低上坡的穩定性。

防傾輪為額外的小輪子，其設計用以防止輪椅向後傾倒。它們會在上坡時影響輪椅的穩定性。雖然防傾輪可以防止輪椅傾倒，但許多使用者並不喜歡，因為它們可能會卡在障礙物上，所以限制輪椅跨越障礙的能力。此外，當乘坐在輪椅上，輪椅乘坐者幾乎不可能將防傾輪從朝下/使用中位置調整為朝上位置；反之亦然，因為不容易握到。參見圖 26。

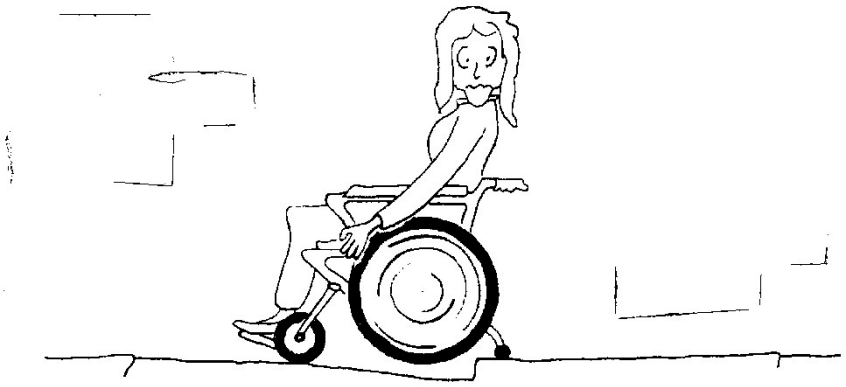

圖 26　防傾輪實際上會讓輪椅的輪子空轉

7.1.4 耐用性－疲勞強度

7.1.5.1 輪椅可持續使用多久呢？

輪椅的採購是一項極為重要採購任務；消費者最不希望買到一台可能支離破碎的輪椅，在歷經一個週的行進碰撞、上下邊石、進出汽車及每天的活動後，

輪椅可持續使用多久呢？

無論使用者是否為活潑好動，輪椅的耐用性都是重要的，若輪椅其中一個組件斷裂，使用者可能會受傷或困於某處。

疲勞測試是為了測定輪椅及其組件的耐用性，使它們得以承受類似於日常生活所承受的力量。

7.1.5.2 耐用性—疲勞強度之測定

耐用性—疲勞強度之測試程序請參考 CNS 14964-8 [輪椅－第 8 部：輪椅靜力、衝擊與疲勞強度測試方法與要求]。

首先將已裝載測試用假人的輪椅，放置於雙滾輪疲勞測試機上，該機器由兩個圓柱形滾輪組成，以馬達進行旋轉。輪椅放置在這些圓柱形滾輪上，隨滾輪旋轉而滾動。滾輪附加的板條，使滾動的輪椅產生碰撞。利用其中一個滾輪旋轉得比另一個快，使碰撞不規則，模擬使用者越過崎嶇地面。並將輪椅以設定的循環次數在滾輪上滾動。

第二項疲勞測試為邊石落下測試。將已負載的輪椅從大約 500 mm 的高度，以自由落體的方式掉落。一次邊石落下之疲勞測試，是在雙滾輪疲勞測試機上以每 30 循環進行。製造商被要求在雙滾輪與邊石落下的測試中，宣告輪椅所完成且未失敗的循環次數。

宣告格式(如製造商所報告)

測試名稱　測試結果

雙滾輪測試　　___循環

邊石落下測試　　___循環

7.1.5.3 結果之詮釋－耐用性

若製造商宣告其輪椅經過數次雙滾輪與邊石落下的循環測試，表示該輪椅比僅通過較少次測試循環的輪椅更為耐久。然而，若製造商宣告其輪椅以較少次數的雙滾輪與邊石落下的循環進行測試，這可能表示他們在經過多次循環後停止測試。

不幸的是，該測試程序並未要求製造商需要測試他們的輪椅，直到失敗為止。製造商僅被要求宣告輪椅已完成而未失敗的循環次數。

在疲勞測試期間，整台輪椅(車架、座椅椅墊、輪子及其它所有的組件)都承受大量的應力。每一組件的材質與結構皆會影響輪椅的耐用性。當輪椅的主要組件失去作用時，測試即告終結。若螺栓變得鬆脫或因需要調整而旋緊，則測試持續進行，直到主要的組件失去作用為止。

參見圖 27。

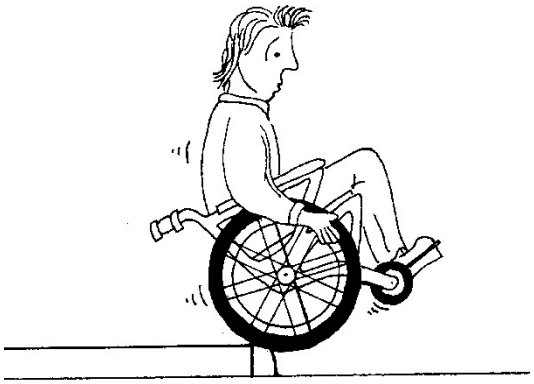

圖 27　使用者想知道你的輪椅在日復一日的使用下能撐多久

7.1.5.4 車架材料

雖然多數的輪椅組件，能以其他低成本的零件取代，但車架卻不能，因為車架關係輪椅整體結構，輪椅的車架通常是以軟鋼、不鏽鋼、鉻鋼、鋁、鈦或複合材料製成。

以某一種材料建造的輪椅，未必比以另一種材料建造的輪椅更耐久。雖然每一種材料都具有該材料特定的質量與強度比值(質量/強度比)，但輪椅的設計如此多樣，並無法單純以所使用的材料來測定產品的耐用性。車架管的厚度及管形、熔接技術及組件如何組裝在一起，只是影響輪椅疲勞強度的部分因素。

雖然車架材料並不代表輪椅可持續使用多久，但它的確提供某些有所助益的資訊。參見表 5。

表 5　車架材料特徵

車架材料	優點	缺點
軟鋼	● 易於維修及熔接，尤其是當地缺乏高科技熔接設備時。 ● 強度與質量的比值適中。	● 相對而言較為笨重。
不鏽鋼	● 高度防鏽。	● 相較於其它鋼材，強度與質量的比值較低。
鉻鋼	● 強度與質量的比值高。 ● 本質上為高科技鋼材。	● 比軟鋼昂貴。
鋁	● 強度與質量的比值高。	● 比軟鋼昂貴。
鈦	● 強度與質量的比值非常高。 ● 高度防鏽。	● 非常昂貴。
複合材料	● 強度與質量的比值高。 ● 能塑造成非傳統的形狀。	● 表面處理容易剝落。

7.1.5.5 車架最後處理

輪椅車架所進行的化學處理、整飾及塗漆式，會影響最後處理的耐用性。將塗料塗佈於不鏽鋼是困難的，至於鈦金屬更是不可能。複合材料先覆蓋一層經染色或塗漆的凝膠，但這些加工可能會剝落。鋼與鋁能以各種標準加工程序進行加工，其中最佳的加工程序為粉體塗裝，其可將塗漆廢料減至最少，並更為耐久。

7.1.5.6 萬向輪

萬向輪的大小與型式都會影響輪椅的耐用性。在雙滾輪測試期間，圓柱形滾輪上的板條不斷碰撞萬向輪，所產生的力量轉移到輪椅的其餘部分，此測試類似於越過障礙或崎嶇地面(例如門檻或人行道裂縫)所發生的狀況。

萬向輪是輪椅與障礙物接觸的第一個組件，由於它們的直徑比較小，因此所承受的衝擊較大。相較於小型的實心萬向輪，大型的氣動式萬向輪更可吸收這些力量，並且緩和輪椅的衝擊，使輪椅其它的組件產生較少的磨損及裂痕。

7.1.5 機動性

7.1.5.1 輪椅需要多大的迴轉空間呢？

也許你已經在住家或辦公環境中開闢了一個容許目前使用的輪椅可自由通行的環境。試著確認新輪椅不會因為其迴轉半徑大於目前輪椅的迴轉半徑，而造成新的空間障礙。另一方面，使用者可能想要改善通行便利性，以便能夠在旅館房間、小型公寓、狹小的辦公空間、狹窄的宿舍走廊、浴室或那些小到離譜的公廁隔間內，更易於機動操作。

7.1.5.2 機動性之測定

機動性之測試程序請參考 CNS 14964-5 為了測量迴轉空間，開發可調式迴廊並進行三點迴轉機動操作，使迴廊逐漸變窄，直到輪椅無法進行機動操作。宣告輪椅可迴轉之最小迴廊寬度。

參見圖 28。

宣告格式(如製造商所報告)

測試名稱 測試結果

最小迴轉寬度 ___mm

未被要求於產品印刷印刷包裝中宣告的額外資訊：

最小迴轉半徑 ___mm

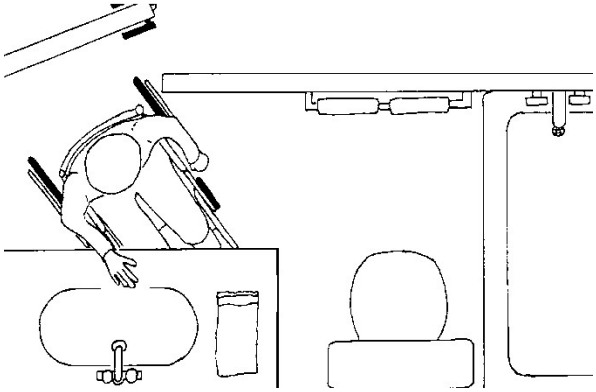

圖 28　在小型浴室裡，額外的 25 mm 可能具有相當大的意義

7.1.5.3 結果之詮釋－機動性

使用者如果生活或工作在狹小空間的環境，本測試結果將是不可或缺的資訊。若住家、工作或學校有特別狹窄的走廊或空間，必須測量輪椅寬度並於相同或更小尺寸的空間進行三點迴轉的測試。記住，腳踏板配件是可以視需要予以移除，以改善輪椅於狹小場所中迴轉的能力。

萬向輪的大小也可以提高或降低輪椅的機動性，較小萬向輪的輪子較易旋轉，而不致碰撞到使用者的腳。

一旦選擇已經縮小範圍到數台輪椅，可能須要確認每一台輪椅的迴轉空間，以確認能夠通行或進出於家中任何狹小場所。

7.2 安全性

7.2.1 通則

大部分時間使用者可以完全控制輪椅，然而有時候，如在需要他人協助或不小心乘坐時，輪椅可能會處於遭破壞或不安全狀態，為了確實防止輪椅不安全的設計，以下測試可得知輪椅之重量承受度或可能導致危險狀況的力量，測試結果以通過或失敗其中一表示。導致使用者陷於危險的測試結果即記錄為失敗。

CNS 輪椅標準規範部分手動輪椅的安全性：靜力與衝擊強度、可燃性及輪鎖。

手動輪椅的強度包括靜力與衝擊強度測試，靜力測試係測定輪椅及其組件在僅可能偶爾發生的高應力負載下的強度，例如當使用者上推挺身時，扶手上被施加的負載。

衝擊測試則測定輪椅及特定組件在衝擊負載狀態下的強度，例如以腳踏板或萬向輪撞擊障礙物，或者掉落部分或整台的輪椅。

7.2.2 靜力與衝擊強度

7.2.2.1 輪椅有多堅固呢？

輪椅每天承受應力，而使用者想知道的是，哪一種輪椅可以禁得起這種種的應力。並非每個人都是完美的輪椅使用者，很多時候使用者或協助的人會讓

萬向輪、腳踏板或輪子撞上門框或其它障礙物。手輪圈一旦撞上門框，可能會導致金屬凹陷或毛邊，可能導致下次抓握手輪圈以煞停時割傷手。使用者也可能會發現自己處於需要被拉上階梯的狀況，而拉舉可能必須抓握輪椅的扶手及腳踏板，為了安全起見，扶手及腳踏板則應該完全拉出或必須支撐使用者及輪椅的重量，扶手也必須可以在上推挺身時支撐使用者的重量。參見圖 29。

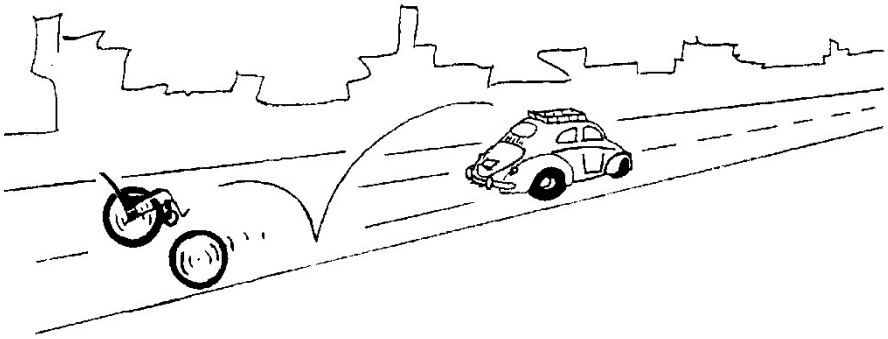

圖 29　輪椅未必能倖存於所有形式的路面；然而，使用者會希望輪椅出現在完整無缺的平面飛馳。

7.2.2.2 靜力與衝擊強度之測定

靜力與衝擊強度之測試程序請參考 CNS 14964-8

表 6　靜力負載測試結果

靜力負載測試	通過之要求	宣告格式
扶手下壓	● 經過上推挺身後，扶手仍可移動及調整。	通過/失敗
腳踏板下壓	● 經過人體的伸展或轉換重心後，腳踏板回歸其原狀並仍可翻轉、擺動或移動及重新安裝。	通過/失敗
後傾桿下壓	● 當一個人踩住後傾桿以使輪椅向後傾斜時，後傾桿不會變形。	通過/失敗
握套	● 當一個人將使用者及其輪椅拉上或拉下階梯時，握套不會滑動。	通過/失敗
扶手上拉	● 若以扶手抬起輪椅，扶手會在輪椅被抬離地面之前拔出溝槽，或扶手可以支撐輪椅及使用者的重量，容許使用者可被安全地抬上或抬下。	通過/失敗
腳踏板支撐物上拉	● 若以腳踏板抬起輪椅，腳踏板會在輪椅被抬離地面之前拔出溝槽，或腳踏板可支撐輪椅及使用者的重量，容許使用者可被安全地抬上或抬下。	通過/失敗

推把手上拉	● 推把手可支撐輪椅及使用者的重量，並可用以將使用者及其輪椅安全地抬離地面。	通過/失敗

表 7　衝擊負載測試結果

衝擊負載測試	通過之要求	宣告格式
座椅	● 當使用者落坐下輪椅時，座椅不會裂開。	通過/失敗
背靠	● 當使用者向後倒下時，背靠可將其支撐住。	通過/失敗
落下測試	● 若某人將輪椅從汽車的後行李箱卸下而掉落時，輪椅仍可打開及轉動。	通過/失敗
滾動－輪子及/或萬向輪	● 當輪椅碰撞邊石或人行道的坑洞時，前輪或萬向輪不會變形。	通過/失敗
腳踏板	● 當使用者碰撞邊石時，腳踏板不會彎曲。	通過/失敗
扶手落下	● 扶手掉落於地板後，扶手仍於輪椅上。	通過/失敗
負載落下	● 若輪椅其中一個輪子從邊石落下時，後輪不會彎曲。	通過/失敗

7.2.3 可燃性

7.2.3.1 若在輪椅上吸煙，輪椅會被火焚毀嗎？

若使用者、使用者的朋友或同事吸煙，則不應忽略本測試結果。因為一根掉落於輪椅椅墊上的香煙，即可能會讓輪椅起火。

7.2.3.2 可燃性之測定

可燃性之測試程序請參考 CNS 14964-16 [輪椅－第 16 部：座墊組件防火性之要求與測試方法]。測試程序同時依照 ISO 8191-1[Furniture − Assessment of the ignitability of upholstered furniture − Part 1: Ignition source: smouldering cigarette]及 ISO 8191-2[Furniture − Assessment of ignitability of upholstered furniture − Part 2: Ignition source: match-flame equivalent] 進行。結果以通過或失敗表示。

宣告格式(如製造商所報告)

測試名稱　　測試結果

防火性　　通過或失敗

參見圖 30。

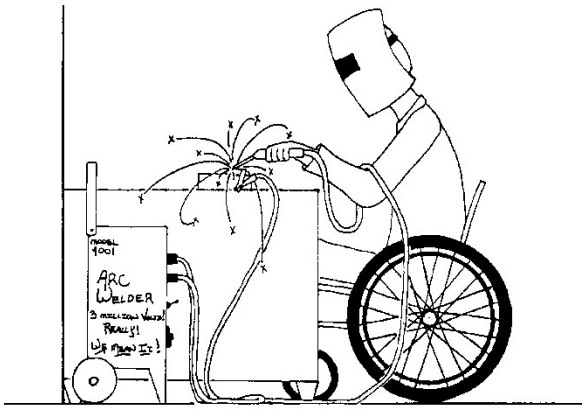

圖 30　可燃性並非僅是與吸煙有關的問題。

7.2.3.3 結果之詮釋－可燃性

本測試僅適用於輪椅製造商所提供的椅墊，而不是附加於輪椅上的任何靠墊。一根點燃的香煙應該只會產生悶燒；而不會造成椅墊起火。置於額外添購的靠墊及支撐物，則可能尚未經過可燃性測試。若使用者為吸煙者或陪伴的人吸煙，那麼應該選擇一台通過本測試的輪椅。

7.2.4 輪鎖

7.2.5.1 輪鎖應有何效力呢？

輪鎖應該可以防止主輪轉動。有些人將輪鎖視為煞車。若煞停在坡道上與朋友閒聊或從背包取物，可能不會特意操作輪鎖及使用手來進行其它工作。若煞停在斜坡上，輪鎖應可防止使用者滾向下坡。

7.2.5.2 輪鎖之測試

輪鎖之測試程序請參考 CNS 14964-3 [輪椅－第 3 部：煞車效率之測定]。首先將測試用假人放置於輪椅上，並將輪鎖處於使用狀況，再將輪椅安置於標準化的測試表面，使表面傾斜而輪椅先面對上坡後轉向下坡。

宣告輪椅開始滾動、滑動或傾斜的角度。

宣告格式(如製造商所報告)

測試名稱　測試結果

駐車煞車測試面對下坡　　___度

駐車煞車測試面對上坡　　___度

未被要求於產品印刷包裝中宣告的額外資訊：

輪鎖控制桿力量　　___ kg

參見圖 31。

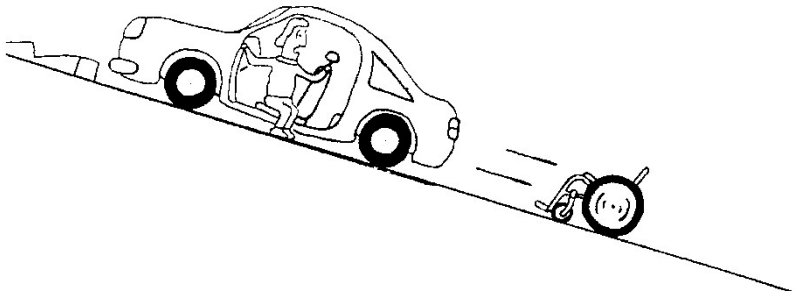

圖 31　有缺陷的輪鎖可能會讓使用者追著輪椅跑！

7.2.5.3 結果之詮釋－輪鎖

輪鎖所宣告的角度越大，表示輪鎖的效力越大，即輪椅在使用輪鎖時，比較不可能於傾斜的表面滾動、滑動或傾斜。要注意的是輪鎖僅能防止輪子轉動，無法防止輪椅滑動。千萬記住，輪鎖只是〝駐車煞車〞；無法在滾動時煞停輪椅。

鎖住或解開輪鎖所需要的力量，也是一件值得關心的事。有關該力量之測試結果，並未要求製造商於產品印刷包裝中宣告。對於手臂強度或活動範圍有限的使用者而言，延伸握把會降低使用輪鎖所需要的力氣。

另一項需考量的因素是輪鎖的位置，輪鎖可有低、中或高架式，低架式輪鎖因為離使用者較遠，因此比較不易傷及使用者拇指或手，當然，它們也可能比較難握到。高架式輪鎖較容易握到，但是在以推動輪胎而非手輪圈方式使輪椅前進時，可能會傷及拇指或手。常見的以推動輪胎前進之方式摩擦力較佳。由於輪鎖會在轉位時有所妨礙，故擺動式設計的輪鎖可降低傷及拇指或手的可能性。

8.3 尺度

8.3.1 通則

尺度為適合於身體之輪椅表面大小。本資訊如測試程序所宣告，極不同於以往測量輪椅的方法。

目前輪椅的測量是將已秤重的測試用假人放置於輪椅上，來模擬乘坐者，這將更準確代表輪椅使用時的真實尺度。一直以來，製造商所提供的尺度資訊中最大的問題在於各廠牌輪椅之車架是以不同方法進行測量，導致不同廠牌的資訊難以比較。在此之前，可以回頭閱讀第 5 節〝個人身體特徵〞中有關座椅尺度的資訊。

下列從屬條款提供有關輪椅尺度的資訊；包括全尺度與座椅尺度。

8.3.2 全尺度

8.3.2.1 輪椅有多大呢？

若你居住在具小型浴室的公寓，或者住家或辦公室有狹窄的入口，則必須考慮輪椅行進時的全尺度。若需要將輪椅放置在汽車的後行李箱或後座時，本測試結果之即為重要的資訊。

輪椅應該適合於日常生活環境，或至少不會嚴重妨礙住家、辦公室或汽車的通行。

8.3.2.2 全尺度之測定

全尺度之測試程序請參考 CNS 14964-5。在輪椅完全打開及折收的狀態下，測量其全長、全寬及全高。

這些尺度代表容納輪椅所需要的箱子大小。

宣告格式(如製造商所報告)

測試名稱 測試結果

全長包括小腿支撐及腳踏板 ___ mm

全長不包括小腿支撐及腳踏板 ___ mm

全寬 ___ mm

最小折收長度 ___ mm

最小折收寬度 ___ mm

最小折收高度 ___ mm

未被要求於產品印刷包裝中宣告的額外資訊，列見附錄 A。

參見圖 32。

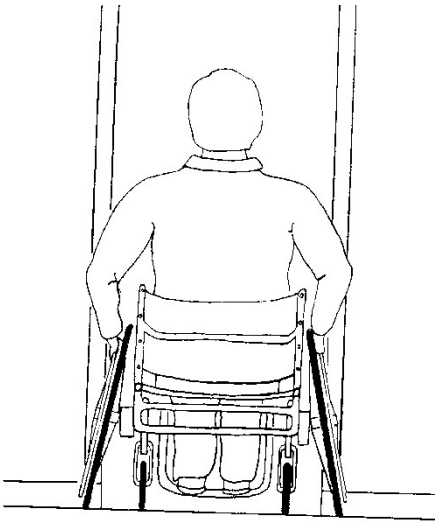

圖 32 過多的輪子外傾角，可提供輪椅較佳的性能，卻未必有利於通行

8.3.2.3 結果之詮釋－全尺度

本測試宣告輪椅折收及打開時的尺度，由於所有的輪椅是採用相同方法測量，因此可以比較不同製造商生產的輪椅。全尺度提供的為組件未移除前輪椅的大小。有助於使用者判斷輪椅是否可通過門口、住家四周、客貨車起重機及辦公室。若使用者的腳伸出腳踏板盡頭，則使用中輪椅的全長會比較長。若使用者覺得空間太過狹小，則可藉由移除輪椅的主後輪，而以防傾輪做為後輪。若防傾輪可轉動，則便於使用者通過狹窄門口或沿著飛機走道前進。若輪椅的輪基可藉由改變後輪或萬向輪位置來調整，則應宣告其數值範圍。

全長若以一範圍之數值表示，代表前輪及/或後輪的水平位置為可調式。全寬若以一範圍之數值表示，代表主後輪的曲弧度為可調式。增加曲弧度會使輪基變寬，因此，通過門口可能較為困難。輪椅的全尺度與穩定性之關係具相互制衡性，雖然減少輪椅輪基，可讓使用者較容易適應環境，但也可能使輪椅較不穩定。

消費者可利用本測試及機動性測試之結果，選購一台不會發生建築物通行障礙的輪椅，甚至可以改善環境通行的便利性。

折收式輪椅的尺度是搬運及收藏時最重要的考慮因素，這些尺度有助於判斷輪椅是否可置入汽車後行李箱、後座或其它的收藏場所。若可能會將輪椅置放及/或收藏於狹小地方，則應該特別注意輪椅的折收尺度及重量(見第 6.1.1 節〝手動輪椅〞以下)。

許多輪椅可以拆卸成數個組件，以便於輪椅的搬運及收藏。某些時候，要將輪椅裝入車內將是個難題。若需要將輪椅裝入小型或形狀不規則的後行李箱車內，了解最大組件的尺度將有所幫助。

本資訊未被要求於產品印刷包裝中宣告，但可經要求向製造商取得。若計畫國外旅行，則需要知道大部分公眾及私人的交通工具(例如飛機、火車)之小型收藏空間大小。

8.3.3 座椅尺度

8.3.3.1 輪椅適合我嗎？

若你曾經乘坐過合適度極差的輪椅，就會知道為何本資訊之相關性。並非所有輪椅的設計都適合於每一種體形、大小及比例。一台合適度不良的輪椅可能造成不舒適、醫學上的併發症及降低身體性能。有關最佳尺度大小的選擇，見第 5 節〝個人身體特徵〞。請參見圖 33。

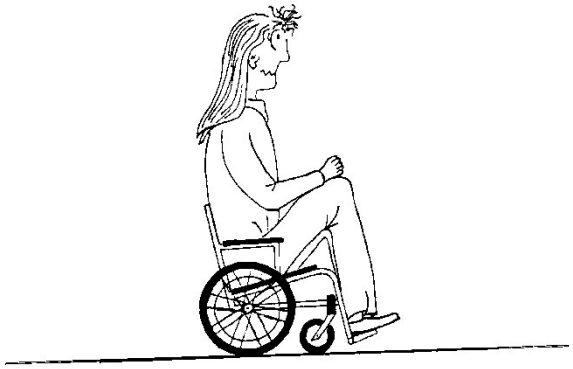

圖 33　要選擇完全適合的輪椅，評估過程需要非常耐心與細心的測量

8.3.3.2 座椅尺度之測定

座椅尺度之測試程序請參考 CNS 14964-7[輪椅－第 7 部：座椅及輪子尺度之量測]。

由於輪椅座椅的尺度在無負載與負載狀態可能有所不同，因此測量時須放置一具參考負載規於輪椅上。具可調特性的輪椅，須逐次施予不同的調整量進行測量，以獲得最小及最大的量測值。

宣告格式(如製造商所報告)

測試名稱	測試結果
座椅平面角度	___度
最大座椅寬度	___ mm
座椅深度	___ mm
座椅前緣(至地板)的表面高度	___ mm
背靠角度	___度
背靠高度	___ mm
座椅上方的頭靠高度	___ mm
腳踏板至座椅的距離	___ mm
腿部至座椅表面的角度	___度
扶手高度	___ mm
扶手前端至背靠	___ mm
扶手長度	___ mm
扶手間距	___ mm
結構為 670 mm 的扶手前端位置	___ mm
手輪圈直徑	___ mm
推進輪直徑	___ mm
輪軸線的水平位置	___ mm

其他未要求於產品印刷包裝中宣告的額外資訊見附錄 A。

8.3.3.3 結果之詮釋－座椅尺度

若知道自己適合的座椅尺度，本測試結果可提供所需要的資訊，以判斷適合於何種輪椅，以一範圍數值表示之尺度代表該尺度可改變或調整。

在依據輪椅性能而做出選擇之前，必須檢查座椅尺度及其可調性，以確保完全適合於使用者，否則，輪椅其它的特性及優點則可能淪為無用武之地。

8. 電動輪椅

8.1 性能

8.1.1 通則

目前市面上有數百種電動輪椅，使用者開始進行選購時，首先會想知道輪椅究竟能夠做什麼。本系列之 CNS 及 ISO 測試程序，適用於全尺度電動輪椅及(三

輪與四輪)代步車，此兩類型之輪椅皆視為電動輪椅。

輪椅

比高速的子彈還快速嗎？

比火車更具動力嗎？

可單純的一躍而過高聳的建築物嗎？

這些及其它性能顯示於下列測試程序

(a) 速率。

(b) 越障能力。

(c) 距離範圍。

(d) 機動性。

(e) 耐用性－疲勞強度。

(f) 耐候測試。

有關上述(a)至(e)所列之性能測試，製造商皆會宣告其結果，但由於缺乏最小的性能數值，因此無法得知輪椅是否通過這些測試。若輪椅只能以 1.6 km/h 的速度行進及跨越 12.5 mm 的階梯，這就是報告的數值。至於輪椅的性能是否符合自身條件、生活方式與環境，乃由個人自行決定。

最後一項測試(耐候)之結果以通過或失敗表示，代表歷經各種氣候狀況之後，輪椅是否可以正常操作。

輪椅的性能較多，未必是較佳的選擇，所有的性能規格應該根據使用者的特殊需求予已決定。

8.1.2 速度

8.1.2.1 輪椅的行進能有多快呢？

你是追求速度的人嗎？若想要市面上最快速的輪椅，這就是你所要尋找的資訊。可以使用這些資訊，就像雜誌上所見到的汽車測試結果一樣，來比較不同輪椅的最大速度。若使用者為藉輪椅通勤上班或上學，則從 A 點行進至 B 點所花費的時間可能是重要的。

8.1.2.2 速度之測定

速度之測試程序請參考 CNS 14964-6 [輪椅－第 6 部：電動輪椅最大速度、加速度與減速度之測定]。

要測定最大速度，首先將輪椅放置於堅硬、平坦及水平的測試表面上，將打算測試的輪椅置於兩個記號之間，並將輪椅全速向前行駛。記錄四次行進於兩記號之間距離所需的時間。最大速度的計算是將記號之間的距離加以劃分，而取四次行進的平均時間。重覆進行其後測試，以最大速度將輪椅倒退行駛。

宣告格式(如製造商所報告)

測試名稱 測試結果

最大速度/前進　　___ m/s 或 ___ km/h

最大速度/後退　　___ m/s 或___ km/h

未被要求於產品印刷包裝中宣告的額外資訊：

最大加速度：

最大減速度(停止)：

參見圖 34。

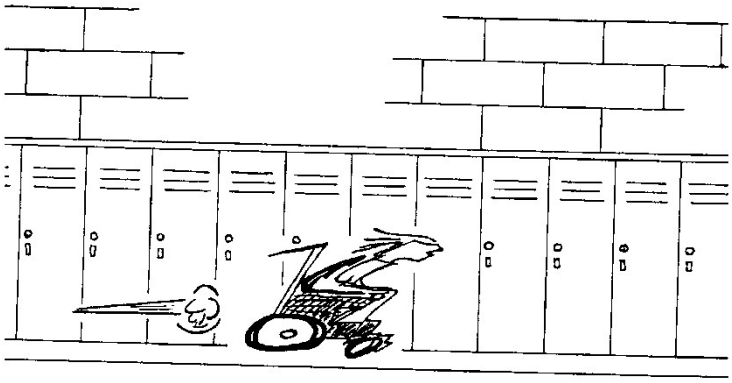

圖 34　在對的環境下速度可能是適當的

8.1.2.3 結果之詮釋－速度

在選擇最合適的速度前，有一個重要的問題要考慮，就是該輪椅的使用環境。在室內行駛通常表示以低速及短距離行進。若主要是在室內使用，或許需要選擇最大速度小於 8 km/h 的輪椅。若打算在戶外使用，則可能以較高的速度行進較遠的距離。若你不想拋下你四肢健全的朋友於塵土中，請參考表 8，以查出一般人步行的速度。

表 8　各種活動之平均速度

活動	平均速度	
	m/s	km/h
一般步行	1.3	5.8
快步走	2.0	7.2
慢跑	2.7	9.7
一般跑步	3.6	12.9
快跑	5.9	17.7

第二個需要考慮的問題是體能可以承受的速度。某些人在崎嶇地面快速移動時，無法保持乘坐的平衡。此外在加速度(加快速度)、減速度(緩慢下來)及旋

轉時，保持平衡的能力也是個問題。

可快速進行的輪椅並不表示具有足夠的動力，可以跨越障礙或登上陡峭斜坡。若輪椅的最大速度為可調式，製造商應註明其速度範圍。在可調整範圍內，容許使用者(或於某些情況，經銷商)改變輪椅的最大速度。

不幸的是，某些輪椅(沒有程式控制器)，降低最大速度時，可能也會降低跨越障礙及登上陡峭斜坡的動力。

一般而言，電動輪椅具有高/低速度開關，用來設定戶外或室內的移動性。然而，現在許多輪椅可以程式控制器進行調整。有關使用者對於動力控制器特性的調整，因為關係著製造商的責任，所以仍有爭議。若容許使用者自行調整這些特性，可能會傷到他們自己。姑且不論這些調整是由經銷商或乘坐者進行，一旦做出改變，應該於所調整的輪椅行駛環境下，測試其性能特性。

使用者可能會想要選擇一台容易自行調整速度或其它功能的輪椅，以使用於不同的環境，若自身能力正在改變，可能會想要一台可任何特定時間調整的輪椅，以符合個人機能需求。若使用者不會頻繁地改變調整，或若不想要其他人(例如兒童)來撥弄調整，則並不需要容易接近的控制裝置。

8.1.3 跨越障礙

8.1.3.1 輪椅能跨越多高的階梯呢？

那是極度令人沮喪的，如果使用者要拜訪的朋友其公寓入口有 75 mm 的階梯，而輪椅卻只能順利通過 62.5 mm 的階梯。雖然大多數的公共場所必須遵照美國殘障人士法案(Americans with Disabilities Act, ADA)通行性指南，但仍可能被迫通過邊石，例如，當汽車堵住坡道。此時，使用者應該只想要得到一台高性能的輪椅。

參見圖 35。

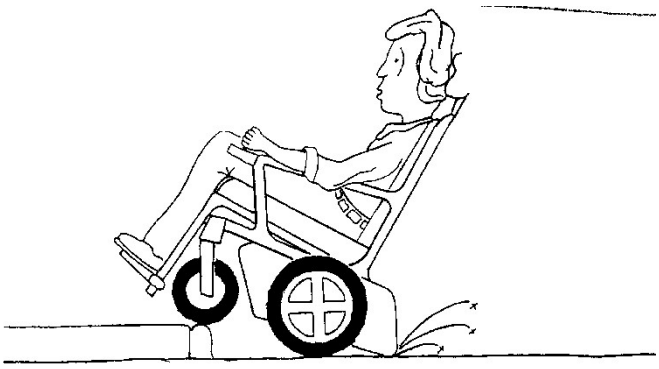

圖 35　對大多數的電動輪椅使用者而言，能夠順利通過小型邊石及障礙物是個非常重要的特性。

8.1.3.2 越障測試

越障之測試程序請參考 CNS 14964-10[輪椅－第 10 部：電動輪椅越障能力試驗]。首先請一名乘坐者位於輪椅上或在輪椅置一個測試用假人，再使輪椅未助跑直接駛向具直角的障礙物，而後輪椅完全登上障礙物的頂部。

逐漸增加障礙物的高度，直到輪椅無法跨越障礙物。再測試經助跑後重覆進行上述測試。

容許輪椅於跨越障礙前，以加快速度行駛 0.5 m 的距離。

宣告輪椅可跨越的最大障礙高度已被。測試結果同時指出迫近障礙物的角度及輪椅是否向前或向後行進以及有無助跑。

宣告格式(如製造商所報告)

跨越最大障礙高度___ mm

行進 (前進/倒退)有

(無助跑/0.5 m 助跑)

已迫近角度 90° (除非另有宣告不同的角度)

8.1.3.3 結果之詮釋－跨越障礙

在選擇具備最高性能的輪椅之前，須考慮個人需求及未來操作輪椅的環境。若主要在室內使用，則跨越大型障礙的能力，並不重要。若將於戶外使用，則可能需要一台具有較佳越障能力的輪椅。

輪椅的越障能力深受輪子大小及其類型影響。較大直徑的萬向輪可跨越較大的障礙物，小型萬向輪則容易阻塞或需要更多動力以跨越障礙。

雖然實心萬向輪在堅硬、平滑及水平的表面上，可產生較小的滾動阻力，但它們越障能力並不佳。氣動式及半氣動式萬向輪可更容易翻越障礙物及戶外的表面。一般而言，常進行戶外活動的輪椅使用者，比較喜歡較大的氣動式或半氣動式萬向輪，而主要使用於室內之堅硬表面的輪椅使用者通常喜歡較小且較硬的萬向輪。具有較大輪子的代步車，通常可跨越較大的障礙物，後輪驅動的代步車則傾向於具有較佳的越障能力。

防傾輪可能會限制戶外的移動性，尤其是上下邊石及進行其它的高度轉換時，防傾輪限制了輪椅的越障能力，因為它們主要功能是為了防止輪椅在通過某個定點時向後傾倒。當向下行進而轉換高度時，例如陡坡的邊石，防傾輪可能會被卡住。移除防傾輪可增加順利通過障礙物的能力，但這也可能會造成潛在的安全危害。

地面間隙(從地表面至輪椅最低配件的距離)也會影響輪椅的越障能力，或許輪椅的前萬向輪能跨越障礙，例如鐵軌，然而輪椅的另一個配件可能會被卡住。目前 CNS 及 ISO 的輪椅標準尚未包含地面間隙的測試。

有關輪椅的越障能力，應該同時考慮輪椅的靜態與動態穩定性，以確保安全的操作。

8.1.4 距離範圍

8.1.5.1 輪椅可以行進多遠呢？

如果使用者在一個暴風雪或極度酷寒的夜晚，身處陌生的城鎮中，而電池的電力即將用盡，這將是一個令人恐懼的經驗，即可能導致喪命。

因此使用者若必須穿越大學校園或於城市中進行遠距離行進，必須知道在電池下一次充電之前，輪椅能行進多遠。參見圖 36。

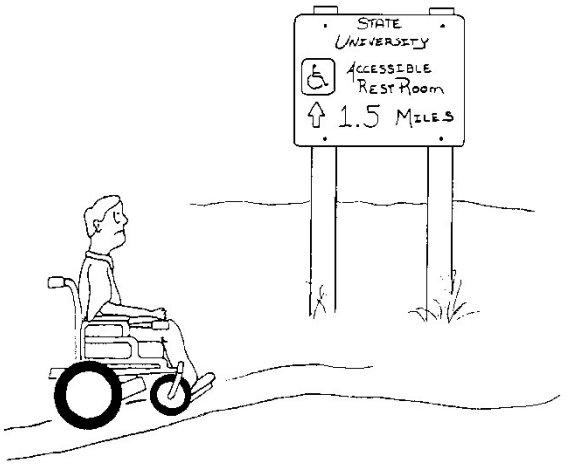

圖 36　電力用盡可真是個問題！

8.1.5.2 距離範圍之測定

距離範圍之測試程序請參考 CNS 14964-4 [輪椅－第 4 部：電動輪椅及代步車之耗能－理論行駛距離之測定]。

首先將輪椅放置於標準化的測試表面上，而乘坐者位於測試的輪椅上，再行駛通過模擬室內或戶外環境的測試跑道。

室內測試環道包含前進與倒退行駛、啟動與靜止。置於戶外測試，輪椅則行駛通過測試環道，並包含靜止至最大速度的加速、行駛特定距離及其後的煞停。

要測量輪椅的能源消耗，使用一具瓦特-小時儀錶，計算輪椅的總距離範圍，並標稱輪椅上電池的容量。

宣告格式(如製造商所報告)

測試名稱　測試結果

距離範圍/室內使用 ___ km

距離範圍/戶外使用 ___ km

8.1.5.3 結果之詮釋 — 距離範圍

本測試類似於美國環境保護局(EPA)對於城市與高速公路上汽車行駛之每公升/公里等級。此資訊提供了一項比較輪椅的基準，但不保證自己的輪椅會得

到相同的結果。電池需要重新充電之前所能行進的距離與環境及乘坐習慣。若居住在舊金山並習慣如同賽車選手般啟動及煞停，則可預料該距離範圍會明顯的小於在大型倉庫工作時。測試程序設定了一般使用狀況，但仍需比較個人生活方式與實際狀況。

8.1.5.4 電池

輪椅之電池的類型及年份會影響其在兩次充電之間能行進多遠。

輪椅的電池有鉛酸及膠體兩種主要的類型。電池的大小是以一組標準的分類尺碼表示，例如 U1、22NF、24 或 27。

一般而言，電池越大則能儲存的能量越多，但並非總是如此。表 9 顯示一般輪椅常用的電池尺度。

表 9　電池尺度

分類尺寸	長度	寬度	高度
U1	7 3/4	5 3/16	7 5/16
22NF	9 7/16	5 1/2	8 15/16
24	10 1/4	6 13/16	8 7/8
27	12 1/16	6 13/16	8 7/8

在大小同類型的電池中，膠體電池型儲存的能量通常比鉛酸型稍微少一些，因此輪椅會有較小的距離範圍。許多航空公司限制鉛酸電池的運輸，因此，若預備搭機旅行，應該使用膠體電池。若必須拆卸輪椅而置入汽車來運輸，則也可能要考慮使用膠體電池型。事實上，膠體電池較為安全，在任何電池可能會翻倒的狀況下，比較不會漏電。

若知道電池正確的分類大小，則可以直接向供應商購買電池，而不是向輪椅的商家。當然，若直接向電池供應商購買電池，那並不包括安裝。

8.1.5 機動性

8.1.5.1 輪椅需要多少的迴轉空間呢？

很可能使用者已經創造一個容許目前使用之輪椅可便利通行的住家或辦公環境。

必須確定所選擇的新輪椅，不會因其迴轉空間大於目前的輪椅，而產生新的空間障礙。另一方面，使用者可能會想要改善通行的便利性，以便能夠在旅館房間、狹小的辦公空間、狹窄的走廊、浴室或那些小到離譜的公廁隔間內，更加容易進行機動操作。此外，三輪代步車、傳統式電動輪椅及前輪驅動式電動輪椅，其機動性有極大的不同。

參見圖 37。

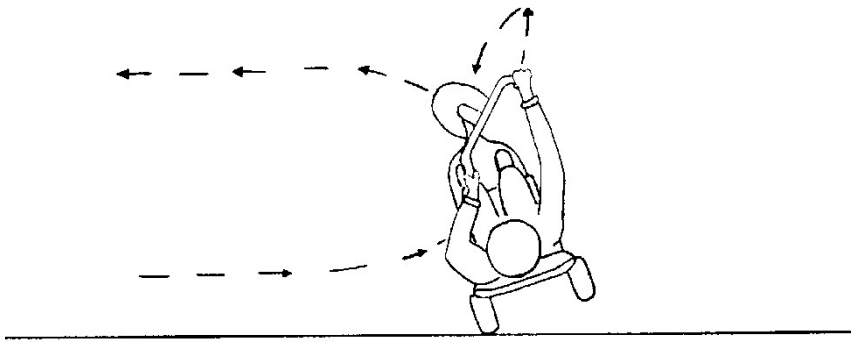

圖 37　在住家或辦公室迴轉，而不會毀損牆壁是相當重要的！

8.1.5.2 機動性之測定

距離範圍之測試程序請參考 CNS 14964-5。有關可調式迴廊的創造及三點迴轉機動操作之進行如圖 37 所示。

將迴廊逐漸變窄，直到輪椅無法進行機動操作，並宣告最小迴廊寬度。

宣告格式(如製造商所報告)

測試名稱　測試結果

最小迴轉寬度　　___ mm

未被要求於產品印刷包裝中宣告的額外資訊：

最小迴轉半徑　　___ mm

8.1.5.3 結果之詮釋－機動性

本測試的結果是不可或缺的，若使用者生活或工作在一個空間狹小的環境。如果住家、工作或學校有特別狹窄的走廊或空間，必須測量其寬度並尋找可於相同或更小的空間進行三點迴轉的輪椅。要記住許多輪椅可能配備有可移除的腳踏板配件。雖然必須在使用輪椅時移除腳踏板是一件不方便的事，但它可以增加輪椅於狹小場所迴轉的能力。前萬向輪或後萬向輪的大小也可能會影響輪椅的機動性。大型萬向輪轉動時可能會妨礙到腳踏板，使難於狹小場地進行機動操作。

一旦已經將選擇限制在少數輪椅上，必須檢查每一台輪椅的迴轉空間，以確認可以通過或進出住家的任何狹小場所。

8.1.6 耐用性－疲勞強度

8.1.6.1 輪椅可持續使用多久呢？

採購輪椅是一項重要的任務；使用者最不願見到的是一台支離破碎的輪椅。在經歷一個月的碰撞、上下邊石及每天通行的環境後。輪椅到底可以持續使用多久呢？

輪椅的耐用性是重要的，無論你是否為活潑好動的乘坐者，若其中一個組件斷裂，使用者可能會受傷或困於某處。

疲勞測試是測定輪椅及其組件的耐用性，讓它們承受類似於輪椅每天使用時所承受的力量之受力。

8.1.6.2 耐用性與疲勞強度之測定

耐用性與疲勞強度之測試程序請參考 CNS 14964-8 [輪椅－第 8 部：輪椅靜力、衝擊與疲勞強度測試方法與要求]。

首先將已負載測試用假人的輪椅放置於由兩個圓桶形滾輪所組成的雙滾輪疲勞測試機。滾輪上的板條先後接觸前輪及後輪，其中一個滾輪旋轉得比另一個稍微快一些，而輪椅以預定的循環次數行駛於測試機上。

在邊石落下測試中，已負載的輪椅從大約 500 mm 的高度，以自由落體的方式掉落。一次邊石落下的疲勞測試，是在雙滾輪疲勞測試機上以每 30 循環加以進行。製造商被要求宣告在雙滾輪與邊石落下的測試機上，輪椅所完成而未失敗的循環次數。

宣告格式(如製造商所報告)

測試名稱 測試結果

雙滾輪測試 ___ 循環

邊石落下測試 ___ 循環

參見圖 38。

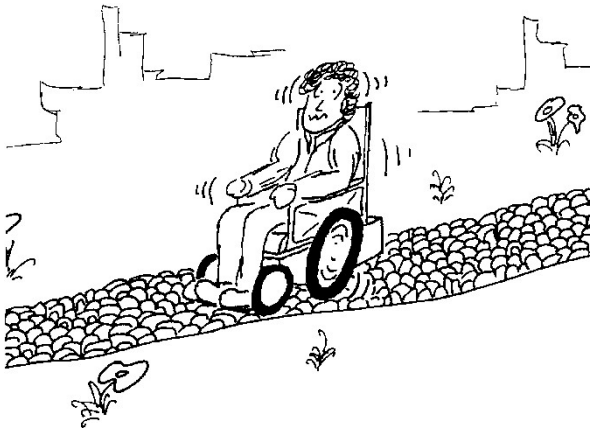

圖 38 輪..輪…輪…椅有多…多…多..耐…耐…耐…久？

8.1.6.3 結果之詮釋 — 耐用性與疲勞強度

若製造商宣告其輪椅經過多次雙滾輪與邊石落下之循環測試，表示輪椅比僅通過較少測試循環次數的輪椅更耐久。然而，若製造商宣告其輪椅以較少次數的雙滾輪與邊石落下的循環進行測試，這可能只是表示他們在經過多次循環後停止測試。

不幸的是，測試程序並未要求製造商要測試他們的輪椅直到它們失敗為止。製造商只被要求宣告輪椅所完成而未失敗的循環次數。

於疲勞測試期間，整台輪椅(車架、座椅椅墊、輪子及所有其它組件)承受大量的應力。每一組件的成分與結構都會影響輪椅完成而未失敗的循環次數。

8.1.6.4 車架材料

雖然多數組件能以成本較低者取代，但車架卻不能。電動輪椅的車架通常有鋼材或鋁材，鋼材車架未必比鋁材車架更為耐久。雖然每一種材料都有每單位質量特定的強度數值，但輪椅的設計如此多樣，並無法儘就所使用的材料來測定產品的耐用性。

車架管的厚度、管形、熔接技術及組件是如何連接的，只是影響輪椅疲勞強度的幾個因素。

雖然車架材料的類型並不代表輪椅可持續使用多久，但它確實提供某些有所助的資訊。參見表 10。

表 10　車架材料特徵

車架材料	優點	缺點
鋼材	● 容易維修及熔接。(若當地沒有高科技的熔接設備) ● 強度與質量的比值適中。	● 相對而言較笨重。
鋁材	● 強度與質量的比值高	● 比軟鋼昂貴

8.1.6.5 車架加工

輪椅車架所進行化學處理、整飾及塗漆的方式會影響加工的耐用性。

鋼材與鋁材須以各種標準的加工程序進行加工。最好的加工程序之一為粉體塗裝，這種加工程序將塗漆的廢料減至最少，並產生耐久的加工。

8.1.6.6 萬向輪

萬向輪的大小與類型兩者都會影響輪椅的耐用性。在雙滾輪測試期間，圓筒形滾輪上的板條不斷碰撞萬向輪，所產生的力量會轉移到輪椅的其餘部分，類似於越過障礙或崎嶇的地面所發生的狀況。較大的氣動式萬向輪可更容易吸收這些力量，並在其它的輪椅組件上產生較少的磨損及裂痕。

8.1.7 耐候測試

8.1.7.1 溫度及溼度會如何影響輪椅的操作呢？

極端的溫度與頻繁的溫度變化可能會影響你的輪椅。若你居住在亞利桑那，你可能會想知道控制器不會於烈日下登上斜坡時失去作用。

當使用者離開溫暖的建築物，而行進至寒冷的戶外時，你輪椅上的電子裝置承受巨大的應力，本測試結果有助於輪椅的選擇。即使並非居住於溫度極端變化之處，有一天也可能會發現自己受困於暴風雨中，所以有必要知道輪椅

被淋濕後是否能夠正常操作。參見圖 39。

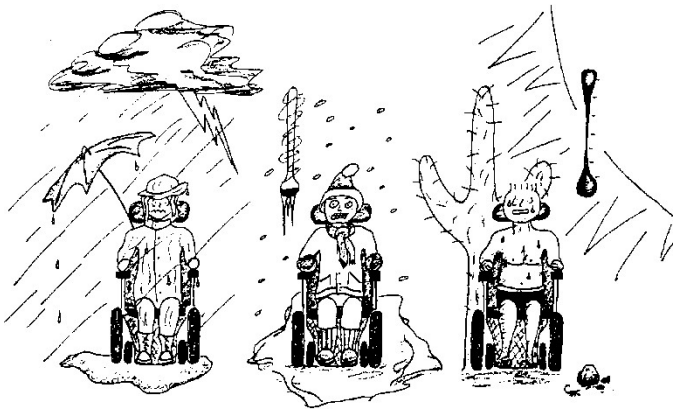

圖 39　試著想像自己的電動輪椅在不同狀況的使用情形

8.1.7.2 於各種氣候下之測試

各種氣候下之測試程序請參考 CNS 14964-9 [輪椅－第 9 部：電動輪椅之耐候測試]。

輪椅若經過一項標準的淋雨測試後，功能變為不正常，則表示未通過淋雨作用測試。

將輪椅暴露於−25 ℃及+50 ℃的溫度下達 3 h，之後立即行駛而不回歸於室溫。同時也要測試運輸及收藏的影響，將輪椅暴露於 40 ℃的溫度下達 3 h 後，再置於+65 ℃的溫度下達 3 h。將輪椅回歸於室溫，至少達 24 h 後予以行駛。經過此兩項測試後，若輪椅功能不正常，則表示未通過溫度變化作用測試。

宣告格式(如製造商所報告)

測試名稱　測試結果

淋雨作用　通過/失敗

溫度變化作用　　通過/失敗

(包括操作及收藏的溫度)

8.1.8.3 結果之詮釋－耐候測試

若輪椅未通過淋雨作用或溫度變化作用測試，則在經過承受淋雨、一般操作中的極端溫度變化或極端收藏溫度的狀況後，會無法正常操作。若會讓的輪椅承受溫度變化或將它暴露於溼氣或雨水中，要確定所選擇的輪椅通過此測試。若輪椅未通過耐候測試之淋雨部分，而使用者卻居住在西雅圖，則可能會想要考慮不同的輪椅。

8.2 安全性

8.2.1 通則

大多數時間使用者可以完全控制自己的輪椅。然而有些時候，如需要其他人協助或因為粗心或魯莽的乘坐，輪椅可能暴露在破壞力之下或處於不安全狀態。為了確實防止不安全的輪椅設計，以下測試讓輪椅承受可能導致危險狀況的力量或狀態。測試結果以通過或失敗兩者之一表示。讓乘坐者陷入危險的測試結果被記錄為失敗。

電動輪椅的安全測試包括

(a) 靜態與動態穩定性。

(b) 煞停距離。

(c) 解除力與非電力推動。

(d) 安全防護。

(e) 電力系統。

(f) 靜力與衝擊強度。

(g) 可燃性。

(h) 電池充電器。

電動輪椅的強度包括靜力與衝擊強度測試。靜力測試測定輪椅及其組件在偶爾可能發生的高壓負載狀態下的強度。衝擊測試測定輪椅及特定組件在衝擊負載狀態下的強度，例如撞擊一個物體或者掉落整台或部分的輪椅。

8.2.2 靜態與動態穩定性

8.2.2.1 輪椅有多穩定呢？

電動輪椅並不會永遠行駛於水平的表面上，很多時候需要上行坡道，使用者當然要確定輪椅不會向後傾倒，同時也會想要在下行坡道時煞停輪椅。

假設有一個坡道通向房屋前門，若使用者試圖行駛輪椅登上坡道，當然不會希望自己正在門階上表演特技!參見圖 40。

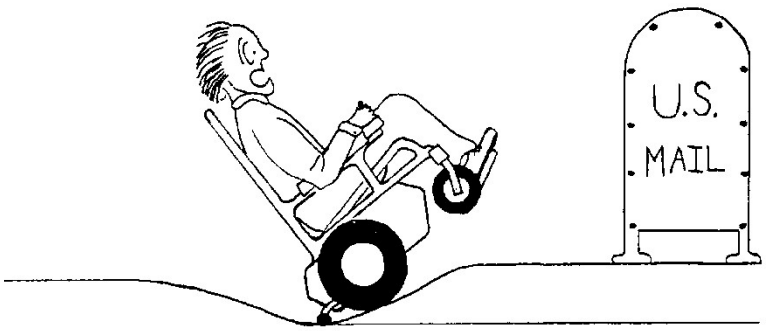

圖 40　靜態與動態穩定性測試結果可提供一份輪椅在不同環境下之穩定度的數據

8.2.2.2 靜態與動態穩定性之測定

靜態與動態穩定性之測試程序請參考 CNS 14964-1[輪椅－第 1 部：靜態穩定性之測定]。在靜態穩定性測試中，首先將輪椅放置於標準化的測試表面上，

並將測試用假人放置於輪椅上，測試表面呈傾斜而輪椅面對上坡、下坡及人行道。以度數記錄輪椅的輪子抬離測試表面的角度。

其他測試程序請參考 CNS 14964-2[輪椅－第 2 部：動態穩定性之測定]。

在上坡啟動測試中，將輪椅放置於標準化的測試表面上，在輪椅上面放置一個測試用假人，或另一名乘坐者位於輪椅上，使測試表面傾斜而輪椅則面對上坡，以度數記錄運用充分的前進動力時，輪椅開始向後傾倒，而超過其平衡點的最小斜面。

在下坡煞車測試中，輪椅以最大速度下行 5°的斜面，然後操作控制器以即時產生煞停。製造商須備註是否有一個或更多輪子抬離測試平面、輪椅是否向前傾斜超過其平衡點，或者輪椅是否於表面滑動。

宣告格式(如製造商所報告)

靜態穩定性測試	測試結果
面對下坡/煞車啟動狀態：於斜面	___度時傾斜
面對上坡/煞車啟動狀態：於斜面	___度時傾斜
面對人行道/煞車啟動狀態：於斜面	___度時傾斜
其它關鍵方向/煞車啟動狀態：於斜面	___度時傾斜

動態穩定性測試	測試結果
上坡啟動/向後傾倒	___度

下坡煞車於 5°的斜面：一個或更多輪子抬起/輪椅傾斜/輪椅滑動或未滑動。

未被要求於輪椅產品印刷包裝中宣告的動態穩定性的額外資訊如下

穩定性於迴轉時：一個或更多輪子抬起/輪椅傾斜/輪椅滑動或未滑動。

8.2.2.3 結果之詮釋－靜態與動態穩定性

上坡傾斜角度越小，輪椅的向後越不穩定，較小的下坡傾斜角度表示輪椅的前方較不穩定。具有較小人行道傾斜角度的輪椅，其側向較不穩定。

三輪代步車的側向通常比四輪代步車及全尺度電動輪椅較不穩定。由於它們有三個輪子，因此放置於某個角度時，代步車不如多數的輪椅穩定。

關於在上坡斜面的啟動前進，較大的傾斜角度表示輪椅較為穩定而較不可能向後傾倒。所宣告的角度是為了可運用充分電力，而不會向後傾斜，超過平衡點的最大斜面。若坡道的建造是依據 ADA 通行性指南，則其最大斜面是 1:12 (5.8°)。若輪椅所宣告的測試結果大於 5°，則在正常環境下登上公用坡道時不會向後傾倒。

防傾輪會影響輪椅上行斜坡的穩定性，雖然可防止輪椅向後傾倒，但多數人並不喜歡使用，因為會限制輪椅跨越障礙的能力。此外，使用者乘坐輪椅時幾乎無法將防傾輪從朝下/使用中的位置調整為朝上位置，反之亦然。總之，無論是否使用防傾輪，在使用者學習如何安全地通過新環境時，應在有介護者陪伴下練習新的操作較為審慎。

一台可在下斜坡時安全煞停而不會傾倒或滑動的輪椅，比一台無此功能的輪椅更令人滿意。即使使用者的房屋或公寓並沒有坡道，然而在公共場還是可能遇到傾斜的表面，而會想要一台可在坡道上安全啟動及煞停的輪椅。

若輪椅加速及減速為可調式，製造商會宣告其穩定性結果的範圍，可容許使用者或廠商在調整範圍內改變輪椅行進速度，多快達到最大速度及多快可煞停。進行這樣的調整後，需要於調整的環境下練習使用輪椅，藉由測試它的所有性能特性，以測定調整的效果。

使用者可能想要一台可以輕易調整速度或其它功能的輪椅，以使用於室內或戶外不同的環境。若使用者的能力在改變當中，可能會想要一台可以在任一時間被調整的輪椅，以符合自身的機能需求，反之，若不會頻繁的進行調整，或不想要其他人(例如兒童)來撥弄調整，則可能並不需要容易接近的控制裝置。

8.2.3 煞停距離

8.2.3.1 輪椅的煞停有多快？

若你的祖母在前方步行，而你正於走廊以最高速度急速接近她，你能夠及時煞停嗎？

很多時候使用者會需要迅速煞停，以防止碰撞某人或某物，因此應該了解輪椅的性能，以及自己身體的機能。

若使用者缺乏上半身的平衡，或許會想要避免輪椅太快煞停。

若使用者失去平衡，而手滑離控制器，可能也會想要知道在達到完全靜止之前輪椅會行進多遠。

例如，在到達人行道的盡頭前輪椅會停住，或者它會繼續行進而掉落於人行道邊緣呢？參見圖 41。

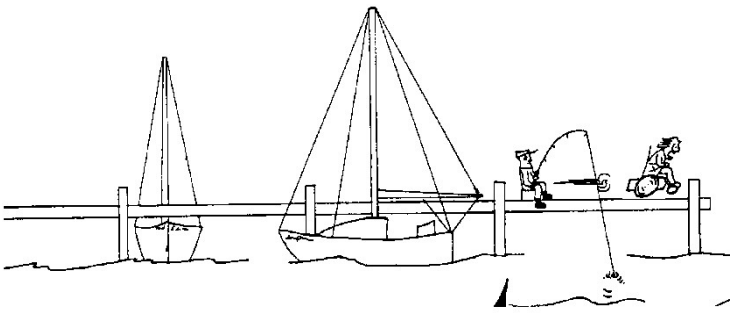

圖 41　在許多環境下，擁有煞停靈敏的控制器是個好主意！

8.2.3.2 煞停距離之測定

煞停距離之測試程序請參考 CNS 14964-3 [輪椅－第 3 部：煞車效率之測定]。在啟動煞車測試中，將輪椅行駛於標準化的水平測試表面，而輪椅上有一名

乘坐者。在達到最大速度後，乘坐者使用控制器以執行最大的煞車，直到輪椅被煞停為止。

記錄輪椅煞停所需的最大速度及距離，之後於斜面 5°的測試表面重覆進行煞車測試。

在自動煞車測試中，將輪椅以最大速度向前行駛於斜面 5°的測試表面後，解除控制功能並記錄輪椅煞停所需的最大速度及距離。

宣告格式(如製造商所報告)

測試名稱 測試結果

啟動煞車/於水平表面向前行進 ___ m

啟動煞車/於 5°斜面向前行進___ m

自動煞車/於 5°斜面向前行進___ m

未被要求於產品印刷包裝中宣告的額外資訊如下：

啟動煞車測試/於水平表面向後行進。

溫度升高作用，藉由持續使用而產生於電動輪椅的煞車系統。

自動煞車/於水平表面向前行進。

8.2.3.3 結果之詮釋－煞停距離

若使用者以相同之最大速度來比較兩台輪椅，則具有較短煞車距離的輪椅，其減速(煞停)的速率較高，該輪椅可在較短的時間及距離內煞停，而使用者需要較佳的平衡，以保持挺直的姿勢。若缺乏平衡，則可緩慢煞停的輪椅可能比反應非常迅速的輪椅更加適合使用者。

若輪椅的減速度為可調式，則廠商會宣告其煞停距離的範圍。在減速的調整範圍內，容許使用者或廠商自行改變輪椅達到煞停的時間。若使用者的能力在改變當中，可能會想要一台在任一時間可被調整的輪椅，以符合使用者本身的機能需求。只要使用者的身體能迅速控制，且不致失去平衡，一台具有可調式減速裝置的輪椅，能容許使用者設定減速度的速率。

下行傾斜表面而缺乏動力煞車的輪椅，其煞停距離會更大，若輪椅沒有動力煞車，則輪椅在下坡時可能因加快速度，而產生潛在的危險狀況。

8.2.4 解除力與非電力推動

8.2.5.1 在沒有電力下，要推動輪椅有多難呢？

若使用者在任何時候，發現自己因控制器或電池故障而受困，必須有人解除輪椅的驅動系統並協助推動。在這樣危險環境中，使用者可能會比較喜歡有人推動而不是駕駛輪椅而解除驅動系統及推動非電動輪椅所需的力氣，應該不至於需要健美選手的力量。參見圖 42。

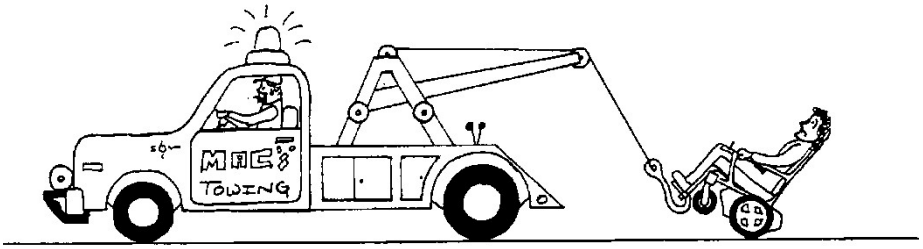

圖 42　當輪椅故障時，若需要很大的力氣來移動輪椅，則可能需要尋求專業的協助。

8.2.5.2 解除力與非電力推動之測定

解除力與非電力推動之測試程序請參考 CNS 14964-14 [輪椅－第 14 部：電動輪椅之電力與控制系統測試方法與要求]。以一可測力量強度的儀錶用來測量解除驅動系統所需的力量，並測量移動已負載測試用假人之輪椅所需的力量。若解除驅動系統所需要的力量超過 75 N (相當於 7.65 kg)或移動已負載的輪椅所需的力量超過 100 N (相當於 10.2 kg)，則輪椅未通過測試。

宣告格式(如製造商所報告)

測試名稱　測試結果

驅動系統之解除　　通過/失敗

非電力推動力　　通過/失敗

8.2.5.3 結果之詮釋—解除力與非電力推動

若輪椅通過本測試，則需要小於 75 N (相當於 7.65 kg)的力量以解除驅動系統，以及小於 100 N (相當於 10.2 kg)的力量以手動推動輪椅。除非使用者周遭有健美選手，否則都應選擇在通過本測試的輪椅。

8.2.5 安全防護

8.2.5.1 輪椅有適當的安全防護嗎？

若你有小孩或你與他人的小孩常在一起，應該知道他們經常觸摸不該觸摸的東西。當使用者乘坐在輪椅上，可能無法監視週遭發生的每件事。若缺乏適當的安全防護，電動輪椅上的許多移動組件可能會對兒童造成危險。對使用者也一樣，需要確定如果手臂掉離扶手，則衣物或手指不會被輪椅的驅動系統捲入。

8.2.5.2 安全防護測試

安全防護之測試程序請參考 CNS 14964-14。

以有關節及無關節的測試用手指插入所有的開口，以測定是否會與移動組件接觸。本測試適用於所有的開口；即使用者或輪椅週遭的人在正常操作期間可能會接觸的移動組件，不包括輪子，於。

若測試用手指可觸及推進系統的任何移動組件(除輪子外)，則輪椅未通過安全防護測試。

宣告格式(如製造商所報告)

測試名稱 測試結果

安全防護要求 通過/失敗

參見圖 43。

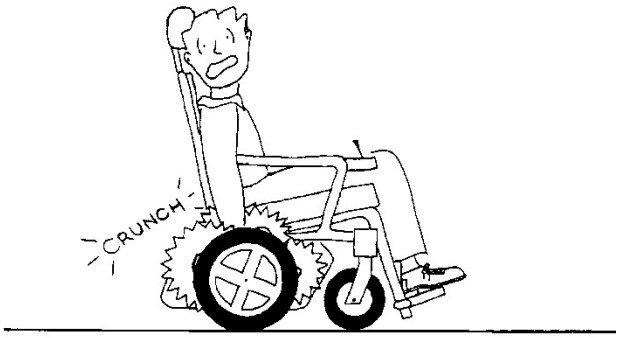

圖 43 這樣砰然一撞手指當然會痛！

8.2.5.3 結果之詮釋 — 安全防護

若輪椅未通過本測試，表示輪椅中的移動組件未加以防護，或所提供的防護並不適當。若使用者週遭有兒童或若手臂可能從扶手滑落，則必須確定輪椅通過本測試。

若使用者決心購買未通過本測試的輪椅，則需要格外小心，旁人可能會觸摸移動組件或所穿著的衣物可能捲入輪椅的移動組件。

8.2.6 電力系統

8.2.6.1 輪椅的電力系統安全嗎？

本測試以輪椅之完整的電力系統為對象，包括線路、連接器及控制器。電動輪椅是一複雜的電力機械系統，必須很確定使用者不會因觸電致死，或失去電力時，輪椅會在使用者陷入障礙前停住。若使用者對於輪椅的連接、線路或控制有疑問或擔心，以下測試可提供所需的資訊。

8.2.6.2 電力系統測試

電力系統之測試程序請參考 CNS 14964-14。

在輪椅上進行一套綜合的測試程序。參見表 11。所有的測試以通過或失敗表示。

表 11　電力系統測試

測試程序概要	結果
輪椅須具備電池連接圖。	通過/失敗
連接於電池正極輸出端子的線路應為紅色或棕色。	通過/失敗
輪椅車架在電力上不得接地。	通過/失敗
更換保險絲時不得有在電力上觸及導電引線或端子的可能。	通過/失敗
不得有以錯誤方法連接線路的可能。	通過/失敗
連接器不得輕易拔開。	通過/失敗
線路不得突出輪椅。	通過/失敗
不得有觸及非絕緣電力組件的可能。	通過/失敗
基本電路防護之裝設應鄰接於電池盒。	通過/失敗
更換電池時不得有行駛輪椅的可能。	通過/失敗
若電池之連接相反，不應損壞控制器。.	通過/失敗
若電池電壓升高 25 %，控制系統不應失去作用。	通過/失敗
指令信號之處理失去作用，不應造成輪椅不受控制的移動。	通過/失敗
任何輸出裝置失去作用，不應造成輪椅不受控制的移動。	通過/失敗
當輪椅速度失控時，電路防護應防止輪椅以以指令信號所作用之最大速度所造成的毀損最少達 5 min。	通過/失敗
使用者可碰觸之所有輪椅表面的溫度不得超過 50 ℃	通過/失敗
當電力供給中斷時，輪椅應自行停止或儘速被行駛於另一方向或處於靜止狀態。	通過/失敗

8.2.6.3 結果之詮釋－電力系統

若製造商報告為輪椅通過電力系統的要求，則表示輪椅符合所有上述測試程序的要求。

8.2.7 靜力與衝擊強度之測定

8.2.7.1 輪椅到底有多堅固呢？

輪椅每天承受不同的應力，想知道哪種輪椅可以禁得起這些應力。參見圖 44。並非每個人都是完美的輪椅使用者。很多時候會讓萬向輪、腳踏板或主輪撞上門框或其它障礙物，而需要被抬上階梯，抬動時可能需要抓握輪椅的扶手及腳踏板。為了安全，扶手及腳踏板應該完全拉出或可支撐使用者及輪椅的重量，扶手也必須可以在使用者上推挺身時支撐其體重。

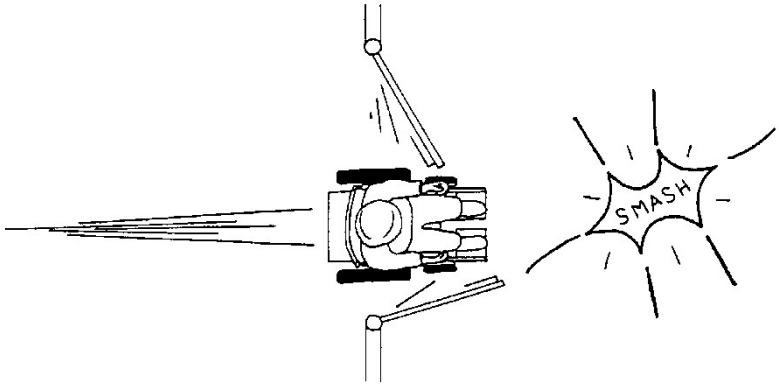

圖 44　腳踏板衝擊強度對於每一天的機動操作而言是個重要的問題，例如開門。

8.2.7.2 靜力與衝擊強度之測定

靜力與衝擊強度之測試程序請參考 CNS 14964-8。

靜力測試是為了測定輪椅及其組件在偶爾發生的高壓負載下的強度。利用標準化的負載襯墊或吊帶，並施予一次強大的力量於輪椅的相關組件，若結果為結構上的失敗，即產生輪椅任何組件的變形及/或失調，表示沒有通過測試。衝擊測試是為了測定輪椅及特定組件在衝擊負載狀態下的強度，例如一個人掉落在輪椅座椅上或碰撞邊石。將一個已秤過重量的球體從特定高度掉落一次，若衝擊結果導致輪椅組件結構上的失敗或變形而不利其功能，則輪椅沒有通過測試。

通過或失敗的結果代表經過施加一已知的力量後，輪椅是否功能正常。

製造商可選擇以較大的力量來測試輪椅，並宣告或不宣告測試結果，除了扶手掉落測試及已負載落下測試外，如宣告最大落下高度則不以失敗表示。

宣告格式(如製造商所報告)

測試名稱	測試結果
靜力強度測試	通過/失敗
衝擊強度測試	通過/失敗

8.2.8.3 結果之詮釋－靜力與衝擊強度之測試

輪椅若通過靜力負載測試，其測試結果如表 12 所列。

表 12　靜力負載測試結果

靜力負載測試	通過之要求	宣告格式
扶手下壓	● 經過上推挺身後，扶手仍可移動及調整。	通過/失敗
腳踏板下壓	● 經過人體的伸展或轉換重心後，腳踏板回歸其原狀並仍可翻轉、擺動或移動及重新安裝。	通過/失敗
後傾桿下壓	● 當一個人踩住後傾桿，使輪椅向後傾斜時，後傾桿不會變形。	通過/失敗
手把	● 當一個人將使用者及其輪椅拉上或拉下階梯時，手把不會滑動。	通過/失敗
扶手上拉	● 若以扶手抬起輪椅，扶手會在輪椅被抬離地面之前拔出溝槽，或扶手可以支撐輪椅及自己的重量，容許使用者可以被安全地抬上或抬下。	通過/失敗
腳踏板上拉	● 若以腳踏板抬起輪椅，腳踏板會在輪椅被抬離地面之前拔出溝槽，或腳踏板可支撐輪椅及自己的重量，容許使用者可以被安全地抬上或抬下。	通過/失敗
推把手上拉	● 推把手可支撐輪椅及自己的重量，並可用以將使用者及其輪椅安全地抬離地面。	通過/失敗

輪椅若通過衝擊負載測試，其測試結果如表 13 所列。

表 13　衝擊負載測試結果

衝擊負載測試	通過之要求	宣告格式
座椅	● 當使用者猛然坐下輪椅時，座椅不會裂開。	通過/失敗
背靠	● 當使用者向後倒下時，背靠可支撐住。	通過/失敗
落下測試	● 若某人將輪椅從汽車的後行李箱卸下而掉落時，輪椅仍可打開及轉動。	通過/失敗
滾動－輪子及/或萬向輪	● 當輪椅碰撞邊石或人行道的坑洞時，前輪或萬向輪不會變形。	通過/失敗
腳踏板	● 當碰撞邊石時，腳踏板不會彎曲。	通過/失敗
扶手落下	● 扶手掉落於地板後，扶手仍合適於輪椅。	通過/失敗
負載落下	● 若輪椅其中一個輪子落下邊石，後輪不會彎曲。	通過/失敗

若輪椅通過所有的靜力負載測試，則它或許不會在表 13 所列出的狀況中失去作用，而輪椅的組件仍可調整或移動。若輪椅通過所有的衝擊負載測試，則表示在衝擊之後其結構或功能沒有改變。

8.2.8 可燃性

8.2.8.1 在輪椅上吸煙，輪椅會被火焚毀嗎？

若使用者、其朋友或同事吸煙，則不應忽略本測試結果，因為一根掉落在輪椅椅墊上的香煙可能會導致輪椅起火。

8.2.8.2 可燃性之測定

可燃性之測試程序請參考 CNS 14964-16 [輪椅－第 16 部：座墊組件防火性之要求與測試方法]。

可燃性之測試程序請參考 ISO 8191-1 [Furniture − Assessment of the ignitability of upholstered furniture − Part 1: Ignition source: smouldering cigarette]及 ISO 8191-2[Furniture − Assessment of ignitability of upholstered furniture − Part 2: Ignition source: match-flame equivalent]。

測試結果以通過或失敗表示。

宣告格式(如製造商所報告)

測試名稱	測試結果
防火性	通過或失敗

參見圖 45。

圖 45　在輪椅上吸煙可能會導致危險狀況！

8.2.8.3 結果之詮釋－可燃性

本測試僅適用於輪椅製造商所提供的椅墊，不包括置於輪椅上的任何靠墊。一根點燃的香煙應該只會悶燒，不至造成椅墊起火。另外添購的靠墊及支撐物，可能未經過可燃性測試。若使用者為吸煙者或陪伴的人吸煙，則應該選擇一台通過本測試的輪椅。

8.2.9 電池充電器

8.2.9.1 電池充電器有多安全？

電池充電器是否能安全操作是一個重要的問題，因為使用者必須定期將電池重新充電。

使用者會想要知道，若自己或協助的人無意中將電池的電纜線向後鉤住，充電器是否會損壞。使用適合於所使用電池之充電器是重要的，某些充電器可用於鉛酸及膠體兩類型電池充電。下列測試係為了解電池的充電器是否符合一定程度的安全要求，以免使用者(電池充電器)在正常操作過程中受傷(受損)。

8.2.9.2 電池充電器測試

電池充電器之測試程序請參考 CNS 14964-14。

必須在鉛酸電池充電器上進行一套完整的測試程序。所有的測試結果以通過或失敗表示。參見表 14。

表 14　電池充電器測試

通過之要求	宣告格式
電池充電器應符合 IEC 標準，以確保電力上的安全性。	通過/失敗
針對超過一額定直流電輸出電壓的電池充電器，不得有未經使用工具，而改變其電壓設定之可能。	通過/失敗
針對輸出適合多種電池類型的電池充電器(例如鉛酸及膠體電池)，其選擇裝置應以所選擇的電池類型明顯地標示於箱外。	通過/失敗
當正確地連接於電池時，充電器應明確地作出指示。	通過/失敗
連接於電池的輸出兩極相反，不應損壞充電器且不得有供給電力於輸出電路之可能。	通過/失敗
於相反的兩極連接後，電路防護裝置需要於正常操作充電之前重新設定或更換。	通過/失敗
當電池的連接是在充電器已經開啟之後，則供給電力於輸出電路之前應該有不小於 0.5 秒的延緩。	通過/失敗
充電器應明確地指出電池的額定容量，以不超過 8 h 的時間充電至額定容量的 80 %，並應顯示該容量。	通過/失敗

宣告格式(如製造商所報告)

測試名稱　測試結果

全面電池充電器要求　　通過/失敗

參見圖 46。

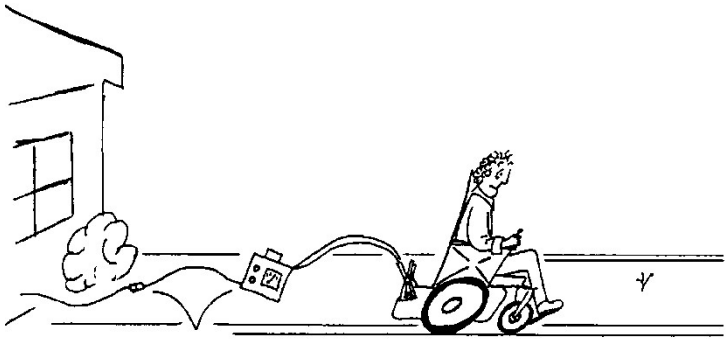

圖 46　為了安全起見，不應在充電器插上插頭時，行駛電動輪椅。

8.2.9.3 結果之詮釋－電池充電器

若製造商的報告為輪椅通過鉛酸電池充電器的測試，則該電池充電器必須符合表 14 所列的要求。

若使用者計畫去旅行的國家，其標準電壓不同於自己國家，則充電器可能失去作用。美國的標準電壓為 110 V，歐洲的標準電壓為 220 V，若要在歐洲使用 110 V 的充電器，則需要一個將 220 V 降為 110 V 的變壓器。要找到變壓器，必須知道充電器流出的電流量，以便找出尺寸適當的變壓器。理想的狀況是取得一個與輪椅相容的 220 V 充電器。

有的電池充電器可以從 110 V 切換為 220 V。

8.3 尺度

8.3.1 通則

尺度測試程序測出的資訊，與目前大多數製造商的量測報告極不同。測試時，在輪椅上放置測試用假人，更能準確代表輪椅使用時的真實尺度。製造商所提供的尺度資訊最大的問題在於輪椅車架的尺寸是以不同方法進行測量，導致各製造商所生產之輪椅無法進行比較。有關座椅尺度的資訊見第 5 節〝個人身體特徵〞。

以下三種規格提供尺度資訊，並解釋這些測量結果與的環境之關係。

(a) 全尺度。

(b) 座椅尺度。

(c) 質量。

8.3.2 全尺度

8.3.2.1 輪椅或代步車究竟多大呢？

若使用者居住在附小型浴室的公寓，或住家及辦公室有狹窄的門口，則選擇時需要考量輪椅的全尺度。此時，三輪或四輪代步車則有明顯的優勢，因為一般代步車可在狹窄的通道作出急劇的迴轉。

若需要將輪椅或代步車放置在輪椅起重機上，以及將輪椅置入客貨車或車輛

(汽車)以便搬運時，本測試也提供了相當重要的的資訊。

想要輪椅適合於環境，或至少不嚴重地妨礙住家、辦公室或汽車的通行請參考圖 47。

全尺度電動輪椅的使用者在面對標準折收式交叉車架與電力基礎結構時，只能有一種選擇。如果使用者未來需要增加座椅寬度，可能會考慮一台全尺度電動輪椅，因為電動輪椅在某種程度內，可以容許座椅的寬度增加，卻不會增加輪椅的全寬。

顯然，若座椅寬於基座本身，則增加座椅的寬度也會同時增加輪椅的全寬。

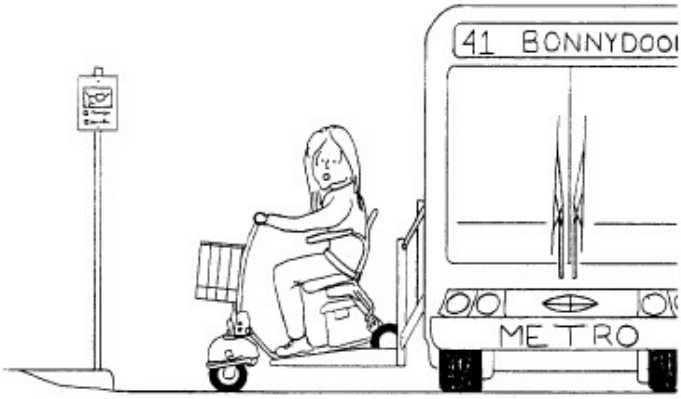

圖 47　三輪或四輪代步車，雖然機動性比較高，但一般而言軸距較長，至於電動輪椅則必須確認全尺度適合使用者的生活方式。

8.3.2.2 全尺度之測定

全尺度之測試程序請參考 CNS 14964-5。輪椅必須在完全打開及折收的狀態下進行測量。這些尺度代表收納輪椅時，所需要最大箱子的大小。

宣告格式(如製造商所報告)

測試名稱	測試結果
全長不包括小腿支撐及腳踏板	___ mm
全寬	___ mm
最小折收長度	___ mm
最小折收寬度	___ mm
最小折收高度	___ mm

未被要求於產品印刷印刷中宣告的額外資訊，見附錄 A。

8.3.2.3 結果之詮釋－全尺度

此測試包括輪椅在打開及折收狀態下的尺度。由於所有的輪椅均使用相同的方法測量，因此消費者可以清楚的比較不同製造商所製造的輪椅。全尺度提供組件未被移除前的輪椅尺寸，有助於消費者判斷輪椅是否能於通過門口、

住家或辦公室四周，以及該選擇何種適合的輪椅起重機。利用本測試結果加上其他機動性的數據，消費者可以選擇一台提高獨立性的輪椅。

折收式輪椅的尺度有助於判斷輪椅是否適合於汽車或飛機之收藏。

8.3.3 座椅尺度

8.3.3.1 輪椅適合我嗎？

如果你曾經坐過合適度極為不良的輪椅，就會知道本資訊的重要性。並非每一種輪椅的設計都能適合於每個人的體型、尺寸及比例。一台合適度不良的輪椅可能造成使用者不適、醫學上的併發症及降低生理機能。有關如何選擇最佳合適度的輪椅，見第 5 節〝個人身體特徵〞。

在根據性能而決定輪椅之前，必須先檢查座椅尺度，並且確認其可調性完全合適，若無法確認個人與輪椅之合適度，則輪椅所有的特性及優點可能無用武之地。

8.3.3.2 座椅尺度之測定

全尺度之測試程序請參考 CNS 14964-7 [輪椅－第 7 部：座椅及輪子尺度之量測]。

由於輪椅座椅的尺度從無負載到負載狀態可能會有所不同，因此測量過程中，須將一具參考之負載規放置於輪椅上。具可調式特性之輪椅，其每一次施予不同程度的調整進行測量，以獲取最大及最小值的。

宣告格式(如製造商所報告)

測試名稱	測試結果
座椅平面角度	___度
最大座椅寬度	___ mm
座椅深度	___ mm
座椅前緣(至地板)的表面高度	___ mm
背靠角度	___度
背靠高度	___ mm
座椅上方的頭靠高度	___ mm
腳踏板至座椅的距離	___ mm
小腿至座椅表面的角度	___度
扶手高度	___ mm
扶手前端至背靠	___ mm
扶手長度	___ mm
扶手之間的距離	___ mm
扶手結構的前端位置	___ mm

未被要求於產品印刷包裝中宣告的額外資訊見附錄 A。

參見圖 48。

圖 48　切勿購買一台無法完全適用的輪椅!

8.3.3.3 結果之詮釋—座椅尺度

若使用者知道什麼樣尺度的座椅適合自己，本測試結果將提供所需要的資訊，以測定何種輪椅較為合適，若測試結果為具一範圍的數值代表輪椅為可調式。

8.3.4 質量(重量)

8.3.5.1 輪椅有多重呢？

電動輪椅非常笨重。然而，重量並不會如同影響手動輪椅一般的影響電動輪椅的性能，因為使用者不會以單手將輪椅拋擲於汽車後方。

那為何需要此資訊呢？因為某些類型的電動輪椅被視為可搬運的，所以了解〝可搬運的〞組件有多重以及如何拆卸才能獲得最輕的組件是重要的。三輪及四輪代步車通常比全尺度的輪椅更加可搬運，因為代步車通常可拆卸成座椅、基座、操縱柄及電池。一台全尺度的電動輪椅可拆卸成：車架、電池盒及控制器。電力基礎的輪椅其拆卸方式相同，且通常具有可移動的座椅系統。參見圖 49。

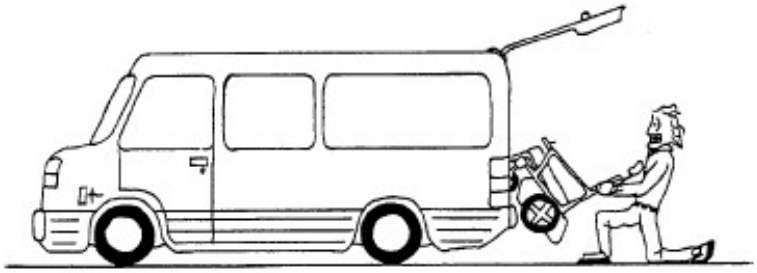

圖 49　如果沒有一台起重機，電動輪椅的重量是一個嚴重的問題...

8.3.5.2 質量之測定

測試程序詳述於 CNS 14964-5，測量配備包括標準扶手、腿墊、輪子及萬向輪的輪椅總質量。

宣告格式(如製造商所報告)

測試名稱　測試結果

輪椅及配件的總質量　　___kg

未被要求於產品印刷包裝中宣告的額外資訊如下：

輪椅中每一個可移動組件的質量___kg

8.3.5.3 結果之詮釋—質量

在此僅要求製造商宣告輪椅的總質量(重量)，包括所有配件，須於銷售前標示於產品印刷包裝中。每個可移動組件的質量雖未被要求宣告，但經要求應可取得。攜帶電動輪椅旅行時，可能會遇到必須將輪椅拆卸並裝入小型車輛來運輸的狀況，組件的質量將是有幫助的資訊，可估計需要拆卸多少組件，及判斷協助的人能否抬起每個組件，而電池通常是其中最笨重的可移動組件。許多航空公司要求搭機時必須將電池從電動輪椅上移除，單個輪椅的電池重量可能是 13.6 kg 至 22.7 kg，若電池置放於單一電池盒，則協助的人必須能抬起 45.5 kg，若電池分別置放於兩個箱子，則搬運則會比較容易。

旅行時，另一項重要的考慮是拆卸及重新組裝輪椅所需的時間；包括電池的拆除、重新安裝以及所需的工具。

附錄 A
(參考)

未被要求於產品印刷包裝中宣告的額外資訊。

備考：若輪椅的製造商聲稱為依照 CNS 或 ISO 國際輪椅標準，則以下任一測試結果應該可直接要求製造商時提供給若製造商不願意提供以下資訊，則代表製造商未依照 CNS 或 ISO 測試程序。

針對名詞釋義，見 CNS 13575。

以下為同時適用於手動與電動輪椅的 CNS 標準，所列出的額外資訊可要求製造商提供。

CNS 14964-1 輪椅－第 1 部：靜態穩定性之測定

- 包括煞車中斷、輪子阻塞。

CNS 13575-5 輪椅－靜穩定度之測定

- 輪椅每一個可移動組件的尺度與質量。
- 輪椅每一個組件的尺度與質量。
- 最小迴轉半徑。
- 背靠於豎直狀態下的全高。
- 最小體積。
- 最大組件的最小尺度。
- 預備用於收藏的非折收式輪椅的尺度。
- 容納於汽車的折收式輪椅的尺度。

CNS 14964-7 輪椅－第 7 部：座椅與輪子尺度之量測

- 有效座椅寬度。
- 背靠寬度。
- 背靠前方的頭靠。
- 腳踏板間隙。
- 腳踏板長度。
- 腳踏板至小腿的角度。
- 扶手寬度。
- 扶手角度。
- 輪軸的垂直位置。

CNS 14964-8 輪椅－第 8 部：靜力、衝擊與疲勞強度之要求與測試方法

製造商可以選擇宣告他們的輪椅於以下領域所作出超過最小建議數值的度數。

靜力強度

扶手下壓。

腳踏板下壓。

後傾桿下壓。

手把。

扶手上拉。

腳踏板支撐上拉。

推把手上拉。

衝擊強度

座椅衝擊負載測試。

背靠衝擊負載測試。

落下測試衝擊負載測試。

滾動衝擊負載測試輪子及/或萬向輪。

手推輪衝擊負載測試。

腳踏板衝擊負載測試。

扶手落下衝擊負載測試

已負載落下衝擊負載測試。

疲勞強度

雙滾輪測試。

邊石落下測試。

CNS 14964-15 輪椅－第 15 部：資訊宣告、文件與標示之要求

CNS 14964-5 輪椅－最大總尺度

以下為僅適用於電動輪椅的測試程序名單

CNS 14964-2 輪椅－第 2 部：動態穩定性之測定

- 上坡啟動，一個或更多輪子抬離測試表面。
- 於最大迴轉操作期間輪椅的抬升或傾斜。

CNS 14964-3 輪椅－第 3 部：煞車效率之測定

- 輪鎖桿力量。
- 向前的水平與自動煞車距離。
- 反向的水平最小煞車距離與自動煞車距離。
- 操作動力煞車桿所需要的力量。

CNS 14964-4 輪椅－第 4 部：電動輪椅及代步車之耗能-理論行駛距離之測定

- 室內及戶外能源消耗。
- W-h/km。

CNS 14964-6 輪椅－第 6 部：電動輪椅最大速度、加速度及減速度之測定

- 最大加速度前進。
- 最大加速度後退。
- 最大減速度前進。

CNS 14964-14 輪椅－第 14 部：電動輪椅之電力與控制系統測試方法與要求

- 操作控制桿所需的力量。

- 操作按鈕、搖桿及小型鍵盤開關所要的力量。
- 操作肘節開關所需的力量。
- 操作氣動式開關(正極與負極)所要的力量。

相對應國際標準

ISO/TR 13570-1:2005 Wheelchairs − Part 1: Guidelines for the application of the ISO 7176 series on wheelchairs

TECHNICAL REPORT

ISO/TR 13570-1

First edition
2005-04-15

Wheelchairs —

Part 1: Guidelines for the application of the ISO 7176 series on wheelchairs

Fauteuils roulants —

Partie 1: Lignes directrices pour l'application de la série ISO 7176 aux fauteuils roulants

94.5.-6
資料中心

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

In exceptional circumstances, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example), it may decide by a simple majority vote of its participating members to publish a Technical Report. A Technical Report is entirely informative in nature and does not have to be reviewed until the data it provides are considered to be no longer valid or useful.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/TR 13570-1 was prepared by Technical Committee ISO/TC 173, *Assistive products for persons with disability*, Subcommittee SC 1, *Wheelchairs*.

This first edition cancels and replaces the first edition of ISO/TR 13570:2001, of which it constitutes a minor revision. This part of ISO/TR 13570 is based on the book, *A Guide to Wheelchair Selection: How to Use the ANSI/RESNA Wheelchair Standards to Buy a Wheelchair,* written by Peter Axelson, Jean Minkel and Denise Chesney, published in 1994 by the Paralyzed Veterans of America, Washington, DC, USA.

ISO/TR 13570 consists of the following parts, under the general title *Wheelchairs*:

— *Part 1: Guidelines for the application of the ISO 7176 series on wheelchairs*

The following part is under preparation:

— *Part 2: Typical values and recommended limits or dimensions, mass and manoeuvring space as determined in ISO 7176-5*

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Wheelchairs —

Part 1: Guidelines for the application of the ISO 7176 series on wheelchairs

1 Scope

The purpose of this part of ISO/TR 13570 is to explain how you can use the International Standards on wheelchairs to select your next wheelchair. The actual standards are very technical and, at first glance, you may not understand how this information will help you select a wheelchair or scooter. This part of ISO/TR 13570 is meant to help you understand the purpose for and content of International Standards on wheelchairs.

This part of ISO/TR 13570 is divided into six clauses.

a) How to use this Technical Report.

b) Standardized testing and information disclosure: Provides background information on standardized testing of wheelchairs. Discusses how chairs are tested and how information is disclosed.

c) General considerations: Discusses general considerations related to choosing a powered or manual wheelchair.

d) Incorporating personal body characteristics: Relates your physical characteristics to the fit of a chair, either manual or powered.

e) Manual wheelchairs: Discusses manual wheelchair test procedures.

f) Powered wheelchairs: Discusses powered wheelchair test procedures; focuses on three- and four-wheeled scooters as well as full-sized powered wheelchairs.

In the manual and powered wheelchair sections, the test procedures are grouped into three categories:

— performance,

— safety, and

— dimensions.

For each test procedure, this part of ISO/TR 13570 includes

— reasons why you might need this information,

— a brief description of the standardized test procedure,

— how the results of the test will be disclosed in the manufacturer's technical product literature, and

— how to interpret the results of the test for your own situation.

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2 How to use this Technical Report

If you are an experienced rider, you may know which elements of performance, safety and dimension are important to you. If not, or if you are a novice, we highly recommend that you involve other knowledgeable people in selecting your wheelchair. Many rehabilitation specialists have the expertise and training in using these standards and can help you select an appropriate wheelchair.

An excellent approach to the wheelchair selection process is to set priorities based on your mobility and seating needs. Setting priorities will help you identify the features that are most important to you and those on which you are willing to compromise. For example, if you live in a small apartment and need to fit your wheelchair into the boot (trunk) of your car, you will probably want to look specifically at the overall dimensions, foldability, and weight of the wheelchair. On the other hand, if you use a van and have an accessible apartment or home, you may not need a folding wheelchair. This part of ISO/TR 13570 will help you understand the test results that pertain to the factors most important to you. Armed with this information, you will be able to accurately compare products and make an informed purchasing decision.

3 Standardized testing and information disclosure

3.1 General

Purchasing a wheelchair can be a harrowing experience and finding the right chair among so many choices might seem impossible. Comparing wheelchair characteristics and performance has been difficult in the past because manufacturers used different standards and procedures to measure and test their chairs. For example, one manufacturer measured seat width from the outside of the seat rails, another measured from inside the rails, and a third measured the distance between the armrest panels. Thus, if you requested a chair with a seat width of 18 inches, the actual distance from the outside of the seat rails could be anywhere from 17 inches to 19 inches. This inconsistency, as well as a general concern for user safety, led to the development of standardized wheelchair measurements and test procedures. The results of these procedures will provide you with the information you need for true comparison shopping.

3.2 Background on tests and standards

The ISO Technical Committee on wheelchairs has been working to provide consumers with objective information about the characteristics and performance of wheelchairs. The committee includes rehabilitation engineers, wheelchair manufacturers, agency representatives, wheelchair users, and wheelchair prescribers.

The standards developed by the committee consist of a number of test procedures that apply to all wheelchairs and some that apply only to powered wheelchairs, including scooters. The test procedures are detailed instructions on how to perform the tests or measurements on wheelchairs. Some of the test procedures suggest minimum performance criteria for durability and safety, while others disclose the results of the tests for comparison purposes. The information obtained from the tests is designed to help you make better-educated selections. See Figure 1. The standardized test procedures also allow you to compare the test results of wheelchairs from different manufacturers. Since many of the test procedures set minimum performance levels, they also help manufacturers produce better products.

3.3 Standards increase your buying power

The standards are voluntary: manufacturers are not required by law to use the test procedures. However, if consumers start using the results as a basis for wheelchair selection, the manufacturers who do not use the standards may lose sales. The US Department of Veterans Affairs (VA), the single largest purchaser of wheelchairs in the United States, is adopting the standards for future wheelchair purchasing. Marketplace pressure will most likely encourage overall compliance with the standards.

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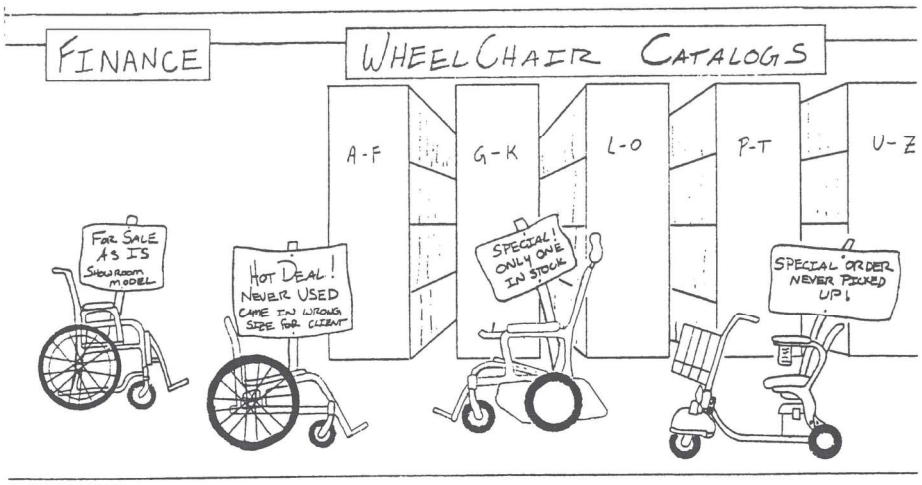

Figure 1 — Finding the right chair among so many choices might seem impossible

3.4 More about International Standards

To gain the maximum benefit from the standardized testing, both consumers and professionals must understand how to use the information.

The following is a list of the test standards, listed by their ISO number designation, that apply to all wheelchairs, with a brief description of the test procedure.

ISO 6440:1985, *Wheelchairs — Nomenclature, terms and definitions*. This International Standard establishes the terms and definitions used in the test procedures.

ISO 7193:1985, *Wheelchairs — Maximum overall dimensions*. This International Standard establishes suggested maximum dimensions of a chair for other organizations to use as guidelines for architectural accessibility.

ISO 7176-1:1999, *Wheelchairs — Part 1: Determination of static stability*. This test determines how stable the wheelchair is when it is resting on a sloped surface.

ISO 7176-3:2003, *Wheelchairs — Part 3: Determination of efficiency of brakes*. This test determines how well the wheel locks (parking brakes) prevent the wheelchair from rolling on a sloped surface. This test also determines the minimum stopping distance of a powered wheelchair at its maximum speed.

ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space*. This part addresses the overall length, width, height, folded width, mass and turnaround space of the chair.

ISO 7176-7:1998, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions*. This part addresses the dimensional information needed to fit a chair to a rider. Standard methods of measurement eliminate the problems that result from variations in measurement methods.

ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*. This part addresses the strength and durability of a wheelchair.

ISO 7176-11:1992, *Wheelchairs — Part 11: Test dummies*. This part addresses the dimensional and mass (weight) specifications of the dummies to be used when conducting the tests.

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ISO 7176-13:1989, *Wheelchairs — Part 13: Determination of coefficient of friction of test surfaces.* This test describes the roughness or slipperiness of the surface to be used for testing.

ISO 7176-15:1996, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling.* This part tells what information manufacturers are required to disclose and how it should be disclosed in their product literature, if they choose to comply with the standards.

ISO 7176-16:1997, *Wheelchairs — Part 16: Resistance to ignition of upholstered parts — Requirements and test methods.* This test addresses the extent to which upholstery will burn and how fire retardant the upholstery is.

ISO 7176-19:2001, *Wheelchairs — Part 19: Wheeled mobility devices for use in motor vehicles.* This part sets out the design and performance requirements, and associated test methods, for wheelchairs that are intended for use as a seat in a motor vehicle.

ISO 7176-22:2000, *Wheelchairs — Part 22: Set-up procedures.* This part specifies the procedures for configuring and adjusting a wheelchair prior to testing.

ISO 7176-23:2002, *Wheelchairs — Part 23: Requirements and test methods for attendant-operated stair-climbing devices.* This part determines the performance of stair-climbing devices that are operated by an attendant.

ISO 7176-24:2004, *Wheelchairs — Part 24: Requirements and test methods for user-operated stair-climbing devices.* This part determines the performance of stair-climbing devices that are operated by the occupant.

The following is a list of test procedures that apply to powered wheelchairs only:

ISO 7176-2:2001, *Wheelchairs — Part 2: Determination of dynamic stability of electric wheelchairs.* This part addresses how stable a powered wheelchair is in the rearward, forward and lateral directions when it is driven.

ISO 7176-4:1997, *Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range.* This test addresses the energy consumption of a powered wheelchair on a standardized track.

ISO 7176-6:2001, *Wheelchairs — Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs.* This part addresses the maximum speed in forward and reverse. It also determines the minimum time from stationary to maximum speed (acceleration) and from maximum speed to a complete stop (retardation).

ISO 7176-9:2001, *Wheelchairs — Part 9: Climatic tests for electric wheelchairs.* This part addresses the effects of rain and temperature changes on the functioning of a powered wheelchair.

ISO 7176-10:1988, *Wheelchairs — Part 10: Determination of obstacle-climbing ability of electric wheelchairs.* This test determines how high an obstacle a powered wheelchair can climb over.

ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods.* This test addresses safety, how well the fail-safe braking mechanism works, the force required to actuate the controls, and other issues related specifically to powered wheelchairs.

ISO 7176-21:2003, *Wheelchairs — Part 21: Requirements and test methods for electromagnetic compatibility of electrically powered wheelchairs and motorized scooters.* This part addresses the electromagnetic emissions and electromagnetic immunity of powered wheelchairs, including scooters.

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3.5 How chairs are tested

The International Standards on wheelchairs are specific instructions on how to perform the test procedures. Some of the test procedures have minimum performance requirements, including flammability and climatic tests, static and impact strength tests, and power and control systems tests for powered wheelchairs. The results of the minimum performance tests are either pass or fail. These tests ensure minimum performance and safety of the product. See Figure 2.

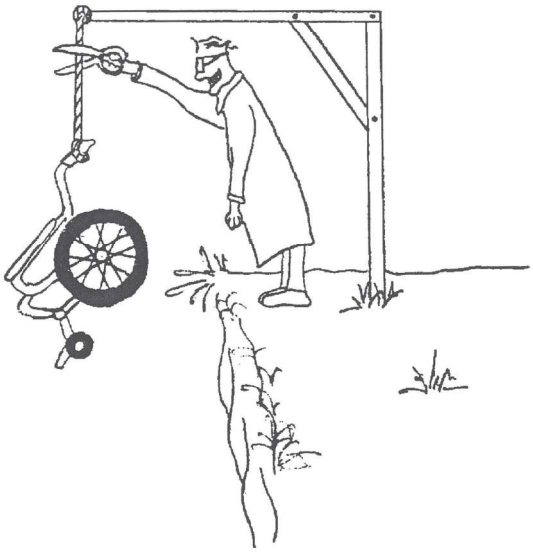

Figure 2 — Testing of wheelchairs has become more sophisticated over the years

Most of the test procedures are performance tests that produce quantified information about a chair. The results give information for comparison purposes only; there is no pass or fail determination. These comparisons are meaningful because, for the first time, each manufacturer uses the same tests. Until now, different manufacturers described their wheelchairs using different terms. By comparing test results of different chairs, you can begin comparative wheelchair shopping.

Most of the tests are conducted with a test dummy in the chair to represent the weight of a person. The results for chairs tested in this "loaded" condition more closely approximate the fit and performance of a chair when it is actually occupied. Your own body size, body proportions riding style may affect the actual fit and performance of a chair.

For wheelchair components that are adjustable, the manufacturer adjusts the wheelchair configuration and controls to obtain the extreme range of outcomes for a specific test procedure. For example, rear axle position and other adjustable features affect the stability of a chair. In this case, the manufacturer tests the wheelchair with its rear wheels and other adjustable features in both the least and most stable configurations. These results give a range of tipping angles that reflects the least stable and most stable configurations that can be obtained by adjusting the rear wheels and other features of the wheelchair. On a powered wheelchair with an adjustable controller, the manufacturer will disclose a range of stopping distances to reflect the adjustability of speed and retardation (deceleration).

3.6 How information is disclosed

Manufacturers that wish to comply with the International Standards on wheelchairs must comply with ISO 7176-15, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*, which specifies which test results must be contained in the pre-sale technical product literature. A list of the additional tests that the manufacturer is required to perform is contained in Annex A. The manufacturer is not required to disclose the results of these additional tests in the technical product literature, but the consumer can request this information. See Figure 3.

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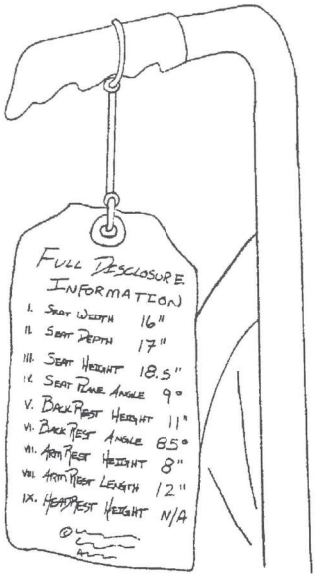

Figure 3 — To be in compliance with the ISO test procedures, manufacturers are required to disclose certain information about the chair in their pre-sale technical product literature

The test results of particular procedures are disclosed as performance values, which at first may have little or no meaning to you. For example, a manufacturer may disclose the rear-tipping angle of a wheelchair, but there is no minimum performance value available for comparison at this time. However, you can look up the tip angle or the range of tip angles for a specific wheelchair with which you have experience, then look at the tip angles of other wheelchairs and figure out how these chairs will perform compared with the chair you know. For example, suppose your current wheelchair has a rear tip angle of 4°. You can determine if the wheelchair you are considering is more or less tippy than your current chair by finding out if its rear tip angle is greater or less then 4°. As you gain experience using one wheelchair, the information about other wheelchairs will become more meaningful to you.

NOTE The performance ratings are usually based on testing only one wheelchair. The results disclosed represent the maximum performance of a new wheelchair tested without failure. The performance you get from your wheelchair will vary depending on your body size and proportion, physical strength, abilities, skills and riding habits and on environmental conditions.

4 General considerations

4.1 Manual versus powered wheelchairs

4.1.1 General

Rehabilitation programmes used to emphasize that if it was possible for you to push a manual wheelchair, you should do so. The saying was "Use it or lose it." However, many people with marginal ability to use a manual wheelchair find that they deplete all their energy resources just trying to get where they want to go. Once they get there, they have no energy left to do what they want to do. Worse yet, people with 20 or 30 years of experience pushing a manual wheelchair realise that their shoulders are worn out as a result of the years of "using it" and not "losing it." Should healthy manual wheelchair riders spend some time in a powered wheelchair? To answer this question, do some self-examination. Ask yourself which type of mobility meets your needs. See Figure 4.

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Figure 4 — In some environments, a manual wheelchair may not leave you with the energy that you will need when you get to your destination

4.1.2 Some reasons to select manual mobility

You have sufficient upper body strength and overall endurance to propel your wheelchair all day.

Reducing the weight or increasing the manoeuvrability of the wheelchair would enhance your independence.

Some of your daily activities are easier to perform in a manual chair.

A manual wheelchair is smaller, lighter and less expensive to maintain and repair.

You are not experiencing chronic pain in your arms or shoulders.

4.1.3 Some reasons to select powered mobility (including scooters)

You have insufficient endurance or functional ability to propel a manual wheelchair independently.

You need to conserve energy during long-distance wheeling to work or school.

Powered mobility would enable you to be more independent in your daily living, work and recreational activities.

You have access to personal or public transportation that accommodates a full-sized powered chair or scooter for longer distance travel.

Many powered wheelchair riders have a manual wheelchair to use when a powered wheelchair is inconvenient. When travelling, a powered wheelchair user may use a manual wheelchair and have a person help with mobility. Other users may rely on a manual wheelchair at home and at work and use a powered wheelchair for travelling to and from work. There is something to be said for the use of a powered wheelchair to prevent overuse of the shoulder muscles, although this option is not often discussed. Financial considerations are important as well, since powered wheelchairs are expensive. Whether the primary wheelchair is powered or manual, a backup manual wheelchair should be available in the event of breakdown of the main wheelchair.

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4.2 Rigid versus folding manual wheelchairs

If you plan to use a manual wheelchair, the first decision you have to make is whether it should be rigid or folding. Nonfolding fixed-frame chairs are more rigid, whereas folding chairs tend to have a little more flex in the frame. This flex can be an advantage when you are travelling over slightly uneven surfaces, because all the wheels of the chair tend to stay on the ground. When you use a rigid wheelchair on an uneven surface, one wheel often lifts off the ground. However, on a hard floor surface, a rigid-frame chair gives a more responsive feeling, since all the energy you expend goes into propulsion and none goes into flexing the frame of the chair. Many people prefer the aesthetics of a rigid frame (see Figure 5), although both types are available in lightweight models and in a variety of colours. Some of the advantages and disadvantages are listed in Table 1.

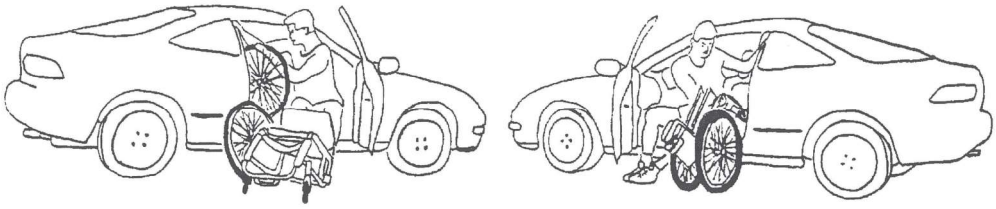

Figure 5 — Getting a folding wheelchair into and out of a car can be quicker than a rigid-frame chair. However, many riders prefer the performance of a rigid-frame chair on hard surface floors

Table 1 — Rigid versus folding wheelchairs

	Advantages	Disadvantages
Rigid frame	• Frame design requires fewer components and thus has more strength for a given mass • Usually a lighter chair than a similarly equipped folding chair • Fewer removable parts • Required to meet National Wheelchair Basketball Association specifications • Seat-to-back angle is often adjustable	• Requires removal of quick-release rear wheels for loading into car • May feel bumpier on uneven surfaces • Does not fold into as small a package for stowing in car or aeroplane
Folding frame	• Folds into compact package for stowing in car or aeroplane • Flexes to enable all four wheels to stay on the ground when riding on uneven surfaces • Can be folded and stowed without removing parts	• More moving, adjustable, and removable components • May not meet rider's sports or leisure activity needs • Seat-to-back angle usually not adjustable • Lateral stability can decrease as the chair flexes or starts to fold

4.3 Direct-drive versus belt-drive powered wheelchairs

When the motors are mounted directly to the drive wheels with only gears in between, the system is called a direct-drive system. When belts connect the motors to the drive wheels, the system is called a belt-drive system. Most wheelchairs are only available one way or the other. Keep in mind when comparing two scooters that one may have a direct-drive system while the other may have a belt-drive system. Full-sized powered chairs are also manufactured with either a direct-drive or a belt-drive system.

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Like the rigid-frame manual wheelchair, the direct-drive system has no flex or slack. The drive wheels respond directly to the actions of the motors. The belt, on the other hand, introduces a slight delay between the action of the motor and the wheel. Depending on your trunk balance, you may find the delay in a belt-driven chair provides a more comfortable ride. Unfortunately, belts can slip if they are not properly adjusted or if they are wet, and the rear wheels will not always respond when you want them to. You must look at the advantages of direct drive versus belt drive and make the best choice for your needs and your environment. See Figure 6.

Figure 6 — Many users choose lower maintenance direct-drive chairs despite some drawbacks

Some of the advantages and disadvantages of the two drive systems are listed in Table 2.

Table 2 — Direct-drive versus belt-drive powered wheelchairs

	Advantages	Disadvantages
Direct drive	• Requires little maintenance • No exposed parts to cause wear from dirt	• Can be noisy during operation • Gears wear if not properly lubricated
Belt drive	• Belts can be easily replaced • Generally quiet during operation • Can provide a smooth ride	• Chair will drive in a circle if a belt breaks • Belts can slip when wet, reducing control • Generally requires more maintenance • May require adjustments if there is a change in temperature • Belts can be noisy during start-up

4.4 Cost

Seating and mobility professionals can provide a thorough clinical evaluation of your needs, environment, size and functional strengths and limitations to help you choose the appropriate wheelchair. In addition, the rehabilitation facility may have a variety of wheelchairs on hand to demonstrate the "latest and greatest" in design and components. A proper clinical evaluation and knowledge of available components may prevent costly mistakes. Many wheelchair users have received chairs that did not fit or did not meet their functional needs as a result of an uninformed decision. In most cases, the rehabilitation centre will assemble and adjust the chair to fit you, and training is often available through the centre or the wheelchair supplier to help you learn the performance characteristics of the chair.

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If you feel you can bypass seating and mobility professionals because you have enough personal experience, you may be able to save money by purchasing the wheelchair directly from a mail-order house or with cash through a local supplier. As with any mail-order purchase, you will forgo local support, including warranty repairs, assembly, set-up and adjustment to fit your body, abilities and skills. Such a purchase also will not include training, which you might need if the new wheelchair has very different performance characteristics from your previous one.

5 Incorporating personal body characteristics

5.1 Body size

Just knowing your height and weight is not enough to determine the appropriate dimensions of your wheelchair. In order to achieve the best fit, you also need to know the dimensions of your body in a seated position. When measuring your body size, it is helpful to sit in a wheelchair that is as close to the correct size as possible. If you are ordering a wheelchair with sling upholstery, you should be measured while sitting in a chair with sling upholstery. If you are ordering a wheelchair with rigid seat and back surfaces, you should be measured sitting in a wheelchair with a rigid seat and back, or at least on a surface with similar characteristics. If you will be using a seat cushion, sit on the same type and size of cushion you will use in the new chair. Be sure to consider the seat cushion as part of your body while making the measurements. If you sit on a cushion that is lower or higher than the one you will be using in your new chair, the measurements will be incorrect.

The measurements you will use are

— seat width,

— seat depth,

— seat surface height,

— backrest height, and

— footrest-to-seat distance.

If you use armrests and/or a headrest you will need to know

— armrest height,

— front of armrest to backrest distance,

— armrest length,

— front location of armrest structure,

— distance between armrests, and

— headrest height.

Until now, figuring the dimensions of a wheelchair to fit an individual used to be a nightmare, because there was no standard measurement method. Each manufacturer had his own way of making measurements. Also, all manufacturers measured their chairs empty, although the size of the chair may change when a person sits in it. The fabric seat and back upholstery may give, pulling the two sides of the chair together, thus changing its size.

The ISO test procedures require that the wheelchair be measured "loaded" with a weighted test dummy. The test dummy sizes represent the size and mass of the intended rider: large adult [100 kg (220 lbs)], adult [75 kg (165 lbs)], small adult [50 kg (110 lbs)] and child [25 kg (55 lbs)]. Specifying a chair to fit you will be

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much more accurate when working with dimensions that represent the size of an occupied chair. Although figuring out the dimensions of a wheelchair can still be pretty challenging, you will find that the test procedures provide more accurate information and that measurements from different manufacturers can be compared.

5.2 Seating

5.2.1 Seat width

Generally, to enhance accessibility, the width of a chair should be as narrow as possible without causing pressure on the rider's hips. An increase in seat width usually results in an increase in the overall width of the chair. You might select a wider wheelchair if you wanted a chair that was more stable sideways.

Another consideration is the type of clothing that you will be wearing. If you generally wear a suit or jacket, you may want a little extra room for tucking in your clothing on the sides. See Figure 7.

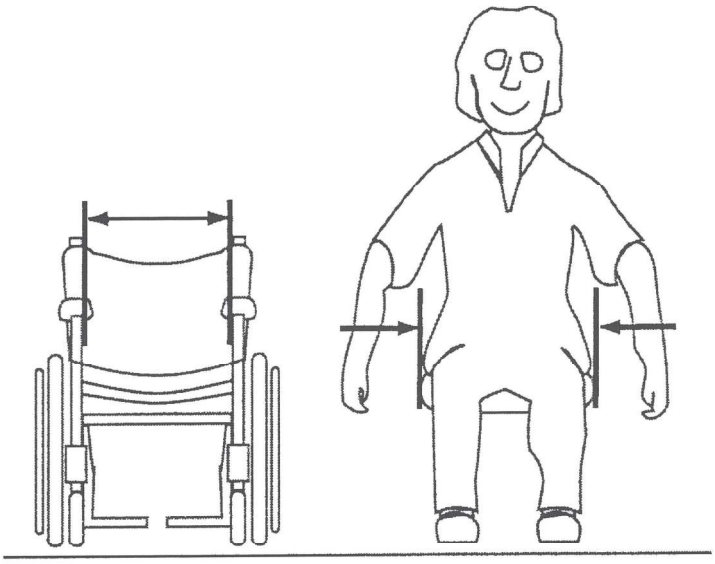

Figure 7 — Seat width

5.2.2 Seat depth

The seat should be long enough to provide adequate leg support, which creates better weight distribution. If your legs can support weight, a longer seat depth will spread your weight out more over your thighs. This means that the amount of weight on your bony prominences will be decreased, thus decreasing the risk of pressure sores. If the seat is too long, however, the front edge will catch the back of your knees. The effective seat depth of a chair with a fabric backrest will measure longer than one with a rigid back support surface.

If you will be adding a rigid back support to a wheelchair with sling upholstery, the seat depth of your chair may change. It is a good idea to install the back support on a wheelchair similar to the one you will be ordering to determine how much the seat depth will change. See Figure 8.

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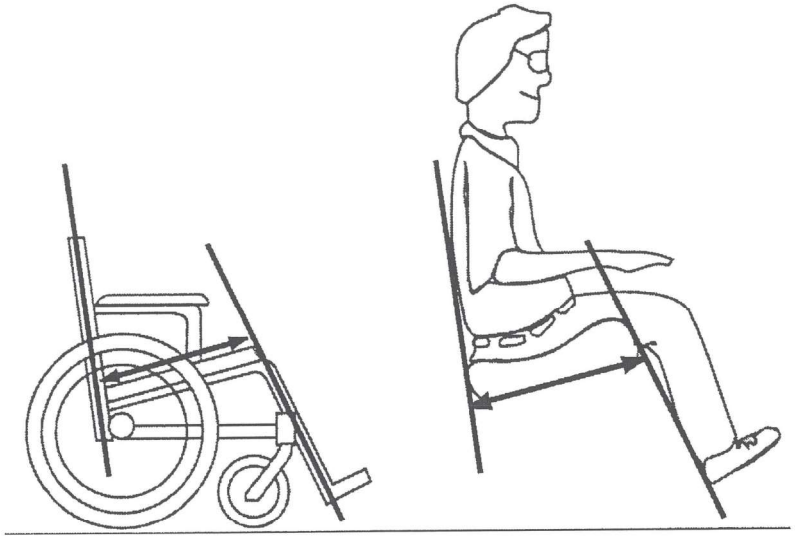

Figure 8 — Seat depth

The seat depth is increased even more when a chair is equipped with legrests that have calf supports. Calf supports hold the legs forward of the front edge of the seat. If this is not taken into consideration when ordering the wheelchair, this may prevent you from positioning your buttocks against the backrest and would then cause you to sit in a slumped sitting posture. See Figure 9.

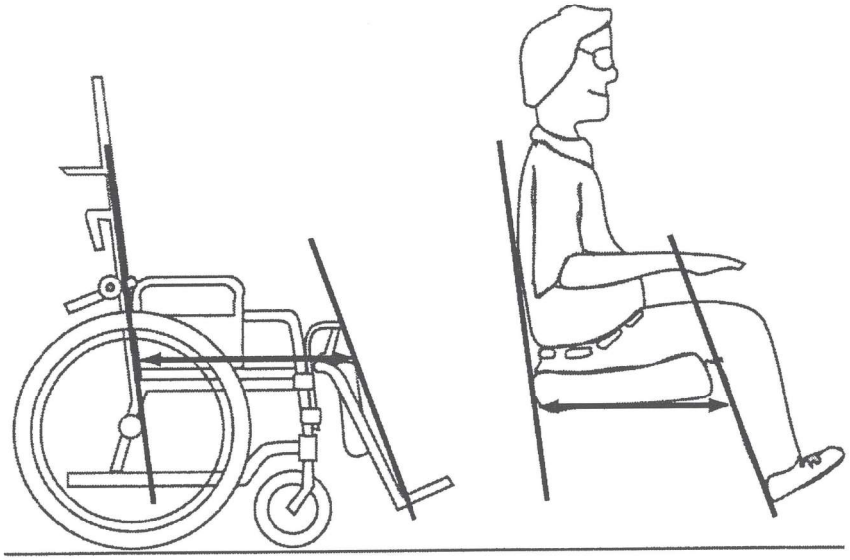

Figure 9 — Calf supports

5.2.3 Seat surface height

The wheelchair seat must be high enough to accommodate the length of your legs and yet low enough so that your legs will fit under tables. Some users prefer to sit up higher so they are more eye-to-eye with people sitting or standing next to them.

If the chair has a fabric seat, the seat surface height will measure a bit lower than one with a rigid seating surface. The distance disclosed by the manufacturer will not include the height of a seat cushion. If you will be

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using a seat cushion, determine your appropriate wheelchair seat height while sitting on that seat cushion. Sit in a similar wheelchair and then measure to the bottom of your seat cushion. See Figure 10.

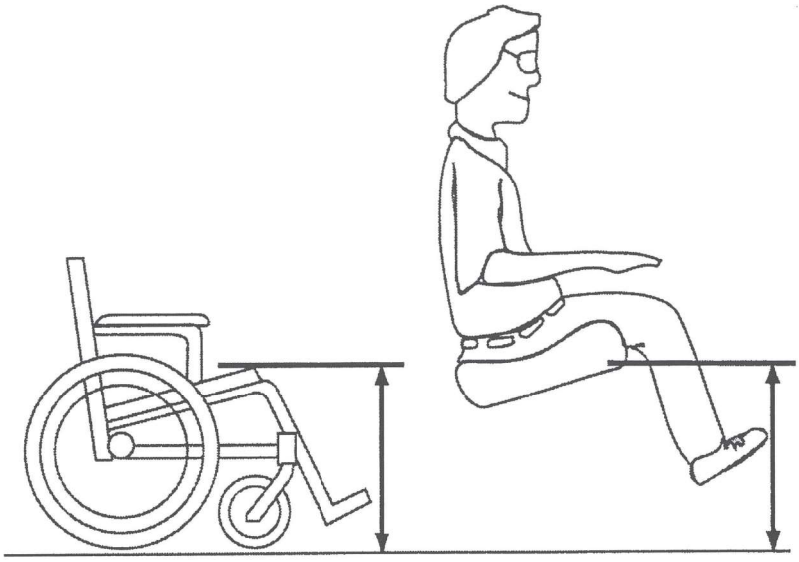

Figure 10 — Seat surface height at front edge

If the seat height is too low and you use footrests, the footrests may not have enough ground clearance and may scrape the ground at dropped kerbs. A seat that is too high can make transferring into and out of your chair more difficult. Manual wheelchair users should keep in mind that changing the seat height will also change your body's relationship to the drive wheels and may affect your ability to push your chair. A higher seat will make it harder to reach the pushrims, while a lower seat will allow you to reach more of the pushrims.

The seat height is very important for people with hemiplegia or others who propel their chairs using their feet. If you propel the chair with your feet, you might need a lower seat.

5.2.4 Backrest height

The height of the backrest depends on the rider. Some wheelchair riders want a low backrest for enhanced upper body movement or because they like the way it looks. Higher backrests help support riders who have less upper body balance. Regardless of the backrest height, be sure that the back posts or push handles do not interfere with your arm movements while you are wheeling.

The backrest height disclosed by the manufacturer will not include the thickness of the seat cushion. The backrest height is measured from the seat surface of the wheelchair. When determining your backrest height, make sure you are seated on the seat cushion that you intend to use. Measure from the surface on which the seat cushion is resting. See Figure 11. Since this measurement is made from the wheelchair upholstery surface, the backrest height measurement will be slightly higher for a wheelchair with sling upholstery than for a chair with a rigid seat.

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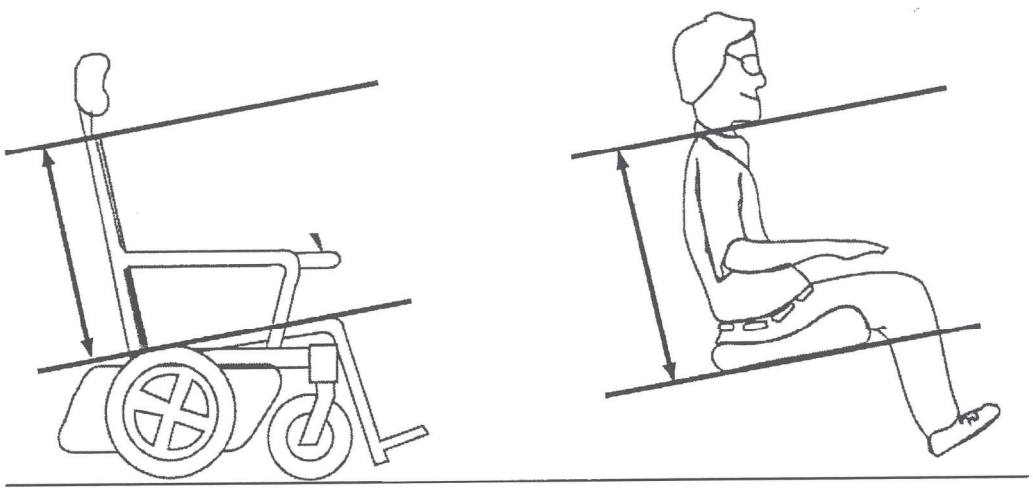

Figure 11 — Backrest height

5.2.5 Footrest-to-seat distance

The manufacturer will measure and report the footrest-to-seat distance without a seat cushion on a loaded wheelchair. To determine if the wheelchair will accommodate your leg length, sit on your cushion in a wheelchair with a similar seating surface. Measure from the bottom of the shoes that you normally wear to the front edge of the seating surface just beneath your cushion. See Figure 12.

If the footrest length is adjustable, the manufacturer will indicate the range available for a particular chair and footrest. If the range does not meet your needs, remember that footrests are usually available in a variety of styles; a different footrest may provide the range of adjustment necessary to accommodate your leg length. Sometimes changing the footrests is not enough. If you have very long or very short legs, you may need to look for a different frame style. Tall or short frames, for proportionately taller or shorter people, are available in some models. To accommodate long legs, you might also need a higher seat or a greater seat-to-leg angle.

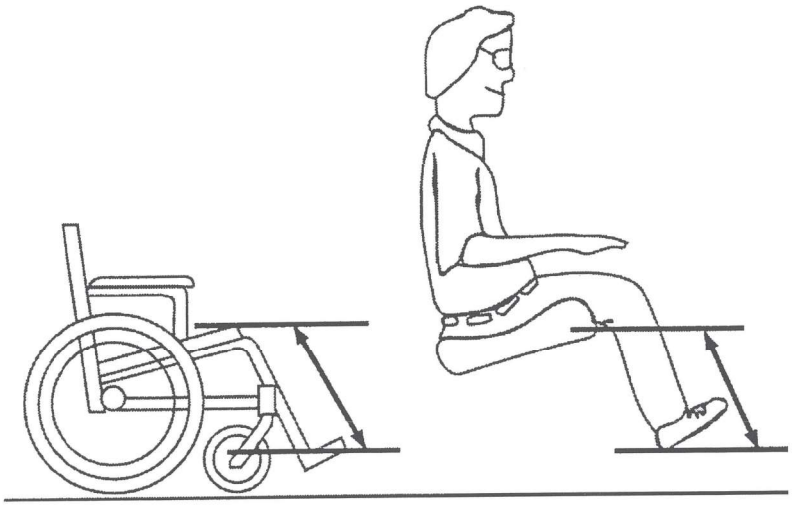

Figure 12 — Footrest-to-seat distance

Once the footrest is adjusted for you, you should have at least 2 inches of clearance under your foot pedals to save you from hitting the bottom of dropped kerbs with your foot pedals. Footrest clearance and leg length must be considered before selecting a seat height.

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Footrests are available in a wide variety of styles and variations. The type of footrest that is appropriate for you will depend on your size, needs and preferences. The features given in Table 3 may be available from the manufacturer.

Table 3 — Features of footrests

Footrests	Description
Adjustable length	• Usually a standard feature • Accommodates a range of leg lengths
Swing away, detachable	• Necessary for some riders to be able to transfer or to put the chair in the car
Flip-up	• Required for folding wheelchairs • Facilitates some types of transfers
Folding footplate	• Non-flip-up • Folds for storage
Impact guard	• Hard plastic, wheel-shaped bumper on the outer front edge of the footrest • Useful for pushing open doors • Prevents the footrest from catching on obstacles, such as dropped kerbs and doors, and from digging into floor surfaces • Required for indoor basketball wheelchairs
Elevating	• Usually an optional feature • Usually enables elevation of one leg at a time
90°-90° platforms	• Accommodates shorter leg lengths • Usually used for children
Rigid single unit	• Usually found on rigid-frame wheelchairs • Generally much stronger
Calf support strap	• Prevents the feet from falling back underneath the chair
Calf support	• Usually provided with elevating leg rests • Prevents the legs from slipping back underneath the wheelchair

5.2.6 Armrest and headrest

5.2.6.1 General

If you use armrests, several measurements in the test procedures may be of interest to you: armrest height, front of armrest to backrest distance, and the armrest length.

5.2.6.2 Armrest height

The armrest height is an important dimension to consider. The manufacturer reports the distance from the top of the armrest to the top of the loaded seating surface of the wheelchair. The measurement for a wheelchair with sling upholstery will be different than for one with a rigid seating surface. To determine the armrest height you need, sit on your seat cushion in a chair with a seating surface like the one you will be purchasing. Hang your arm down at your side, bend your elbow 90°, and measure the distance from the bottom of your elbow down to the seating surface of the wheelchair beneath the cushion. See Figure 13.

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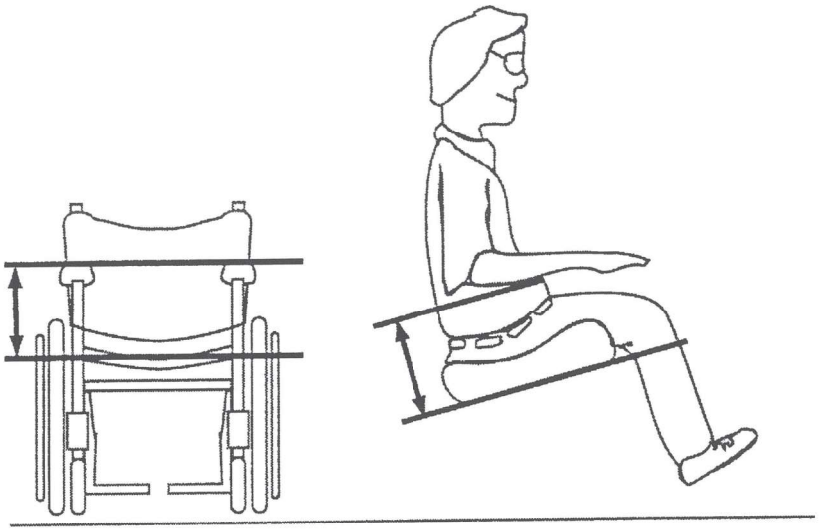

Figure 13 — Armrest height

The armrest height of a wheelchair with a fixed-height armrest is given as a single value. For wheelchairs with adjustable-height armrests, a range of heights is given. Some adjustable armrests have infinite adjustments within the range, while others have a limited number of pre-set height adjustments.

Armrests that are too high can cause your shoulders to be elevated; armrests that are too low can contribute to a slumped posture or even shoulder subluxation in riders without good shoulder muscles. Make sure your armrest height is appropriate to prevent shoulder problems and further complications caused by poor posture. If you use armrests, you may find the following additional measurements helpful.

5.2.6.3 Front of armrest to backrest distance

The distance from the backrest to the front of the armrest is important if you use the armrests to transfer into or out of your chair. If the armrests do not extend far enough forward, they may not provide the support you need. If the armrests are too far forward, they may prevent you from getting close to a desk or table. See Figure 14. This measurement will be slightly longer for a wheelchair with sling upholstery.

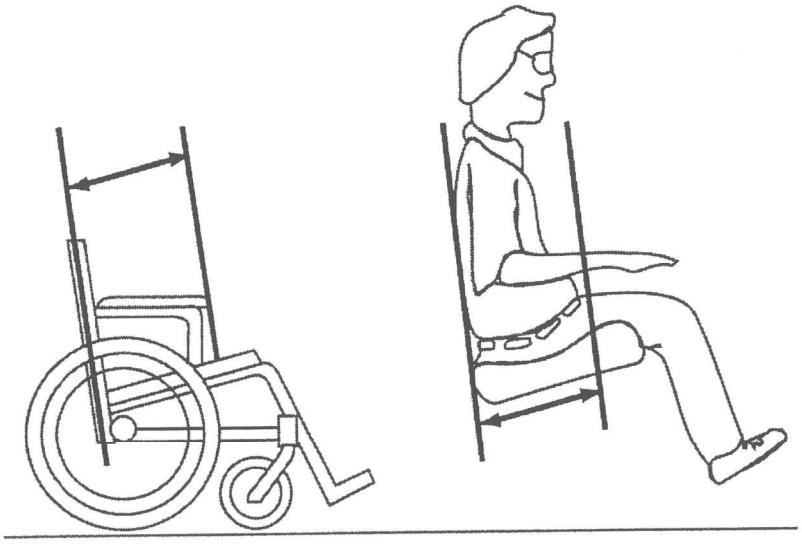

Figure 14 — Front of armrest-to-backrest distance

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5.2.6.4 Armrest length

The length of the padded part of the armrest is the armrest length. See Figure 15. When you sit back in the chair, the armrest pad should reach far enough forward from the backrest to support your arm in a comfortable position. If you use a lap tray, the length of the armrests should provide enough support for the tray.

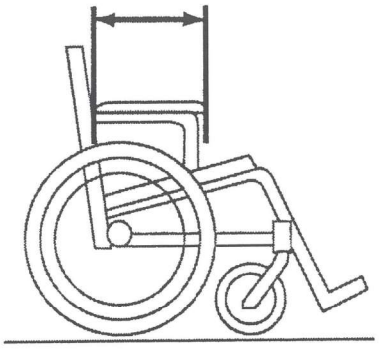

Figure 15 — Armrest length

5.2.7 Front location of armrest structure

The front location of the armrest structure is the distance from the backrest to the most forward part of the armrest. See Figure 16. This distance is measured at a height of about 27 inches from the ground and thus indicates how close you will be able to pull up to a desk or table. The distance from the backrest to the front location of desk-style armrests is shorter because they are specifically designed to enable you to pull up closer to a desk, writing surface or table.

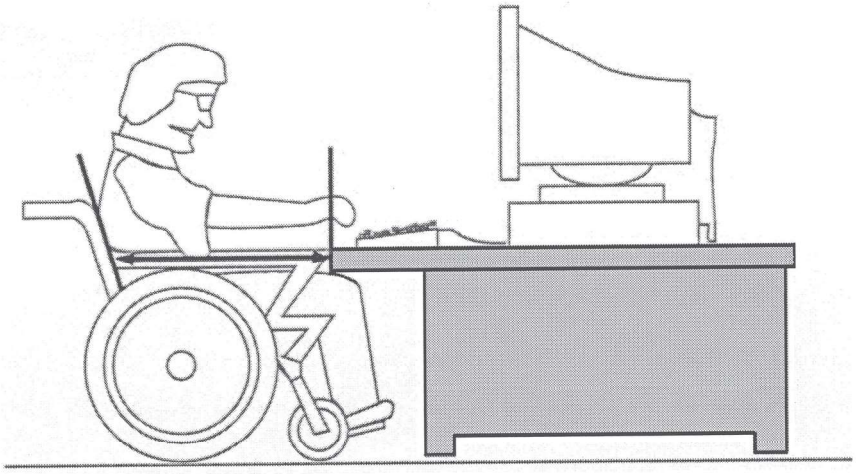

Figure 16 — Front location of armrest structure

5.2.8 Distance between armrest

The distance between the innermost edges of the armrests is only measured on wheelchairs with fixed armrests. See Figure 17. Armrests welded directly to the frame of the chair tend to limit the maximum available seat width at the height of the armrest pads because of the width of the support pads.

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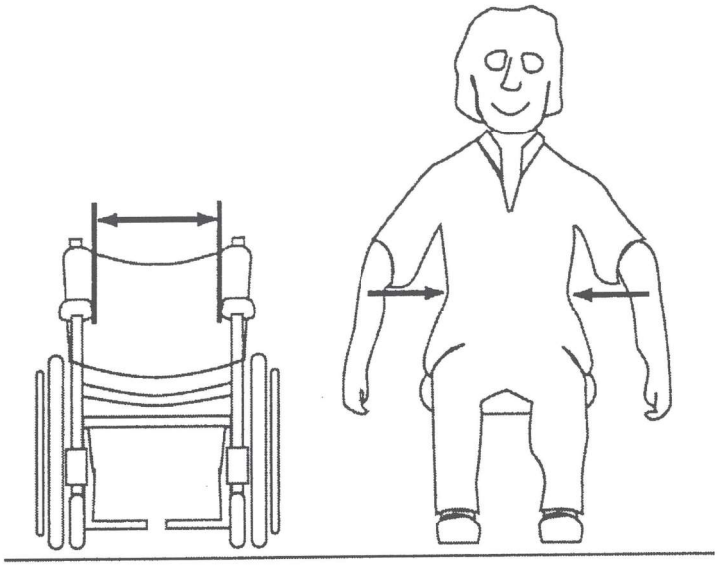

Figure 17 — Distance between armrests

Armrests are available in many styles and sizes. Armrest measurements may vary if you change the type of armrest on the wheelchair. The type of armrest that is best suited for you depends on your size, your needs and your preferences. The armrest features listed in Table 4 may be available from the manufacturer.

Table 4 — Features of armrests

Armrests	Description
Adjustable-height	• Desirable for setting the armrests at the height you need • The height can vary to facilitate transfers
Clothing guard	• Prevents your clothing and your body from touching the wheel • Available in either a fabric or rigid style
Desk-style	• Shorter armrests that enable you to pull up close to a desk, writing surface, or table
Fixed	• Cannot be removed from the wheelchair
Full-length	• Extend at the same height from the backrest forward
Pivoting	• Can be pivoted into another position (usually behind the back posts) • Can be pivoted out of the way for transfers
Removable	• Can be removed to facilitate transfers
Sloping	• Slope downward toward the front of the wheelchair • Reduced profile for approaching a desk, writing surface, or table
Wraparound	• Often create a narrower overall wheelchair width without significantly decreasing the width between the armrest panels • The rear lock on the armrest may be farther back on the chair and more difficult to reach

5.2.9 Headrest height

If a chair comes with a headrest, International Standards require that the manufacturer disclose how high the centre of the headrest is above the seat upholstery. If the headrest is adjustable, the test results will indicate the range of heights at which it can be positioned. To determine your headrest height, sit on your seat cushion

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in a chair with a seating surface like the one you will be purchasing. Measure from the back of your head down to the seating surface beneath your cushion. See Figure 18.

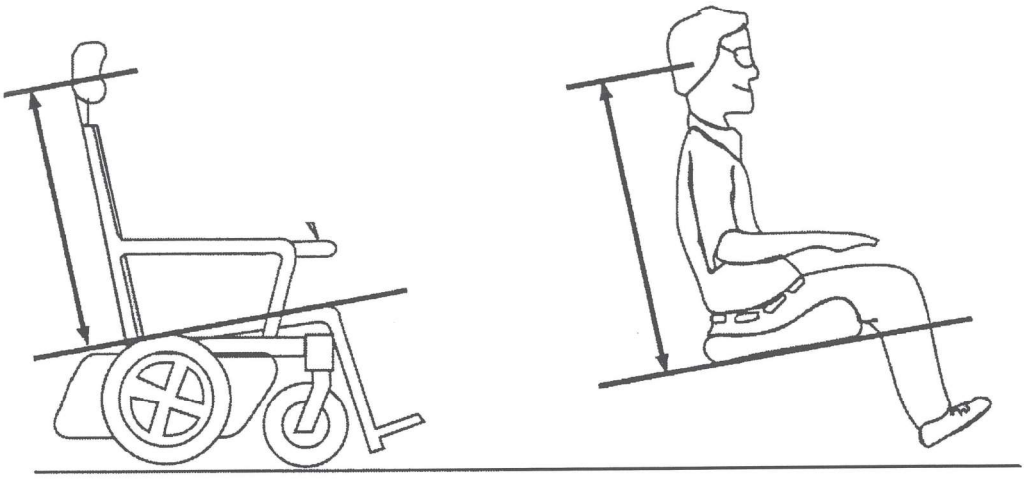

Figure 18 — Headrest height

Another measurement that may be of interest to you is the distance the headrest is in front of the backrest. Manufacturers are not required to disclose this measurement in the pre-sale technical product literature, but you can request it. This measurement will indicate if the headrest is directly in line with the backrest or if it can be positioned in front of or behind the backrest. It may be a single value or, if the headrest position is adjustable, a range of values.

5.3 Joint flexibility

5.3.1 General

In addition to your size, the flexibility of your joints (how far your arms and legs bend and straighten) will influence the fit of your chair. Your ability to maintain your sitting balance will also affect your choice.

The flexibility of your hips affects the seat-to-backrest angle you need. In International Standards, the seat-plane angle refers to the slope of the seat. Some riders have found that wedged or squeeze frames (chairs with a rearward slope to the seat) help with balance and stability. If you keep your backrest upright (not reclined) and increase the rearward slope of your seat, you will need to bend your hips more to fit into the chair. If you do not have good hip flexion, too much squeeze can cause pressure problems because your body cannot bend enough to fit into the chair.

If you are not very flexible, you may want to look for a chair with an adjustable backrest angle. If you recline the backrest just a little, the angle between the seat and the backrest will more closely match the angle between your thigh and your trunk.

Some powered wheelchairs are available with a power recline feature. This option may be necessary if you must perform independent weight shifts and repositioning for increased sitting tolerance and cannot shift weight by yourself. A power recline feature can also eliminate the need for transfers to bed for rest or catheterisation. Quick position changes can help reduce spasticity, your body's response to low blood pressure, and dysreflexia.

It is also important to know the flexibility of your knee and ankle joints. Many wheelchair manufacturers offer chairs with the foot pedals closer to the front edge of the seat. These "tighter" footrests reduce the overall length of the chair and make it easier to get closer to things in your environment. To fit into these tighter wheelchairs, you need good knee flexion.

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5.3.2 Leg-to-seat surface angle

The smaller the leg-to-seat surface angle, the more flexion or bend you will need at your knees. If you have limited knee movement, look for the angle that most closely matches the angle between your thigh and lower leg. See Figure 19.

NOTE Many wheelchair manufacturers used to measure this angle using a different method. They were not measuring the leg-to-seat surface angle as illustrated here. When this angle is measured correctly, it will almost always be greater than 90°.

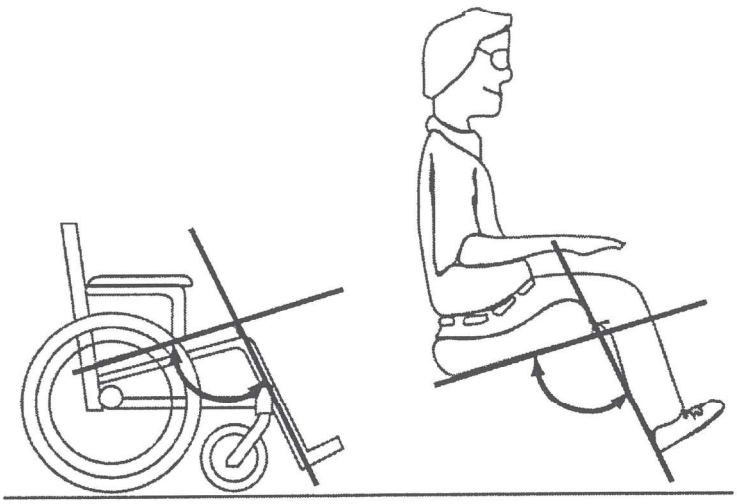

Figure 19 — Leg-to-seat surface angle

5.3.3 Seat-plane angle

The seat-plane angle can be positive, negative or zero. A zero seat-plane angle means that the seat is level. A positive seat-plane angle means that the seat slopes downwards to the rear and that the front edge of the seat is higher than the back edge. Seats with a positive seat-plane angle require good hip flexion. A negative seat-plane angle means that the seat slopes forwards and the front edge of the seat is lower than the back edge. Seats with a negative seat-plane angle require good trunk balance. See Figure 20.

Some wheelchair users like sitting with their knees up high on a wedge to increase their trunk stability. However, while doing this increases trunk stability in the short term, it tends to round your spine and, in the long term, can lead to back pain.

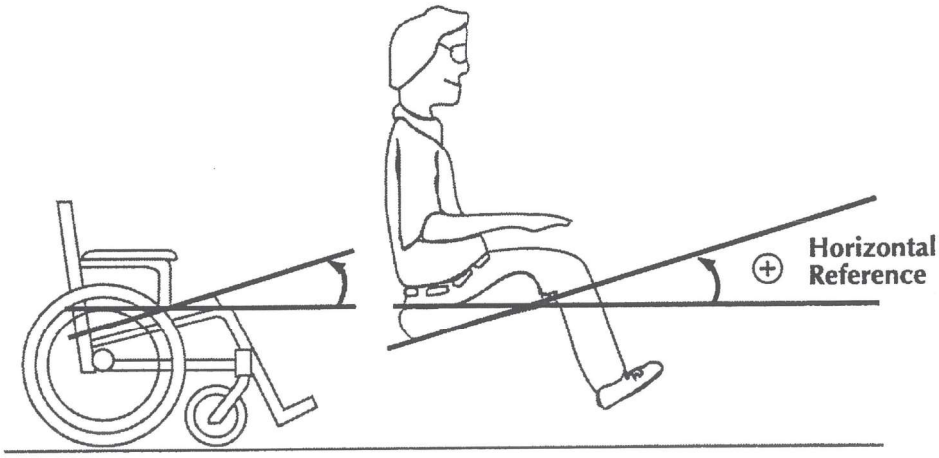

Figure 20 — Seat-plane angle

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5.3.4 Backrest angle

A zero backrest angle means that the backrest is upright or vertical. A positive backrest angle means that the backrest is reclined. See Figure 21. Backrests that can be reclined quite far have large positive angles. The larger the angle, the more you will lean back in your wheelchair. A reclined position accommodates less flexible hips. Backrests that can be adjusted into a forward-leaning position have negative backrest angles. A forward-leaning backrest requires greater hip flexion. The more vertical the backrest angle, the more you will sit up straight in your wheelchair. Some wheelchair users like sitting in a chair with a negative backrest angle. If the backrest angle is adjustable, the manufacturer will give a range of angles.

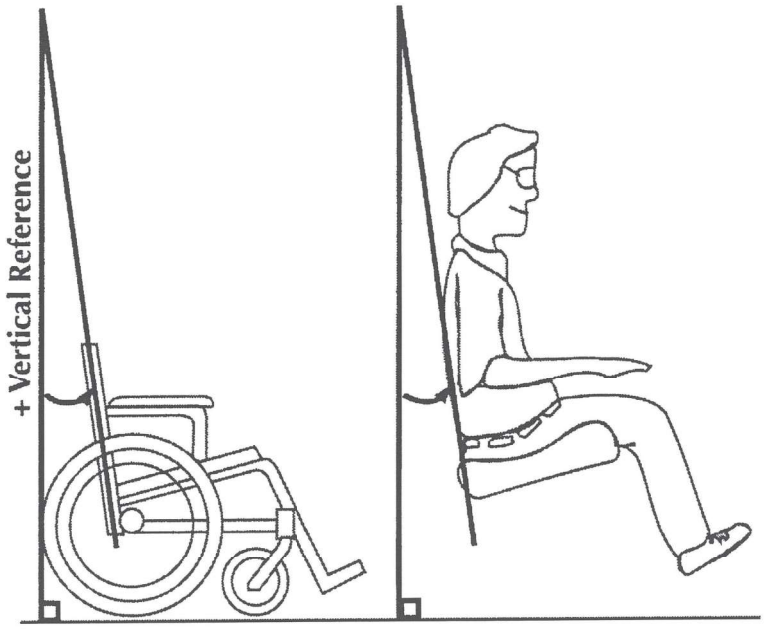

Figure 21 — Backrest angle

5.4 Propulsion skill

5.4.1 General

Wheelchair handrims are usually mounted on the rear wheels. How easily you can reach the handrims greatly affects your ability to propel the chair. Three standard measurements can help you determine how well you will be able to propel the wheelchair:

— the propelling wheel diameter,

— the handrim diameter, and

— the horizontal location of the rear axle.

5.4.2 Propelling wheel diameter

Most chairs have a 24 inch diameter propelling wheel and a slightly smaller handrim (pushrim), usually 20 inches to 21 inches in diameter. For many users, these wheel and handrim sizes put the top of the handrim in a good position to push. However, if you sit very high or very low in the chair, or if you have very long or very short arms, you may want smaller or larger wheels. Smaller wheels are more efficient if you have longer arms, because you do not have to bend your elbow and shoulder as much to reach the top of the handrim. Conversely, larger wheels (26 inches or 28 inches in diameter) bring the wheel closer to your hand if you have short arms or need to sit higher in the chair (for example, for proper ground clearance under the foot pedals). Bringing the handrim closer to the arms also helps if you have limited arm movement.

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5.4.3 Handrim diameter

Many riders who race wheelchairs have found that a smaller handrim (pushrim) diameter increases the effectiveness of the pushing stroke. They can maintain contact on the handrim while pushing down and back with their arms during the propulsion phase of the stroke. Using a long stroke with a complete follow-through maximizes speed. This may not be practical in everyday propulsion, but you may want to experiment with smaller handrims to determine the handrim diameter that matches your propulsion needs.

Smaller handrims may increase your risk of injury during activities of daily living, and they require more strength to propel the wheelchair. For a small amount of handrim movement, the wheelchair moves a lot, like using a high gear on a bicycle. Also, to reach smaller handrims, you must sit very low, which may not be practical in an everyday wheelchair.

5.4.4 Horizontal location of the axle

In addition to the size of the propelling wheel, the fore-aft (horizontal) location of the wheel affects how easily you can reach the handrim. The horizontal location of the axle is the position of the wheel relative to the rider. See Figure 22. A positive value indicates that the wheel is mounted in front of the intersection of the backrest and seat planes. A negative value means that the rear wheel axle is located behind the intersection. A range of values indicates that the wheel can be moved within that range. Adjusting the axle position usually requires tools to unbolt the sockets into which the quick-release axles plug.

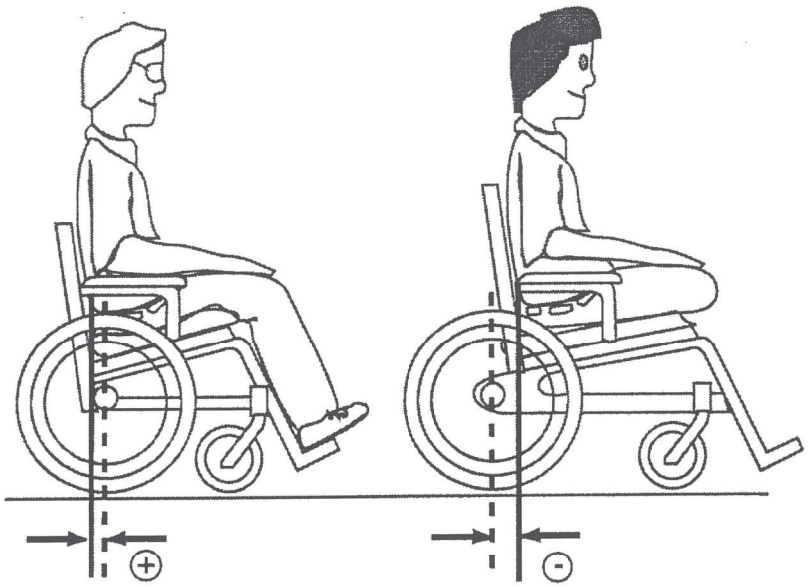

Figure 22 — Horizontal location of the axle

5.4.5 Advantages and disadvantages of different wheel placements

A forward-mounted wheel may be easier to reach, but the user will need good wheelchair mobility skills, because the chair will tip backward more easily. This chair also will be easier to get into a wheelie. Another advantage of a forward-mounted wheel is a reduced wheelbase, which allows you to get around in tight quarters. Also, the wheelchair will have less tendency to turn downhill on a side slope. Finally, the rear wheels will have greater traction since a greater percentage of your weight is riding on them.

If the horizontal axle position is far back, the wheelbase length will be increased, and it will be more difficult for you to reach the wheels. However, the rear stability of the chair will be increased. A more stable chair is harder to get into a wheelie, but is less likely to tip backward. There may be an increased tendency for the wheelchair to turn downhill when travelling across a side slope, and there will be less traction on the rear

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wheels, which will reduce stopping ability. With the wheels mounted toward the rear, forward tipping can become a problem as well. Many wheelchair accidents are related to forward tipping.

For amputees, having the drive wheels farther back is essential since the lack of weight on the front of the wheelchair can make it very unstable.

Because many wheelchairs have adjustable rear axle positions, it is possible to move the axle forward as you become more experienced with using the wheelchair.

6 Manual wheelchairs

6.1 Performance

6.1.1 General

There are hundreds of manual wheelchairs on the market today. As you begin the process of comparison shopping, you will want to know exactly how your wheelchair will perform. The International Standards on wheelchairs address four aspects of the wheelchair that affect its performance:

a) mass (weight),

b) stability,

c) durability-fatigue strength, and

d) manoeuvrability.

For these performance tests, the manufacturer gives the results as specific values. There are no minimum performance values, therefore no wheelchair fails these tests. If the chair tips over backwards on a slope of only 1°, that is what is reported. It will be up to you to determine if the wheelchair's performance is compatible with your abilities, lifestyle and environment.

Until you understand exactly what these performance values mean, your experience with using a particular wheelchair will help you understand how other wheelchairs will perform. By comparing test results, you will learn how other wheelchairs perform compared with the wheelchair you currently use. The information provided by these tests will enable you to make true comparisons among wheelchairs, because each chair will be tested the same way.

6.1.2 **Mass** (weight)

6.1.2.1 How heavy is the chair?

Whether you prefer a tank-style chair or a super lightweight chair, you will want to know and compare the weights of several different chairs. The weight of the chair may also be important if you need to stow it in the back of your car when you drive, or if the person assisting you needs to lift the chair into and out of the trunk. See Figure 23.

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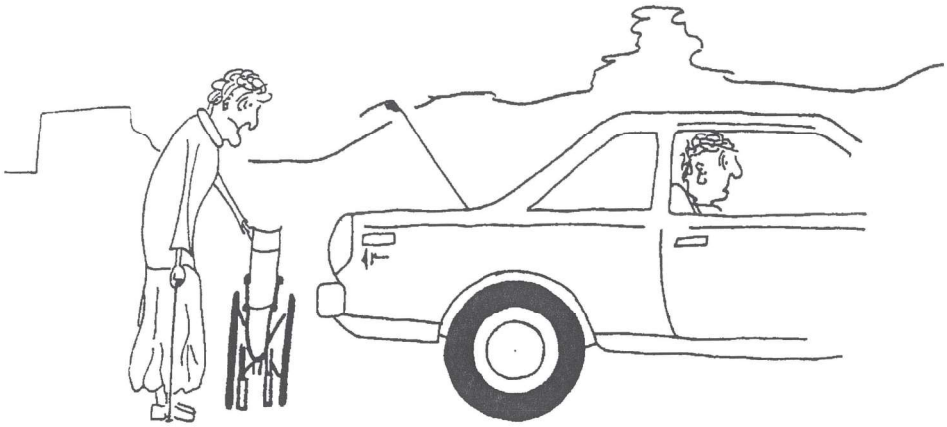

Figure 23 — The weight of your wheelchair is not just an issue for you as the rider

6.1.2.2 Determination of mass

A test procedure is given in ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space.*

The total mass of the wheelchair equipped with standard armrests, legrests, wheels and castors is measured.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Total mass of wheelchair with accessories	___ kg (___ lb)

Additional information not required for disclosure in the product literature:

Mass of each removable component of the wheelchair	___ kg (___ lb)

6.1.2.3 Interpretation of results — Mass

The results of this test procedure help you to compare wheelchairs manufactured by different companies. Using these results, you will be able to identify the lightweights and the heavyweights. Most importantly, you will be able to find the chairs that fall within the weight range you desire. This information indicates how the wheelchair will perform and whether you or the person assisting you will be able to load it into a car.

Knowing the weight of each removable component of the wheelchair may also help in your selection process. If fully equipped wheelchairs (with standard armrests, legrests, wheels and castors) are too heavy to lift, you may choose a wheelchair based on the weight of the heaviest component, which is usually the frame. This information is not required for disclosure in the product literature, but it is available upon request from the manufacturer. Using the weights of the wheelchair and each of the components, you can calculate the weight of the chair equipped the way you like it.

One component that significantly changes the weight of the wheelchair is the main drive wheels. Depending on the chair, either spoke or mag wheels are standard. In general, spoke wheels are lighter, but they require more maintenance, since the spokes can become loose or break. Mag wheels are heavier but are virtually maintenance free. The tyre you choose also can make a difference to the weight. A lightweight, Kevlar-reinforced tyre with a thin tube can be significantly lighter than a heavy rubber tyre with a thick-walled tube. Your own body weight represents a large percentage of the combined weight of the wheelchair and rider. Therefore, shaving off a pound here and there on the wheelchair may not result in a significant difference in wheelchair performance, but it may be necessary if you need to load it into your car.

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6.1.3 Stability

6.1.3.1 How tiltable is the chair?

Let's face it, the world is not flat. Hills, ramps, dropped kerbs and sidewalks with side slopes are just a few of the reasons you might want to know how tiltable your wheelchair will be. The stability of the wheelchair standing still not only indicates how tiltable the chair is when at rest; it also indicates how stable the chair will be when it is moving. If you have a lot of rider experience or are very active, you may prefer a chair that tips back into a wheelie position with just a slight shift of your weight. If you do not have much experience or upper body mobility, you may want a more stable, less tiltable chair.

6.1.3.2 Determination of stability

A test procedure is given in ISO 7176-1:1999, *Wheelchairs — Part 1: Determination of static stability*.

The wheelchair is placed on a standardized test surface with a weighted test dummy positioned in the chair. The test surface is tilted with the wheelchair facing uphill, downhill and sideways. The angle at which the wheels of the wheelchair lift off the test surface is recorded in degrees.

See Figure 24.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Facing downhill/brakes on: tips at	___ degrees of slope
Facing uphill/brakes on: tips at	___ degrees of slope
Facing sideways/brakes on: tips at	___ degrees of slope
Other critical direction/brakes on: tips at	___ degrees of slope

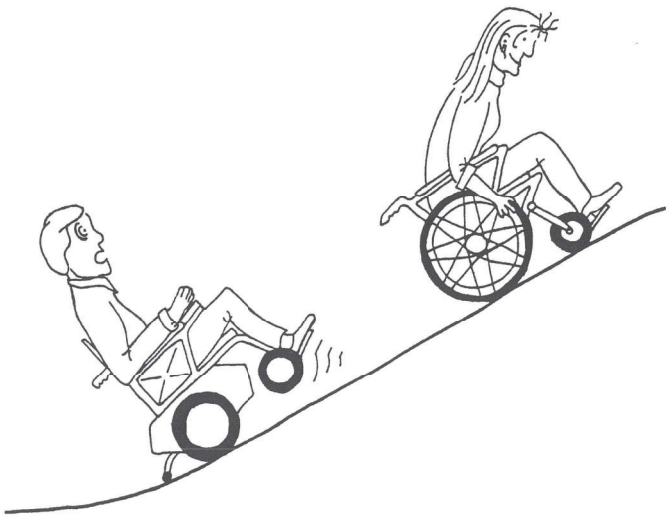

Figure 24 — Having the ability to lean forward in your wheelchair allows you to negotiate steeper ramps

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6.1.3.3 Interpretation of results — Stability

During the test, the wheel locks are engaged, simulating you, the wheelchair rider, holding onto the handrims on an incline. The best way to create the same effect during testing is to apply the wheel locks.

The smaller the uphill tip angle, the more easily tiltable is the wheelchair. This means that the chair will start to tip when the platform is tilted a small amount. A wheelchair that tips more easily will be easier to manoeuvre and will have less tendency to turn downhill on side slopes. Because a larger percentage of your weight is on the rear wheels, the wheelchair will have greater traction. However, the wheelchair will be less stable and more likely to tip over backwards when you go uphill unless you can adjust your body weight by leaning forward. When your body weight is over the main drive wheels of your wheelchair, the chair is easily tiltable. When you shift your weight forward (either by leaning forward or by moving the main drive wheels back) you make the wheelchair less tiltable.

Conversely, a greater uphill tip angle means that the platform will be tilted more before the chair's wheels lift off the platform. Chairs with larger tip angles are less tiltable, harder to manoeuvre, and have a greater tendency to turn downhill on side slopes. Less weight is distributed over the rear wheels, which may result in rear wheel slippage when you go down an incline.

A chair with a smaller downhill tip angle is less stable going forwards. During testing the platform is tilted, raising the back end of the wheelchair. This simulates a wheelchair facing downhill. When you travel down ramps and dropped kerbs, you may need to lean back in the chair to prevent it from tipping forward. Unless you have good balance and a low-back chair, you may not be able to lean back in the wheelchair. If you cannot lean back in the chair, you should probably consider a chair that is more stable in the forward direction: one with a greater downhill tip angle.

If the manufacturer reports a range of tip angles, this indicates that the position of the rear wheel, front castor and/or other features is adjustable. Some wheelchairs have only distinct vertical and/or horizontal positions in which the main drive wheels can be located. Other chairs offer an infinite number of horizontal axle positions. Adjusting the rear wheel forwards will decrease the wheelbase and will decrease the stability of the chair in the rearward direction. Moving the rear wheel backwards will increase the wheelbase and consequently increase the rearward stability of the chair. Changing the vertical position of the rear wheel changes the seat height and angle and can either increase or decrease stability, depending on the location of the centre of mass of the system. The fore-aft adjustment of the castor, if available, changes the length of the wheelbase. The smaller the wheelbase, the more tiltable is the chair in either the forwards or backwards direction. Many users change to a more easily tiltable wheelchair as they gain more rider experience.

A chair with a smaller sideways tip angle is less stable side to side. A chair with a smaller sideways tip angle is more likely to tip over sideways when you travel across surfaces with steep cross slopes or lean over the side of the chair.

A range of sideways tip angles usually indicates that the amount of camber is adjustable. Camber is the angling of the main drive wheels out at the bottom of the chair. Some manufacturers allow users to customize their chair by changing the camber. Increasing the camber will make a wheelchair more stable from side to side but will also increase the overall width of the chair and make it difficult to get through narrow doorways. Camber also moves the pushrims in closer at the top of the main drive wheels, which will enable you to reach your pushrims easier and may actually prevent you from hitting your fingers as you pass through doorways. See Figure 25.

Remember that the tip angle is not an indication of the quality of the wheelchair, but a matter of personal preference.

To give you an indication of the angles of the slopes you may encounter in public places, accessible environments that comply with the Americans with Disabilities Act Accessibility Guidelines (ADAAG) will not have slopes greater than 1:12 (4,8°). Therefore, a wheelchair with an uphill tip angle of greater than 5° will probably not tip backwards when you climb a public ramp, especially if you can lean forwards in the wheelchair. If, however, the downhill tip angle is close to 5°, you may end up performing somersaults while trying to wheel down the ramp, unless you can shift your body weight by leaning backwards.

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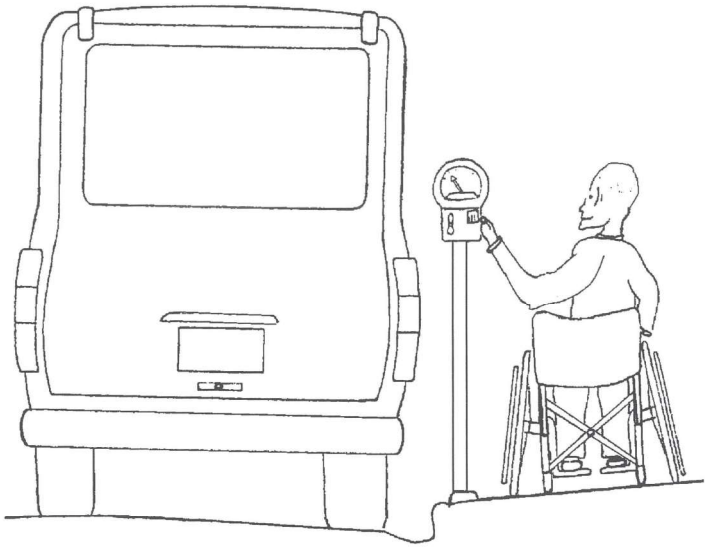

Figure 25 — Extra camber on your wheelchair makes your chair a little more stable on cross slopes and moves the handrims a little closer in on the sides

The disclosed test results apply only to the wheelchair as tested by the manufacturer. If you want different main drive wheels or castors, the stability of the chair may change. For example, smaller diameter rear wheels or larger front castors will tilt the wheelchair to the rear and possibly decrease its stability going uphill.

Anti-tippers are extra little wheels designed to prevent a wheelchair from tipping over backwards. They will affect the stability of the chair when going uphill. Although anti-tippers prevent the wheelchair from tipping, many riders do not like using them. They restrict the chair's ability to go over obstacles, because they can get caught on the obstacle. In addition, it is almost impossible for the wheelchair rider to adjust anti-tippers from the down/engaged position to the up position or vice versa while sitting in the wheelchair because they are difficult to reach. See Figure 26.

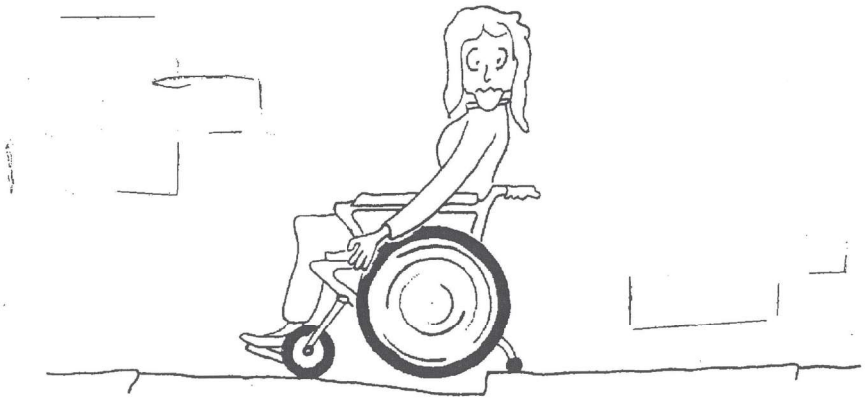

Figure 26 — Anti-tippers can literally leave you spinning on your wheels

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6.1.4 Durability — Fatigue strength

6.1.4.1 How long will the wheelchair last?

A wheelchair is a major purchase; the last thing you want is a chair that falls apart after a week of taking it over bumps, up and down kerbs, in and out of the car, and through all the other activities you do in your chair every day. How long will a wheelchair last? The durability of the chair is important, whether you are a very active rider or not. If a wheelchair component breaks, you could be hurt or stranded somewhere. Fatigue tests are intended to determine the durability of the wheelchair and its components by subjecting them to a large number of low-level stresses, similar to the forces the chair is subjected to in daily use.

6.1.4.2 Durability — Determination of fatigue strength

A test procedure is given in ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*.

The wheelchair, loaded with the test dummy, is positioned on a double-drum fatigue test machine. This machine consists of two cylindrical drums that are rotated by an electric motor. The wheelchair is placed on these cylindrical drums and it rolls as the drums turn. Slats attached to the drums cause the chair to bump as it rolls. One cylinder turns more quickly than the other, making the bumping uneven. This bumping simulates a user riding over rough ground. The chair rolls on the cylinder for a set number of cycles.

A second fatigue test is the kerb drop test. In the kerb drop test, the loaded wheelchair is dropped in a free-fall manner from a height of approximately 2 inches. One kerb drop fatigue test is performed for every 30 cycles on the double-drum fatigue test machine. The manufacturer is asked to disclose the number of double-drum and kerb drop cycles that the wheelchair completes without failure.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Double-drum test	___ cycles
Kerb drop test	___ cycles

6.1.4.3 Interpretation of results — Durability

If the manufacturer discloses that its chair has been tested with a large number of double-drum and kerb drop cycles, it means that the chair is more durable than one that only passed a smaller number of test cycles. However, if the manufacturer discloses that its chair has been tested to a smaller number of double-drum and kerb drop cycles, it may only mean that they stopped testing after that many cycles. Unfortunately, the test procedures do not require the manufacturers to test their wheelchairs until they fail. The manufacturers are only required to disclose how many cycles the wheelchair completed without failure.

During fatigue testing the entire wheelchair (frame, seat upholstery, wheels and all other components) is subjected to a large number of stresses. The composition and construction of each of these components affects the durability of the wheelchair. When a major component of the chair fails, the testing is terminated. If a bolt comes loose or an adjustment needs to be tightened, the testing is continued until a major component failure occurs.

See Figure 27.

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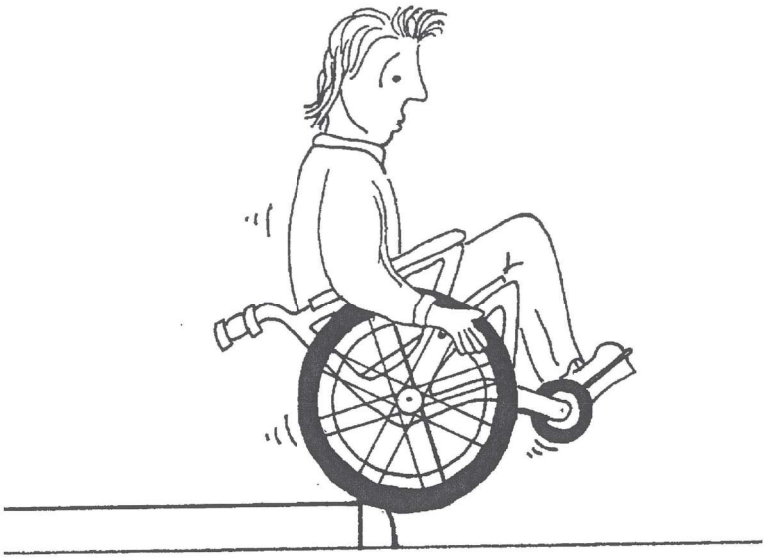

Figure 27 — You want to know that your chair will hold up to the sort of use it sees from day to day

6.1.4.4 Frame materials

While many components can be replaced for a small fraction of the cost of the wheelchair, the frame cannot, because of the cost of frame construction. Wheelchair frames are usually made from mild steel, stainless steel, chromoly steel, aluminium, titanium or a composite. A wheelchair constructed from one type of material is not necessarily more durable than one constructed from another. Although each material has a specific amount of strength per mass of material (strength-to-mass ratio), wheelchair designs vary so much that you cannot determine the durability of the product solely by the material used. The frame tubing thickness, tubing shape, welding technique, and how the components are assembled together, are just a few of the factors affecting the fatigue strength of the chair.

While the type of frame material may not indicate how long the chair will last, it does provide some other helpful information. See Table 5.

Table 5 — Characteristics of frame materials

Frame material	Advantages	Disadvantages
Mild steel	• Easily repaired and welded in places where high-technology welding equipment is not available • Moderate strength-to-mass ratio	• Relatively heavy
Stainless steel	• Highly resistant to corrosion	• Lower strength-to-mass ratio than other steels
Chromoly steel	• High strength-to-mass ratio • Essentially a high-technology steel	• More expensive than mild steels
Aluminium	• High strength-to-mass ratio	• More expensive than mild steels
Titanium	• Very high strength-to-mass ratio • Highly corrosion resistant	• Very expensive
Composite	• High strength-to-mass ratio • Ability to form nonconventional shapes	• Surface finish chips easily

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6.1.4.5 Frame finish

The way the frame of the chair is chemically prepared, primed and painted will affect the durability of the finish. Getting paint to adhere to stainless steel is difficult, and it is almost impossible for titanium. Composite materials are covered with coloured gel coat or painted, but these finishes can chip. Steel and aluminium can be finished with various standard processes. One of the best processes is powder coating. This finishing process minimizes paint waste and results in a durable finish.

6.1.4.6 Castors

Both the size and the type of castor affect the durability of the wheelchair. During the double-drum test, the slats on the cylindrical drum constantly hit the castors, and the forces generated are transferred to the rest of the chair. This is similar to what occurs when you ride over obstacles or uneven terrain (e.g. door thresholds, sidewalk cracks). Because the castors are the first part of the wheelchair that contacts the obstacles and because of their small diameter, they take a substantial beating. Large pneumatic castors can absorb these forces better than small solid castors and can cushion the wheelchair, causing less wear and tear on other wheelchair components.

6.1.5 Manoeuvrability

6.1.5.1 How much space does the wheelchair need to turn around?

You have probably created a home or office environment that allows you as much access as possible in your current wheelchair. Try to make sure your new wheelchair does not create new architectural barriers because its turning radius is larger than that of your current chair. On the other hand, you may want to improve your access so you can manoeuvre more easily in hotel rooms, small apartments, tight office spaces, narrow dormitory hallways, bathrooms, or those ridiculously small public toilet stalls.

6.1.5.2 Determination of manoeuvrability

A test procedure is given in ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space.*

In order to measure turning space, an adjustable corridor is created and a three-point turn manoeuvre is performed. The corridor is narrowed until the wheelchair is unable to perform the manoeuvre. The minimum corridor width in which the chair can turn is disclosed. See Figure 28.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Minimum turnaround width	___ mm (___ inches)

Additional information not required for disclosure in the product literature:

Minimum turning radius	___ mm (__ inches)

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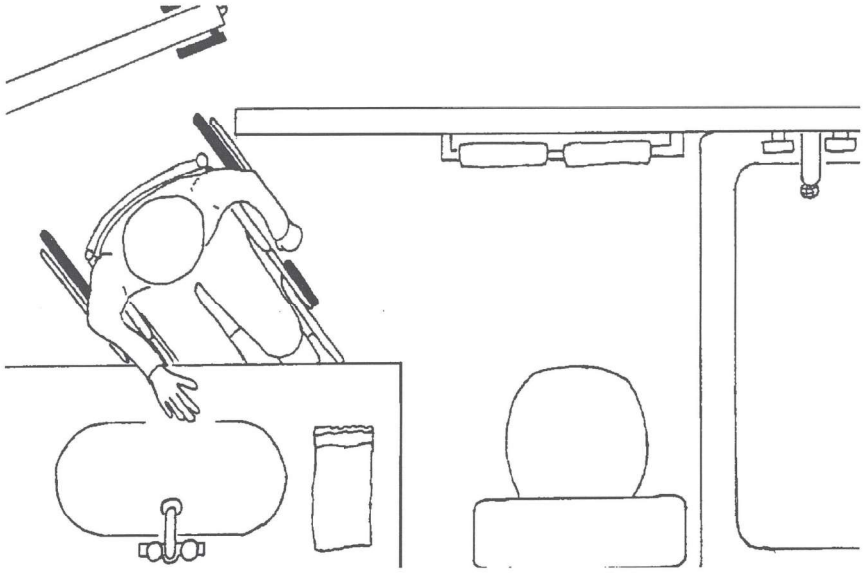

Figure 28 — An extra inch can mean a lot in a small bathroom

6.1.5.3 Interpretation of results — Manoeuvrability

The results of this test are essential if you live or work in an environment with tight spaces. If there is a particularly narrow hall or space at home, work or school, measure its width and search for chairs that can perform a three-point turn in spaces that size or smaller. Remember that footrest assemblies can be removed, if necessary, to improve the chair's ability to turn around in tight places. The size of the castor can also increase or decrease the wheelchair's manoeuvrability. Smaller castor wheels swivel more easily without hitting your feet.

Once you have limited your choice to a few chairs, you may want to check the turnaround space for each of the chairs to make sure they will be able to get you through or into and out of any tight spots in your home.

6.2 Safety

6.2.1 General

Most of the time you have full control of your chair. At times, however, either when you need assistance from someone else or because of careless or reckless riding, the chair may be exposed to damaging forces or unsafe conditions. To ensure against an unsafe wheelchair design, the following tests subject the chair to forces or conditions that could result in a hazardous situation. The test results are either pass or fail. Test outcomes that place the rider at risk are recorded as a failure.

International Standards on wheelchairs address the following areas of manual wheelchair safety:

— static and impact strength,

— flammability, and

— wheel locks.

The strength of a manual wheelchair includes static and impact strength testing. Static tests determine the strength of the wheelchair and its components under high-stress loads that may occur only occasionally, such as the loads exerted on the armrests when you do a push-up. Impact tests determine the strength of the wheelchair and specific components under conditions of impact loading, such as striking an obstacle with the footrests or castors or dropping part or all of the wheelchair.

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6.2.2 Static and impact strength

6.2.2.1 How strong is the wheelchair?

Every day you subject your wheelchair to stresses, and you want to know which wheelchairs will be able to withstand these various stresses. Not everyone is a perfect wheelchair driver. There will be times when you or the person assisting you runs into a doorway frame or other barrier with your castor, footrest or wheel. A simple bang of the handrim on the doorway frame could lead to a dent or a burr in the metal that could cut your hand the next time you grab the handrim to stop. You may find yourself in a situation in which you need to be pulled up stairs, and those lifting may grab the armrests and footrests of your wheelchair. To be safe, armrests and footrests should either pull right out or they should support the weight of you and your chair. Armrests must also be able to support your weight when you do push-ups.

See Figure 29.

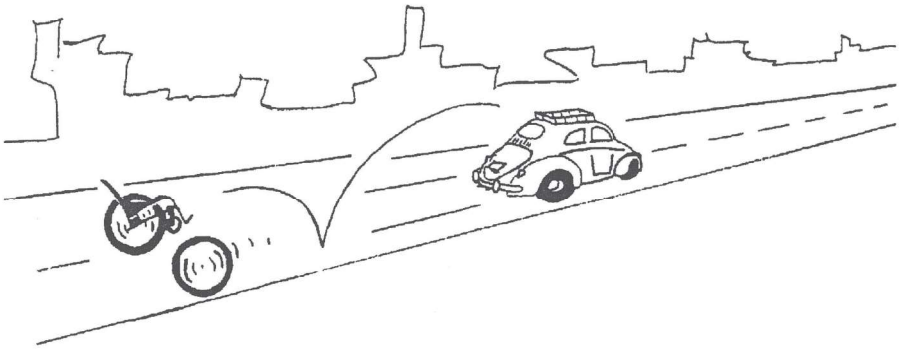

Figure 29 — Your wheelchair will not necessarily survive all types of mishandling; however, you would like your chair to show up at the end of a plane flight in one piece

6.2.2.2 Determination of static and impact strength

A test procedure is given in ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths.*

Static strength tests are intended to determine the strength of the wheelchair and its components under particular high-stress loads that may occur only occasionally. Using a standardized loading pad or strap, a large force is applied once to the relevant part of the wheelchair. If a structural failure, deformation and/or maladjustment of any part of the wheelchair occurs, it does not pass the test.

Impact strength tests are intended to determine the strength of the wheelchair and specific components under conditions of impact loading. Impact tests are conducted by dropping a weighted ball against part of the wheelchair, by running the wheelchair into an obstacle, or by dropping all or portions of the wheelchair on the ground. If the impact results in a structural failure or deformation of part of the wheelchair that adversely affects its function, the wheelchair does not pass the test.

A pass or fail result indicates whether or not the wheelchair was functional after a known force was applied. The manufacturer may choose to test the wheelchair at higher forces or higher drop heights and may disclose the results.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Static strength tests	pass/fail
Impact strength tests	pass/fail

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6.2.2.3 Interpretation of the results — Static and impact strength

See Tables 6 and 7.

Table 6 — Results of static load tests

Static load test	Requirements for pass	Disclosure format
Armrest downward	• The armrest can still be removed and adjusted after a push-up.	pass/fail
Footrest downward	• The footrest returns to its original condition and can still be flipped up, swung away, or removed and reinstalled after a person extends or does a weight shift.	pass/fail
Tipping levers downward	• The tipping lever will not be deformed when a person steps on the lever to tilt the wheelchair backward.	pass/fail
Hand grip	• The handgrips will not slip off when a person pulls you and your wheelchair up or down steps.	pass/fail
Armrest upward	• If the wheelchair is lifted by the armrests, the armrests will either lift out of the socket before the chair is lifted off the ground or the armrests will be able to support the weight of the wheelchair and you, allowing you to be lifted up or down safely.	pass/fail
Footrest supports upward	• If the wheelchair is lifted by the footrests, the footrests will either lift out of the socket before the chair is lifted off the ground or the footrests will support the weight of the wheelchair and you, allowing you to be lifted up or down safely.	pass/fail
Push handle(s) upward	• The push handles support the weight of the wheelchair and you and can be used to safely lift you and your chair off the ground.	pass/fail

Table 7 — Results of impact load tests

Impact load test	Requirements for pass	Disclosure format
Seat	• The seat will not rip when you flop into the chair.	pass/fail
Backrest	• The backrest will hold you when you fall back against it.	pass/fail
Drop test	• The chair will still open and roll if someone drops it while unloading it from the boot (trunk) of the car.	pass/fail
Rolling – wheels and/or castors	• The front wheels or castors will not deform when the wheelchair hits a kerb or pothole in the pavement.	pass/fail
Footrest	• The footrest will not bend when you hit a kerb.	pass/fail
Armrest drop	• The armrest will still fit on the chair after it is dropped on the floor.	pass/fail
Loaded drop	• The rear wheel will not bend if the chair is dropped off a kerb onto one wheel.	pass/fail

If the wheelchair passes all the static load tests, it will probably not fail under the conditions listed above, and the wheelchair components will still be adjustable and removable. If the wheelchair passes all the impact tests, you know that there was no change in its structure or function after the impacts.

6.2.3 Flammability

6.2.3.1 Will the wheelchair go up in flames if I smoke in my chair?

If you, your friends, or co-workers smoke, you should not overlook the results of this test. A cigarette dropped onto the wheelchair upholstery could ignite the chair.

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6.2.3.2 Determination of flammability

A test procedure is given in ISO 7176-16:1997, *Wheelchairs — Part 16: Resistance to ignition of upholstered parts — Requirements and test methods.*

The test procedure is performed in accordance with ISO 8191-1:1987, *Furniture — Assessment of the ignitability of upholstered furniture — Part 1: Ignition source: smouldering cigarette*, and ISO 8191-2:1988, *Furniture — Assessment of ignitability of upholstered furniture — Part 2: Ignition source: match-flame equivalent*. These are pass or fail tests.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Resistance to ignition	pass/fail

See Figure 30.

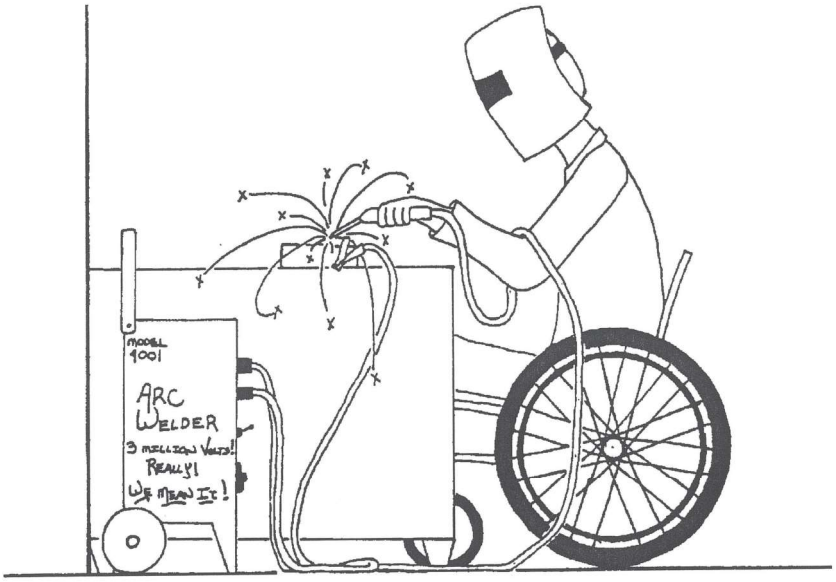

Figure 30 — Flammability is not just an issue related to cigarette smoking

6.2.3.3 Interpretation of results — Flammability

This test applies only to the upholstery supplied by the wheelchair manufacturer, not to any cushions that you add to the chair. A lit cigarette should only smoulder; it should not cause the upholstery to ignite. Cushions and supports added after purchase may not have been subjected to the flammability test. If you are a smoker or you spend time with people who smoke, then you should choose a wheelchair that passes this test.

6.2.4 Wheel locks

6.2.4.1 How effective are the wheel locks?

Wheel locks are supposed to keep the main wheels from turning. Some people refer to wheel locks as brakes. If you stop on a ramp to chat with a friend or take something out of your backpack, you may not think twice about engaging the wheel locks and using your hands for other tasks. If you stop on a slope, the wheel locks should prevent you from rolling downhill.

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6.2.4.2 Test on wheel locks

A test procedure is given in ISO 7176-3:2003, *Wheelchairs — Part 3: Determination of effectiveness of brakes.*

The wheelchair, with the wheel locks engaged, is placed on a standardized test surface with a test dummy positioned in the chair. The surface is tilted with the wheelchair facing uphill then downhill. The angle at which the wheelchair begins to roll, slide or tip is disclosed.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Parking brake test facing downhill	___ degrees
Parking brake test facing uphill	___ degrees

Additional information not required for disclosure in the product literature:

Wheel lock lever force	___ kg (___ lb)

See Figure 31.

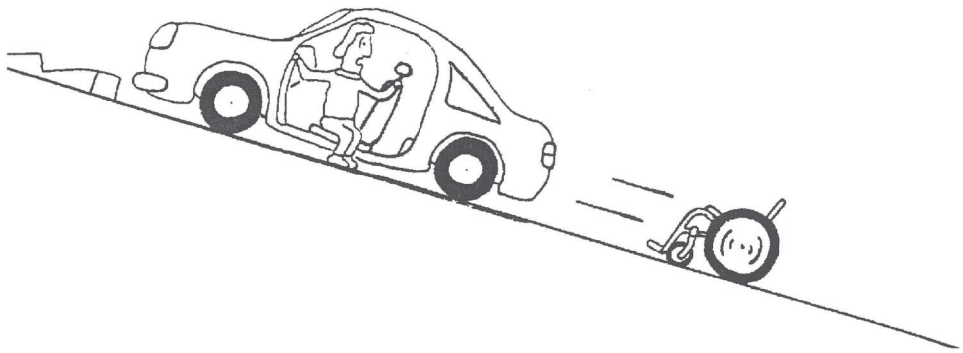

Figure 31 — Faulty wheel locks could leave you driving after your chair!

6.2.4.3 Interpretation of results — Wheel locks

The larger the angle disclosed, the greater the effectiveness of the wheel locks and the less chance the wheelchair will roll, slide or tip on an inclined surface with the wheel locks engaged. It is important to remember that wheel locks only prevent the wheels from turning; they do not prevent the chair from sliding. Remember, wheel locks are just "parking brakes"; they are not for stopping your chair while you are rolling.

The force required to lock and unlock the wheel locks may also be a concern. There is a test procedure for measuring this force, but manufacturers are not required to disclose the results of this test in the product literature. For users with limited arm strength or range of motion, extension handles can decrease the effort required to engage the locks.

Another item to consider is the location of the wheel locks. Low-, mid- or high-mount wheel locks are available. Because low-mount wheel locks are farther away from you, they are less likely to injure your thumbs or hands. Of course, they may also be more difficult to reach. High-mount wheel locks are easier to reach but can injure your thumbs or hands when you push on the tyres instead of the handrims to propel your chair. Pushing on the tyres is common to get better traction at times. Wheel locks also can get in the way during transfers. Swing-away wheel lock designs virtually eliminate the possibility of injury to your thumbs or hands.

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6.3 Dimensions

6.3.1 General

Dimensions are the sizes of the wheelchair surfaces where your body will fit. This information, as disclosed in the test procedures, is very different from previous methods for measuring wheelchairs. Wheelchairs are now measured with a weighted test dummy sitting in the chair to simulate a rider, which more accurately represents the true dimensions of the wheelchair when it is occupied. The biggest problem with the dimensional information provided by manufacturers has been that the size of the wheelchair frame was measured using different methods, resulting in information that could not be compared from one manufacturer to another. If you have not already done so, you may want to go back and read Clause 5, "Incorporating personal body characteristics," for information on seating dimensions.

The following subclauses provide information on the dimensions of the wheelchair:

— overall dimensions, and

— seating dimensions.

6.3.2 Overall dimensions

6.3.2.1 How big is the wheelchair?

If you live in an apartment with a small bathroom, or if there are narrow doorways in your home or office, you will need to consider the overall size of the wheelchair when you make your selection. This test also discloses information that is important if you need to put your wheelchair in the boot (trunk) or backseat of your car. Your wheelchair should fit into your environment or at least not significantly hinder access to your home, office or car.

6.3.2.2 Determination of overall dimensions

A test procedure is given in ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space*.

A wheelchair is measured in the fully opened and folded positions for its overall length, width, and height. These dimensions represent the maximum size box required to contain the wheelchair.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Overall length including leg support and footrest	___ mm (___ inches)
Overall length excluding leg support and footrest	___ mm (___ inches)
Overall width	___ mm (___ inches)
Minimum folded length	___ mm (___ inches)
Minimum folded width	___ mm (___ inches)
Minimum folded height	___ mm (___ inches)

For a list of additional information not required for disclosure in the technical product literature, see Annex A.

See Figure 32.

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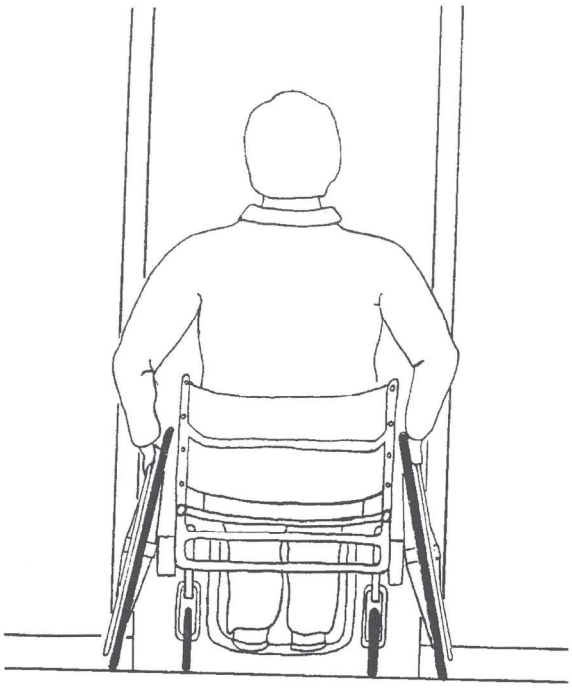

Figure 32 — Extra wheel camber can be a great performance feature, but not necessarily an access feature

6.3.2.3 Interpretation of results — Overall dimensions

This test discloses the dimensions of a wheelchair when it is folded and when it is open. Since all chairs are measured using the same method, you can compare wheelchairs made by different manufacturers. The overall dimensions give you the size of the wheelchair with no parts removed. This helps you determine whether or not the wheelchair will fit through doorways, around your home, on your van lift, and in your office. The overall length of an occupied wheelchair will be longer if your feet stick out over the end of the footrests, as they usually do. If you find yourself in a really tight spot, anti-tippers can be used as rear wheels by removing the main rear wheels of the chair. If the wheels of the anti-tippers can roll, they may enable you to pass through a narrow doorway or down the aisle of an aeroplane.

If the wheelbase of the wheelchair is adjustable by changing the position of the rear wheels or castors, a range of values will be disclosed. A range of values for overall length indicates that the horizontal position of the front and/or rear wheels is adjustable. A range of values for the overall width indicates that the main rear wheel camber is adjustable. Increasing the camber makes the wheelbase wider; consequently, passing through doorways may be more difficult. There is a trade-off between the overall dimensions and the stability of a wheelchair. While decreasing the wheelbase of the chair may make it easier for you to fit into your environment, it may also make the chair less stable.

Using the results of this test and the results of the manoeuvrability test, you will be able to select a chair that will not create additional architectural barriers. Your new wheelchair may even improve access to your environment.

Folded wheelchair dimensions are important to consider for transport and storage. These dimensions help you determine whether the wheelchair will fit in the boot (trunk), in the backseat of your car, or in other storage areas. You should pay particular attention to the folded dimensions and the weight of the wheelchair if you will be picking up your wheelchair and/or storing it in small places (see 6.1.1 under "Manual wheelchairs").

Many wheelchairs can be disassembled into several parts to facilitate transport or storage of the chair. Sometimes, fitting a wheelchair into a car can seem like a puzzle. If you need to fit your wheelchair into a car with a small or irregularly shaped boot (trunk), knowing the dimensions of the largest component will be helpful. This information is not required for disclosure in the product literature, but can be obtained from the manufacturer upon request. If you travel abroad or are thinking about it, be aware that most public and private transportation vehicles (e.g. planes, trains) have small storage spaces.

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6.3.3 Seating dimensions

6.3.3.1 Will the wheelchair fit me?

If you have ever sat in a poorly fitted wheelchair, you know why this information is critical. Not all wheelchairs are designed to fit every body shape, size and proportion. An improperly fitted wheelchair can result in discomfort, medical complications and decreased performance. To understand how to choose the best size for you, see Clause 5, "Incorporating personal body characteristics."

See Figure 33.

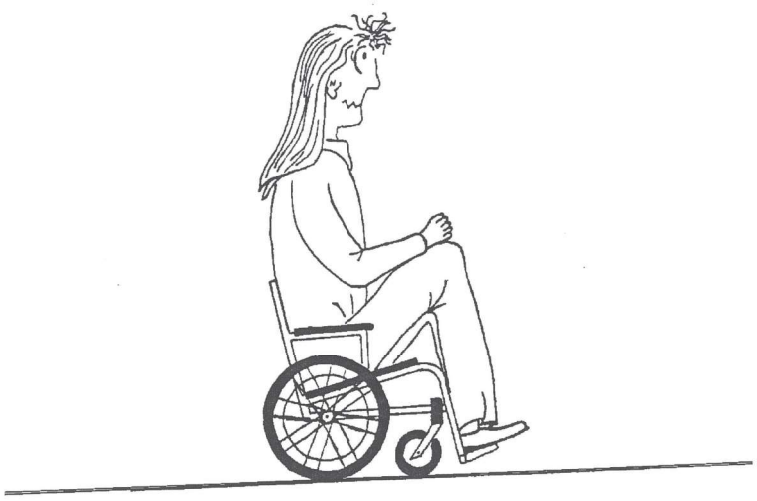

Figure 33 — Getting a wheelchair to fit properly takes a lot of patience and careful measurement during the assessment process

6.3.3.2 Determination of seating dimensions

A test procedure is given in ISO 7176-7:1998, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions*.

Because the dimensions of a wheelchair seat may vary from an unloaded state to a loaded state, a reference loader gauge is placed in the wheelchair during the measurement process. For wheelchairs with adjustable features, each measurement is made with variations in adjustments such that the minimum and maximum measurements are obtained.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Seat plane angle	___ degrees
Maximum seat width	___ mm (___ inches)
Seat depth	___ mm (___ inches)
Seat surface height at front edge (to floor)	___ mm (___ inches)
Backrest angle	___ degrees
Backrest height	___ mm (___ inches)

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Headrest height above seat	___ mm (___ inches)
Footrest to seat distance	___ mm (___ inches)
Leg to seat surface angle	___ degrees
Armrest height	___ mm (___ inches)
Front of armrest to backrest	___ mm (___ inches)
Armrest length	___ mm (___ inches)
Distance between armrests	___ mm (___ inches)
Front location of armrest structure at 26,75 in	___ mm (___ inches))
Handrim diameter	___ mm (___ inches)
Propelling wheel diameter	___ mm (___ inches)
Horizontal location of wheel axle	___ mm (___ inches)

See Annex A for additional dimensional information that is not required for disclosure in the product literature.

6.3.3.3 Interpretation of results — Seating dimensions

If you know the seating dimensions that are appropriate for you, the results of this test will provide the information you need to determine which wheelchairs will fit. A range of values indicates that a particular dimension can be changed or adjusted.

Before you set your mind on a particular wheelchair based on its performance, examine the seating dimensions and their adjustability to ensure a proper fit. If you do not fit correctly in the chair, all the other features and benefits of the chair may be useless.

7 Powered wheelchairs

7.1 Performance

7.1.1 General

When you consider both scooters and full-sized chairs, there are hundreds of powered wheelchairs on the market today. As you begin the process of comparison shopping, you will want to know exactly what the chair is capable of doing. The ISO test procedures apply to both full-sized powered wheelchairs and three- and four-wheeled scooters. In this clause both types of chairs are referred to as powered chairs.

Is the wheelchair

— faster than a speeding bullet?

— more powerful than a locomotive?

— able to leap tall buildings in a single bound?

These and other performance features are revealed in the following test procedures:

a) speed;

b) obstacle-climbing ability;

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c) range;

d) manoeuvrability;

e) durability — fatigue strength;

f) climatic test.

For performance tests a) to e) listed above, the manufacturer will disclose the results as specific values. There are no minimum performance values; therefore, no wheelchair will fail these tests. If a chair is only capable of going 1 mile/h and climbing a half-inch step, that is what is reported. It will be up to you to determine if the wheelchair's performance is compatible with your abilities, lifestyle and environment.

The last test (climate) is a pass/fail test. The wheelchair will either perform or not perform properly after being subjected to various climatic conditions.

More performance does not necessarily mean a better wheelchair; all performance specifications for powered wheelchairs should be viewed in relationship to your specific needs.

7.1.2 Speed

7.1.2.1 How fast can the chair go?

Are you a speed demon? If you want the fastest wheelchair on the market, this is the information you are looking for. You can use this information, like the results of automobile testing found in magazines, to compare the maximum speeds of different wheelchairs. If you commute to work or school via your wheelchair, the time it takes you to travel from point A to point B is probably important to you.

7.1.2.2 Determination of speed

A test procedure is given in ISO 7176-6:2001, *Wheelchairs — Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs*.

To determine maximum speed, the wheelchair is placed on a hard, flat, horizontal test surface. A test subject drives the wheelchair forward at full speed between two markers. The time to cover the distance between the markers is recorded for four runs. The maximum speed is calculated by dividing the distance between the markers by the average time of the four runs. The test is then repeated with the wheelchair driven backward at maximum speed.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Maximum speed / forward	___ m/s or ___ km/h (___ miles/h)
Maximum speed / backward	___ m/s or ___ km/h (___ miles/h)

Additional information not required for disclosure in the product literature:

Maximum acceleration:

Maximum retardation (stopping):

See Figure 34.

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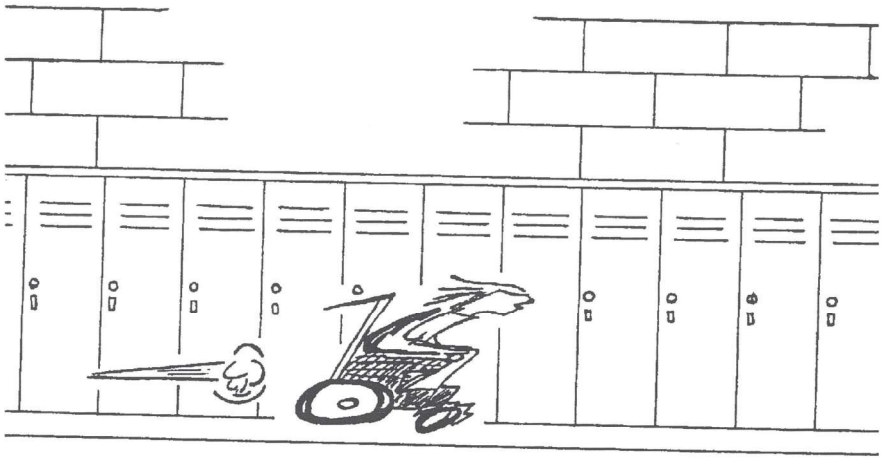

Figure 34 — Speed can be appropriate in the right environment

7.1.2.3 Interpretation of results — Speed

An important issue to consider when deciding what speed best meets your needs is the environment in which you will be operating your chair. Driving a wheelchair indoors usually means travelling short distances at lower speeds. If you will be riding your wheelchair mainly indoors, you will probably want to select a chair with a maximum speed of less than 5 miles/h. If you plan to use your chair outdoors, you will most likely be travelling longer distances at higher speeds. If you do not want to leave your able-bodied friends in the dust, refer to Table 8 to find out how fast the average person travels by foot.

Table 8 — Average speeds for various activites

Activity	Average speed		
	miles/h	m/s	km/h
Average walk	3,0	1,3	4,8
Brisk walk	4,5	2,0	7,2
Slow jog	6,0	2,7	9,7
Moderate run	8,0	3,6	12,9
Fast run	11,0	4,9	17,7

A second issue to consider is your physical ability to tolerate speed. Some people are unable to maintain sitting balance when moving quickly over rough terrain. The ability to maintain your balance also is an issue during acceleration (speeding up), retardation (slowing down) and turning.

Just because a wheelchair is fast does not mean it has enough power to climb an obstacle or go up a steep hill. If the maximum speed of the wheelchair is adjustable, the manufacturer will give a range of speeds. The maximum speed adjustment allows you (or in some cases, the dealer) to change the chair's maximum speed. Unfortunately, on some wheelchairs (those without programmable controllers), reducing the maximum speed may also reduce the power available for climbing over obstacles and up steep inclines.

Traditionally, powered wheelchairs have a high/low speed switch that is used to set the chair for outdoor or indoor mobility. However, many wheelchairs now have programmable controllers that can be permanently adjusted. There is some controversy about rider adjustment of dynamic controller characteristics. Manufacturers are concerned about liability and feel that if riders are allowed to adjust these features, they may hurt themselves. Regardless of whether adjustments are performed by the dealer or the rider, after they are made you should drive the wheelchair in a controlled environment to test its performance features.

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You may want to choose a wheelchair that lets you adjust the speed or other functions easily for use in different environments. If your abilities are changing, you may want a chair that can be adjusted to meet your functional needs at any given time. If you won't be changing the adjustments frequently, or if you do not want other people (such as children) to fiddle with the adjustments, easy access to the controls may not be important.

7.1.3 Obstacle climbing

7.1.3.1 How high a step can the wheelchair climb?

It would be terribly frustrating if there was a 3-inch step at the entrance to your friend's apartment and your wheelchair could only negotiate a 2 ½-inch step. Although the majority of public places must comply with ADA Accessibility Guidelines, you may be forced to negotiate a kerb, for instance, when a car has blocked the ramp. Or perhaps you just want a high-performance wheelchair.

See Figure 35.

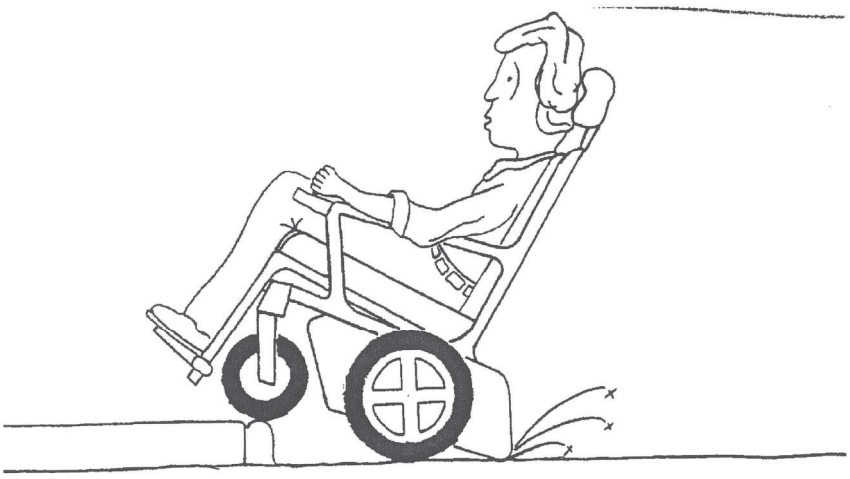

Figure 35 — Negotiating small kerbs and obstacles is a very important feature to most powered wheelchair users

7.1.3.2 Obstacle climbing test

A test procedure is given in ISO 7176-10:1988, *Wheelchairs — Part 10: Determination of obstacle-climbing ability of electric wheelchairs.*

A test dummy or a driver is positioned in the wheelchair. The wheelchair is driven, without a run-up, towards a rectangular obstacle such that it climbs completely on top of the obstacle. The height of the obstacle is increased until the wheelchair is unable to complete the obstacle climb. The test is then repeated with a run-up. The wheelchair is allowed to pick up speed by driving it a distance of 0,5 m (1,6 ft) before climbing the obstacle.

The maximum obstacle height that the wheelchair is able to climb is disclosed. The test results also indicate the approach angle to the obstacle and whether the wheelchair was travelling forwards or backwards, with or without a run-up.

Disclosure format (as reported by manufacturers)

> Climbs a maximum height obstacle of ___ mm (___ inches), travelling (forwards/backwards) with (no run-up/0,5-m run-up) at an approach angle of 90° (unless a different angle is disclosed).

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7.1.3.3 Interpretation of results — Obstacle climbing

Before you choose the wheelchair with the highest performance, consider your needs and the environment in which you will be operating your chair. If you plan to use your chair mainly indoors, the ability to climb large obstacles may not be important. If you will use the wheelchair outdoors, you may want a chair with better obstacle-climbing ability.

The obstacle-climbing ability of the wheelchair is greatly affected by the size and type of the wheels. Larger diameter castors will climb over larger obstacles; small castors will tend to get stuck or will require more power to climb over obstacles. Although solid castors provide less rolling resistance on hard, smooth, level surfaces, they are poor obstacle climbers. Pneumatic and semi-pneumatic castors will roll over obstacles and outdoor surfaces much more easily. Generally, wheelchair users who spend a lot of time outdoors prefer larger pneumatic or semi-pneumatic castors; those who use the chair primarily indoors on hard surfaces usually prefer smaller, harder castors. Scooters with larger wheels will generally climb larger obstacles. Scooters with rear-wheel drive tend to have better obstacle-climbing ability as well.

Anti-tippers may restrict mobility outdoors, particularly going up and down kerbs and making other height transitions. Anti-tippers limit the obstacle-climbing ability of the wheelchair because they prevent the wheelchair from tipping backwards past a certain point. When you are travelling down a transition in height, such as a dropped kerb, the anti-tippers can get caught. Removing anti-tippers could increase your ability to negotiate obstacles, but this could also cause a potential safety hazard.

Ground clearance (the distance from the ground surface to the lowest part of the wheelchair) also affects the obstacle-climbing ability of the wheelchair. While the front castors of a wheelchair may be able to climb over an obstacle, such as a railroad track, another part of the chair may get caught. International Standards on wheelchairs do not currently include a test for ground clearance.

In conjunction with the obstacle-climbing ability of the wheelchair, you should consider the static and dynamic stability of the chair to ensure safe operation.

7.1.4 Range

7.1.4.1 How far can the wheelchair go?

Running out of battery power at night, in the middle of a strange part of town, could be a frightening or a character-building experience. In a snowstorm or on an extremely cold night, it could be fatal. If you must travel long distances across a college campus or in a city, you will want to know just how far the wheelchair will travel before the batteries need to be recharged. See Figure 36.

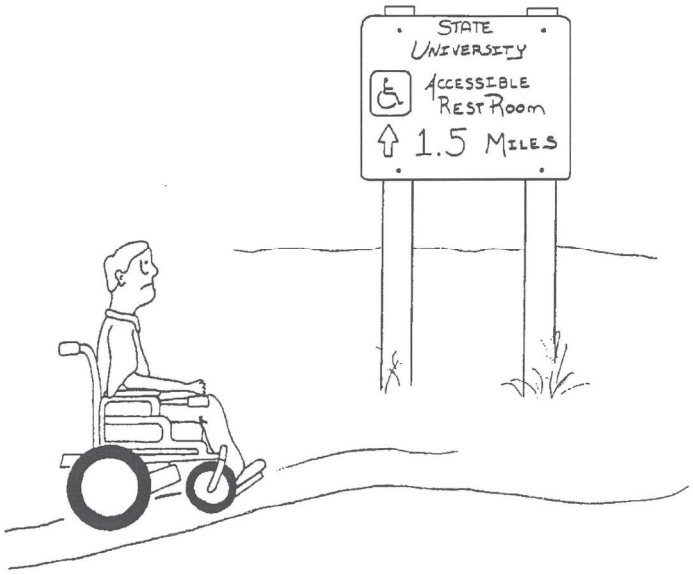

Figure 36 — Running out of power can be a real problem!

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7.1.4.2 Determination of range

A test procedure is given in ISO 7176-4:1997, *Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*.

The wheelchair is placed on a standardized test surface with a test rider in the chair. The test rider drives the wheelchair through a specified test course that simulates an indoor or outdoor environment. The indoor test circuit involves driving forwards and backwards, starting and stopping. In the outdoor test, the wheelchair is driven through a test circuit involving accelerating from a stop to maximum speed, driving a specified distance, and then stopping.

By measuring the energy consumption of the wheelchair using a watt-hour meter, the total range of the wheelchair is calculated, given the nominal capacity of the batteries on the wheelchair.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Range/Indoor use	___ km (___ miles)
Range/Outdoor use	___ km (___ miles)

7.1.4.3 Interpretation of results — Range

This test is similar to the Environmental Protection Agency's (EPA) miles-per-gallon rating for city and highway automobile driving. This information provides a basis for comparing wheelchairs, but does not guarantee that you will get the same results in your own wheelchair. The distance you will be able to travel before the batteries need to be recharged depends greatly on the environment and your riding habits. If you live in San Francisco and tend to start and stop like a race car driver, you can expect the range of the wheelchair to be significantly less than if you use it in a large warehouse during work. The test procedures set up an average use situation, but you will need to compare your lifestyle with that situation.

7.1.4.4 Batteries

The type and age of the batteries on your wheelchair will affect how far it will be able to go between charges. There are two main types of wheelchair batteries: lead acid and gel cell. The size of the battery is indicated by a standard group size number, such as U1, 22NF, 24, or 27. Generally, the bigger the battery the more energy it can store, although this is not always the case. Table 9 shows the dimensions of batteries commonly used on wheelchairs.

Table 9 — Dimensions of batteries

Values in inches

Group size	Length	Width	Height
U1	7 3/4	5 3/16	7 5/16
22NF	9 7/16	5 1/2	8 15/16
24	10 1/4	6 13/16	8 7/8
27	12 1/16	6 13/16	8 7/8

Among batteries of the same group size, a gel cell generally has slightly less energy than a lead acid, and consequently the wheelchair will have less range. Many airlines restrict the transport of lead acid batteries; therefore, if you anticipate travelling by plane, you should use gel cell batteries. If you have to take your wheelchair apart for transport in a car, you also might want to consider the use of gel cells. In fact, gel cell batteries are safer in any situation in which your batteries might tip over, as they are much less likely to leak.

If you know the correct group size, you can buy the batteries directly from a battery supplier rather than a wheelchair dealership. However, installation will not be included if you purchase batteries from a battery supplier.

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7.1.5 Manoeuvrability

7.1.5.1 How much space does the wheelchair need to turn around?

Most likely, you have created a home or office environment that allows you as much access as possible in your current wheelchair. You want to be sure any new chair you select does not create new architectural barriers because its turning space is larger than that of your current chair. On the other hand, you may want to improve your access so you can manoeuvre more easily in hotel rooms, tight office spaces, narrow hallways, bathrooms, or those ridiculously small public toilet stalls. There is a tremendous difference in the manoeuvrability of three-wheel scooters, traditional powered chairs and front-wheel-drive powered chairs.

See Figure 37.

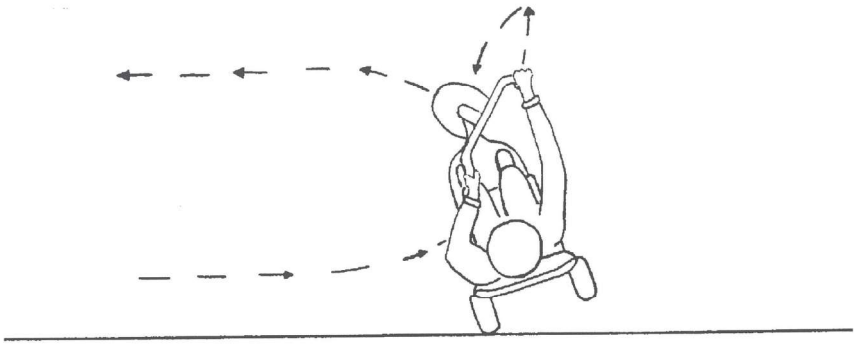

Figure 37 — Being able to turn around without destroying the walls is important in your home or office!

7.1.5.2 Determination of manoeuvrability

A test procedure is given in ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space*.

An adjustable corridor is created and a three-point turn manoeuvre is performed as illustrated in Figure 37. The corridor is narrowed until the wheelchair is unable to perform the manoeuvre. The minimum corridor width is disclosed.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Minimum turnaround width	___ mm (___ inches)

Additional information not required for disclosure in the product literature:

Minimum turning radius	___ mm (___ inches)

7.1.5.3 Interpretation of results — Manoeuvrability

The results of this test are essential if you live or work in an environment with tight spaces. If there is a particularly narrow hall or space at home, work or school, measure its width and search for chairs that can make a three-point turn in spaces that size or smaller. Remember that many wheelchairs can be equipped with footrest assemblies that can be removed. Although having to remove the footrests while using the wheelchair is an inconvenience, it can increase the chair's ability to turn around in a tight spot. The size of the front or rear castors can also affect the wheelchair's manoeuvrability. Large castors may interfere with your footrests when they swivel, making it more difficult to manoeuvre in small areas.

Once you have limited your choice to a few chairs, you may want to check the turnaround space for each of the chairs to make sure they will be able to get you through or into and out of any tight spots in your home.

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7.1.6 Durability — Fatigue strength

7.1.6.1 How long will the wheelchair last?

A wheelchair is a major purchase; the last thing you want is a chair that falls apart after a month of taking it over bumps, up and down kerbs, and through all the environments you go through every day. How long will a wheelchair last? The durability of the chair is important, whether you are a very active user or not. If a wheelchair component breaks, you could be hurt or stranded somewhere. Fatigue tests are intended to determine the durability of the wheelchair and its components by subjecting them to a large number of low-level stresses, similar to the forces a chair is subjected to in daily use.

7.1.6.2 Determination of durability and fatigue strength

A test procedure is given in ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*.

The wheelchair, loaded with the test dummy, is positioned on the double-drum fatigue test machine that consists of two cylindrical drums. Mounted on the drums are slats which contact the front and rear wheels at different times, as one drum rotates slightly faster than the other. The chair drives the test machine for a pre-determined number of cycles.

In the kerb drop test, the loaded wheelchair is dropped in a free-fall manner from a height of approximately 2 inches. One kerb drop fatigue test is performed for every 30 cycles on the double-drum fatigue test machine. The manufacturer is asked to disclose the number of cycles that the wheelchair has performed without failure on the double-drum and kerb drop test machines.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Double-drum test	___ cycles
Kerb drop test	___ cycles

See Figure 38.

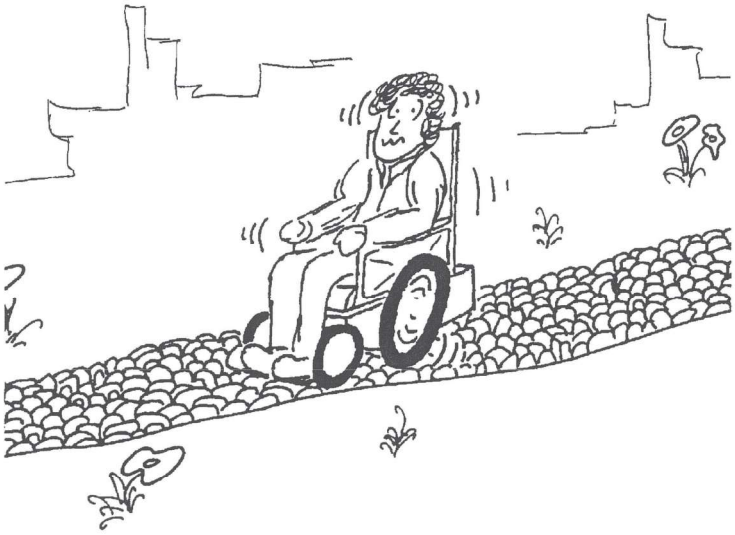

Figure 38 — Hhhoowww dddurrrabble is thththe chchchair?

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7.1.6.3 Interpretation of results — Durability and fatigue strength

If the manufacturer discloses that the chair has been tested with a large number of double-drum and kerb drop cycles, it means that the chair is more durable than one that only passed a smaller number of test cycles. However, if the manufacturer discloses that the chair has been tested to a smaller number of double-drum and kerb drop cycles, it may only mean that they stopped testing after that many cycles. Unfortunately, the test procedures do not require manufacturers to test their wheelchairs until they fail. The manufacturers are only required to disclose how many cycles the wheelchair completed without failure.

During fatigue testing, the entire wheelchair (frame, seat upholstery, wheels and all other components) is subjected to a large number of stresses. The composition and construction of each of these components affects how many cycles the wheelchair can perform without failure.

7.1.6.4 Frame material

While many of the components can be replaced for a small fraction of the cost of the wheelchair, the frame cannot. Powered wheelchair frames are generally available in steel or aluminium. A steel frame is not necessarily more durable than an aluminium frame. Although each material has a specific amount of strength per unit mass, the designs vary so much that you cannot determine the durability of the product solely by the material used. The frame tubing thickness, tubing shape, welding technique, and how the components are joined, are just a few of the factors that affect the fatigue strength of the chair.

While the type of frame material may not indicate how long the chair will last, it does provide some other helpful information. See Table 10.

Table 10 — Characteristics of frame materials

Frame material	Advantages	Disadvantages
Steel	• Easily repaired and welded in places where high-technology welding equipment is not available • Moderate strength-to-mass ratio	• Relatively heavy
Aluminium	• High strength-to-mass ratio	• More expensive than mild steel

7.1.6.5 Frame finish

The way the frame of the chair is chemically prepared, primed and painted will affect the durability of the finish. Steel and aluminium can be finished with various standard processes. One of the best processes is powder coating, which minimizes paint waste and results in a durable finish.

7.1.6.6 Castors

Both the size and the type of castor affect the durability of the wheelchair. During the double-drum test, the slats on the cylindrical drum constantly hit the castors, and the forces generated are transferred to the rest of the chair. This is similar to what occurs when you ride over obstacles or uneven terrain. Larger pneumatic castors absorb these forces better than smaller castors and will result in less wear and tear on other wheelchair components.

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7.1.7 Climate tests

7.1.7.1 How will temperature and moisture affect the operation of the chair?

Extremes in temperature and frequent temperature changes may affect your wheelchair. If you live in Arizona you may want to know that your controller won't fail while you are climbing a hill in the hot sun. When you leave a warm building and go outside into the cold, the electronics on your wheelchair are significantly stressed. For this reason you will find the results of this test helpful in your wheelchair selection process. Even if you don't live where there are extreme changes in temperature, you may find yourself caught in a rainstorm someday, and you will need to know that your wheelchair will perform properly after getting wet. See Figure 39.

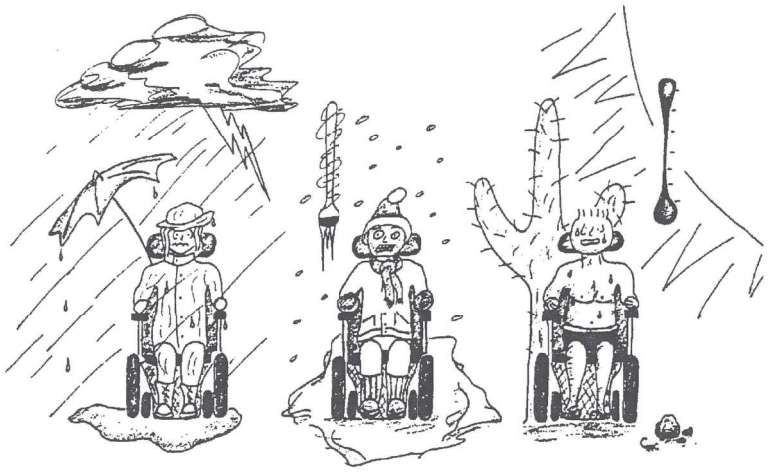

Figure 39 — Try to foresee different situations in which you might end up using your powered chair

7.1.7.2 Tests in various climates

A test procedure is given in ISO 7176-9:2001, *Wheelchairs — Part 9: Climatic tests for electric wheelchairs.*

The wheelchair is subjected to a standardized shower test. If the wheelchair does not function properly after this test, it fails the effects-of-rain test.

The chair is exposed to temperatures of –25 °C (–13 °F) and +50 °C (122 °F) for 3 h and then driven immediately, without allowing it to return to room temperature. To test the affects of shipping and storage, the wheelchair is exposed to a temperature of 40 °C (–40 °F) for 3 h and then to a temperature of +65 °C (149 °F) for 3 h. The wheelchair is returned to room temperature for at least 24 h and then driven. If the wheelchair does not function properly after these two tests, it fails the effects-of-temperature-change test.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Effects of rain	pass/fail
Effects of temperature change	pass/fail
(includes operation and storage temperature)	

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7.1.7.3 Interpretation of results — Climate tests

If a wheelchair fails the effects-of-rain or effects-of-temperature-change test, it did not operate properly after being subjected to rain, extreme temperature changes during regular operation, or extreme storage temperature conditions. If you will be subjecting your chair to changes in temperature or exposing it to moisture or rain, make sure the wheelchair you are considering passed this test. If a wheelchair failed the rain portion of the climate test and you live in Seattle, you may want to consider a different wheelchair.

7.2 Safety

7.2.1 General

Most of the time you have full control of your chair. At times, however, either when you need assistance from someone else or because of careless or reckless riding, the chair may be exposed to damaging forces or unsafe conditions. To ensure against an unsafe wheelchair design, the following tests subject the chair to forces or conditions that could result in a hazardous situation. The test results are either pass or fail. Test outcomes that place the rider at risk are recorded as a failure.

The safety tests for powered wheelchairs include:

a) static and dynamic stability;

b) stopping distance;

c) disengage force and non-powered push;

d) safety guards;

e) electrical systems;

f) static and impact strength;

g) flammability;

h) battery chargers.

The strength of a powered wheelchair includes static and impact strength. Static tests determine the strength of the wheelchair and its components under high-stress loads that may occur only occasionally. Impact tests determine the strength of the wheelchair and specific components under conditions of impact loading, such as striking an object or dropping all or part of the wheelchair.

7.2.2 Static and dynamic stability

7.2.2.1 How stable is the wheelchair?

Your powered wheelchair will not always be driven on a level surface. There will be times when you need to go up a ramp, and you want to be sure that the wheelchair will not tip over backwards. You will also want to be able to stop your wheelchair when you are going down a ramp. Suppose there is a ramp leading to the front door of your house. If you attempt to drive your wheelchair up the ramp, you don't want to find yourself performing acrobatics on your doorstep! See Figure 40.

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Figure 40 — Static and dynamic stability test results will give you an indication of how stable the wheelchair will be in different environments

7.2.2.2 Determination of static and dynamic stability

One test procedure is given in ISO 7176-1:1999, *Wheelchairs — Part 1: Determination of static stability*.

In the static stability test, the wheelchair is placed on a standardized test surface with a test dummy positioned in the chair. The surface is tilted with the wheelchair facing uphill, downhill and sideways. The angle at which the wheels of the wheelchair lift off the test surface is recorded in degrees.

Other test procedures are given in ISO 7176-2:2001, *Wheelchairs — Part 2: Determination of dynamic stability of electric wheelchairs*.

In the starting uphill test, the wheelchair is placed on a standardized test surface with a test dummy or driver positioned in the chair. The surface is tilted with the wheelchair facing uphill. The minimum slope at which the wheelchair begins to tip back past its balance point when full forward power is applied is recorded in degrees.

In the braking downhill test, the wheelchair is run at maximum speed down a slope of 5°. The controls are then operated to produce an immediate stop. The manufacturer notes if one or more wheels lift from the test plane, if the wheelchair tips forward beyond its balance point, or if the wheelchair slides on the surface.

Disclosure format (as reported by manufacturers)

Static stability test	**Test result**
Facing downhill/brakes on, tips at	___ degrees of slope
Facing uphill/brakes on, tips at	___ degrees of slope
Facing sideways/brakes on, tips at	___ degrees of slope
Other critical direction/brakes on, tips at	___ degrees of slope
Dynamic stability test	**Test result**
Starting uphill/tipping backwards	___ degrees
Braking downhill on 5° slope:	one or more wheels lift/wheelchair tips/wheelchair slides or does not slide

Additional information on the dynamic stability of the wheelchair not required for disclosure in the product literature includes:

Stability when turned:	one or more wheels lift/wheelchair tips/wheelchair slides or does not slide

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7.2.2.3 Interpretation of results — Static and dynamic stability

The smaller the uphill tip angle, the less stable the wheelchair is in the backwards direction. A smaller downhill tip angle means that the chair is less stable in the forward direction. A chair with a smaller sideways tip angle is less stable to the side.

Three-wheeled scooters are generally less stable to the side than four-wheeled scooters and full-sized powered chairs. Because they have three wheels, scooters are less stable when positioned at an angle, unlike most other chairs.

With regard to starting forwards on an uphill slope, a larger tip angle means that the wheelchair is more stable and less likely to tip over backwards. The angle disclosed is the maximum slope on which full power can be applied without tipping over backwards past the balance point. If a ramp has been built in compliance with ADA Accessibility Guidelines, the maximum slope will be 1:12 (4,8°). Therefore, a wheelchair with a disclosed test result of greater than 5° will not tip backwards under normal circumstances when you climb a public ramp.

Anti-tippers affect the stability of the chair going uphill. Although they prevent the wheelchair from tipping to the rear, many people do not like using them because they restrict the chair's ability to climb over obstacles. In addition, it is almost impossible for the wheelchair user to adjust anti-tippers from the down/engaged position to the up position or vice versa while seated in the wheelchair. Whether or not you use anti-tippers, it may be prudent to practice new manoeuvres with an attendant as you learn how to safely negotiate new environments.

A wheelchair that can stop safely while travelling down a slope without tipping or sliding is obviously more desirable than one that cannot. Even if you don't have a ramp at your house or apartment, if you spend any time in public places, you will encounter sloped surfaces and will want a chair that can start and stop safely on ramps.

If the speed, acceleration and retardation of the wheelchair are adjustable, a range of stability results will be disclosed by the manufacturer. These adjustments allow you or the dealer to change how fast the chair can go, how quickly it reaches top speed, and how quickly it stops. After you make such adjustments, practice using the wheelchair in a controlled environment in which you can test all of its performance features to determine the effects of the adjustments.

You may want a wheelchair that lets you adjust the speed or other functions easily for use in different indoor and outdoor environments. If your abilities are changing, you may want a chair that can be adjusted to meet your functional needs at any given time. On the other hand, if you won't be changing the adjustments frequently, or if you do not want other people (such as children) to fiddle with the adjustments, easy access to the controls may not be important or even desired.

7.2.3 Stopping distance

7.2.3.1 How quickly does the wheelchair stop?

If your grandmother steps out in front of you as you're zooming down the hallway at top speed, will you be able to stop in time? There will be times when you will need to stop quickly to avoid hitting someone or something; therefore, you should know the capabilities of the wheelchair, as well as your own functional abilities. If you have poor upper body balance, you will probably want to avoid chairs that stop too quickly. If you lose your balance and your hand slips off the controller, you may also want to know how far the chair will travel before it comes to a complete stop. For example, will the wheelchair stop before reaching the end of the sidewalk, or will it continue off the edge? See Figure 41.

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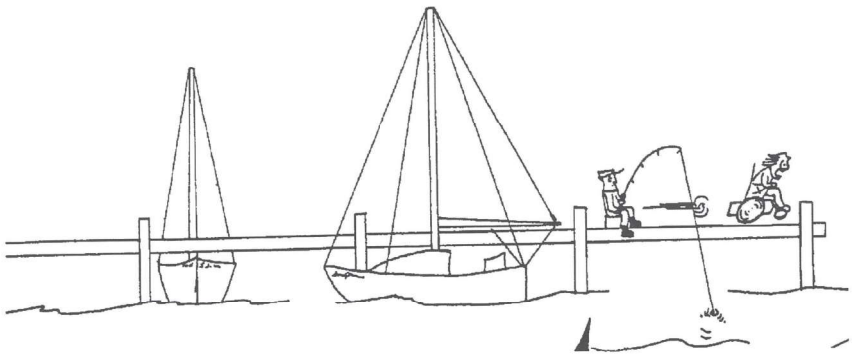

Figure 41 — Having a controller with responsive stopping characteristics is a good idea in many environments!

7.2.3.2 Determination of stopping distance

A test procedure is given in ISO 7176-3:2003, *Wheelchairs — Part 3: Determination of effectiveness of brakes*.

In the running brake test, the wheelchair is driven on a standardized, horizontal test surface with a driver in the chair. After reaching maximum speed, the wheelchair driver uses the controller to execute maximum braking until the wheelchair is brought to a stop. The maximum speed and the distance required for the wheelchair to stop are recorded. The running brake test is then repeated on a test surface with a slope of 5°.

In the automatic braking test, the wheelchair is driven forward down a test surface with a slope of 5° at its maximum speed and then the control mechanism is released. The maximum speed and the distance required for the wheelchair to stop are recorded.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Running brake/travelling forward on horizontal surface	___ m (___ ft)
Running brake/travelling forward down 5° slope	___ m (___ ft)
Automatic braking/travelling forward down 5° slope	___ m (___ ft)

Additional information not required for disclosure in the product literature:

Running brake test/travelling backward on a horizontal plane

Effect of raised temperature, induced by continuous use, on the braking systems of powered wheelchairs

Automatic braking/travelling forward on a horizontal plane

7.2.3.3 Interpretation of results — Stopping distance

If you compare two chairs with the same maximum speed, the chair with the shorter braking distance has a higher rate of retardation (stopping). This wheelchair will stop in a shorter time and distance and you will need better balance to maintain an upright posture. If you have poor balance, a wheelchair that stops slowly might be better for you than one with a very rapid response.

If the rate of retardation of the wheelchair is adjustable, a range of stopping distances is disclosed. The retardation adjustment allows you or the dealer to change how quickly the chair comes to a stop. If your abilities are changing, you may want a chair that can be adjusted to meet your functional needs at any given

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time. A wheelchair with adjustable retardation will allow you to set the rate of retardation as fast as your body can handle without losing your balance.

The stopping distance will be much greater for a wheelchair without dynamic braking travelling down a sloped surface. If a wheelchair does not have dynamic braking, the chair may pick up speed as it travels downhill, creating a potentially hazardous situation.

7.2.4 Disengage force and non-powered push

7.2.4.1 How hard is it to push the wheelchair without power?

If you ever find yourself stranded as a result of controller or battery malfunction, someone will have to disengage the wheelchair drive system and push you. In a hazardous environment, you might prefer to have someone push you rather than driving the wheelchair. The force required to disengage the drive system and push the non-powered wheelchair should not require the strength of a body builder. See Figure 42.

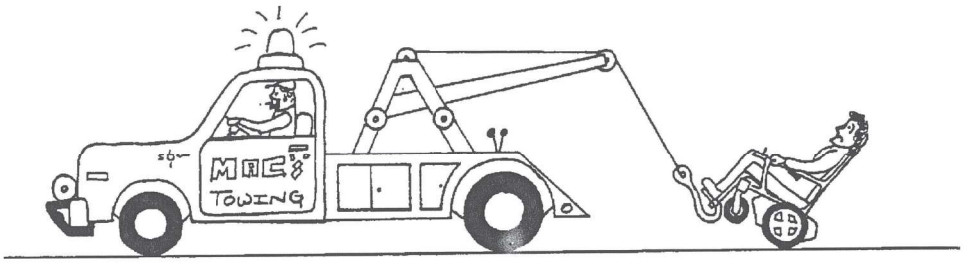

Figure 42 — If it takes a lot of force to move your wheelchair when it breaks down, you might need professional assistance

7.2.4.2 Determination of disengage force and non-powered push

A test procedure is given in ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods.*

A force gauge is used to measure the force required to disengage the drive system. The force required to move the wheelchair loaded with a test dummy is also measured. If the force necessary to disengage the drive system exceeds 75 N (equivalent to16,9 lbs) or the force necessary to move the loaded wheelchair exceeds 100 N (equivalent to 22,5 lbs), the wheelchair fails the test.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Disengagement of drive system	pass/fail
Non-powered push force	pass/fail

7.2.4.3 Interpretation of results — Disengage force and non-powered push

If a wheelchair passes this test, it requires less than 75 N (equivalent to16,9 lbs) of force to disengage the drive system and less than 100 N (equivalent to 22,5 lbs) to manually push the wheelchair. Unless you have a body builder nearby, you will probably want to limit your selection of wheelchairs to those that pass this test.

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7.2.5 Safety guards

7.2.5.1 Are there appropriate safety guards on the wheelchair?

If you have children or you spend time with someone else's children, you know that they are constantly touching things they should not touch. As you sit in your wheelchair, you may not be able to watch everything that is going on around you. Without proper safety guards, the many moving parts on a powered wheelchair can create a dangerous situation for children. You, too, need to be assured that your clothing or fingers will not be eaten up by the wheelchair's drive system if your arm falls off the armrest.

7.2.5.2 Safety guard test

A test procedure is given in ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods.*

A jointed and unjointed test finger is inserted into all openings to determine if contact can be made with moving parts. This test is applied to all openings where an occupant or someone out of the chair may contact a moving part, excluding the wheels, during normal operation.

If the test finger touches any of the moving parts of the propulsion system (except the wheels), the wheelchair fails the safety guard test.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Safety guard requirements	pass/fail

See Figure 43.

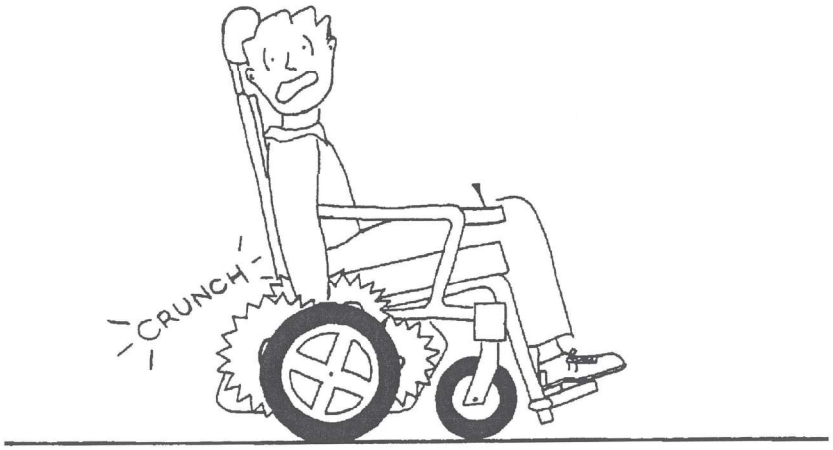

Figure 43 — And you thought slamming your fingers in a door hurt!

7.2.5.3 Interpretation of results — Safety guards

If the wheelchair fails this test, one or more moving parts on the chair are not guarded, or the guard does not provide adequate protection. If you operate your wheelchair around children or if your arm might slip from the armrest, you will want to make sure the chair passes this test. If you have your heart set on a wheelchair that fails this test, you will need to take extra care when you operate it around others who might touch the moving parts or when you wear clothing that could become entangled in the moving parts of the chair.

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7.2.6 Electrical systems

7.2.6.1 Is the wheelchair electrically safe?

These tests target the complete electrical system on your wheelchair, including the wiring, connectors and controller. The powered wheelchair is a complex electromechanical system. You, the user of this system, need to feel confident that you will not be electrocuted, or that if you lose power the chair will stop before you drive into an obstacle. If you have questions or concerns regarding the connections, wiring or control of the wheelchair, the following tests will provide the needed information.

7.2.6.2 Electrical systems test

A test procedure is given in ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods*.

A comprehensive set of test procedures is performed on the wheelchair. See Table 11. All of these tests are pass/fail.

Table 11 — Tests on electrical systems

Synopsis of test procedure	Result
The wheelchair must have a battery connection diagram.	pass/fail
Wiring connected to the positive output terminal of the battery shall be red or brown.	pass/fail
The frame of the wheelchair shall not be electrically grounded.	pass/fail
It shall not be possible to touch electrically live leads or terminals when changing fuses.	pass/fail
It shall not be possible to connect wiring in an incorrect manner.	pass/fail
Connectors shall not easily pull apart.	pass/fail
Wiring shall not protrude from the wheelchair.	pass/fail
It shall not be possible to touch noninsulated electrical parts.	pass/fail
Primary circuit protection shall be provided next to the battery pack.	pass/fail
It shall not be possible to drive the wheelchair when charging the batteries.	pass/fail
If the connections to the battery are reversed there should be no damage to the controller.	pass/fail
The control system shall not fail if the battery voltage rises by 25 %.	pass/fail
A command signal processing failure shall not result in uncontrolled movement of the wheelchair.	pass/fail
Failure of any output device shall not result in uncontrolled movement of the wheelchair.	pass/fail
When the wheelchair is stalled, circuit protection shall prevent damage to the wheelchair for a minimum of five minutes with a maximum speed command signal applied.	pass/fail
The temperature of all external surfaces accessible to the wheelchair user shall not exceed 50 °C (122 °F).	pass/fail
When the power supply is interrupted, the wheelchair shall stop on its own accord or as soon as it is steered in another direction or put in the stop position.	pass/fail

Disclosure format (as reported by manufacturers)

Name of test	Test result
Overall electrical system requirements	pass/fail

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7.2.6.3 Interpretation of results — Electrical systems

If the manufacturer reports that the wheelchair passes the electrical system requirements, the wheelchair meets the requirements of all the above test procedures.

7.2.7 Determination of static and impact strength

7.2.7.1 How strong is the wheelchair?

Every day you subject your wheelchair to different stresses, and you want to know which wheelchairs will be able to withstand these stresses. See Figure 44. Not everyone is a perfect wheelchair driver. There will be times when you run into a doorway frame or other barriers with the castors, footrests, or main wheels. You may find yourself in a situation in which you need to be lifted up stairs and those lifting may grab the armrests and footrests of your wheelchair. To be safe, armrests and footrests should either pull right out or they should support the weight of you and your chair. Armrests must also be able to support your weight when you do push-ups.

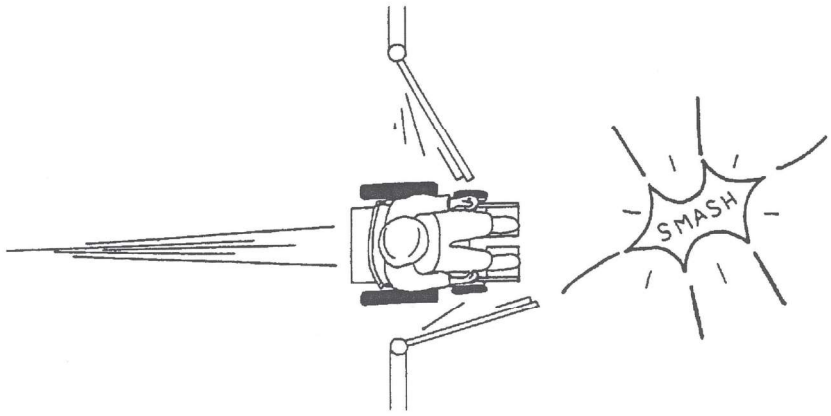

Figure 44 — The impact strength of your footrests is an important issue for simple everyday manoeuvres such as opening doors

7.2.7.2 Determination of static and impact strength

A test procedure is given in ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*.

Static tests are intended to determine the strength of the wheelchair and its components under the high-stress loads that may occur only occasionally. Using a standardized loading pad or strap, a large force is applied once to the relevant part of the wheelchair. If a structural failure, deformation or maladjustment of any part of the wheelchair occurs, it does not pass the test.

Impact tests are intended to determine the strength of the wheelchair and specific components under conditions of impact loading, such as a person dropping onto the seat of the wheelchair or striking a kerb. A weighted ball is dropped once from a given height. If the impact results in a structural failure or deformation of part of the wheelchair that adversely affects its function, the wheelchair does not pass the test.

A pass or fail result indicates whether or not the wheelchair was functional after a known force was applied. The manufacturer may choose to test the wheelchair at higher forces and may or may not disclose them except for the armrest drop test and the loaded drop test, in which the maximum drop height that does not produce a failure is disclosed.

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Disclosure format (as reported by manufacturers)

Name of test	Test result
Static strength tests	pass/fail
Impact strength tests	pass/fail

7.2.7.3 Interpretation of results — Static and impact strength tests

The wheelchair passes the static loads if the test results are as given in Table 12.

Table 12 — Results of static load test

Static load test	Requirement for pass	Disclosure format
Armrest downward	• The armrest can still be removed and adjusted after a push-up.	pass/fail
Footrest downward	• The footrest returns to its original condition and can still be flipped up, swung away, or removed and reinstalled after a person extends or does a weight shift.	pass/fail
Tipping levers downward	• The tipping lever will not be deformed when a person steps on the lever to tilt the wheelchair backward.	pass/fail
Hand grip	• The handgrips will not slip off when a person pulls you and your wheelchair up or down steps.	pass/fail
Armrest upward	• If the wheelchair is lifted by the armrests, the armrests will either lift out of the socket before the chair is lifted off the ground or the armrests will be able to support the weight of the wheelchair and you, allowing you to be lifted up or down safely.	pass/fail
Footrest supports upward	• If the wheelchair is lifted by the footrests, the footrests will either lift out of the socket before the chair is lifted off the ground or the footrests will support the weight of the wheelchair and you, allowing you to be lifted up or down safely.	pass/fail
Push handle(s) upward	• The push handles support the weight of the wheelchair and you and can be used to safely lift you and your chair off the ground.	pass/fail

The wheelchair passes the impact load test if the test results are as shown in Table 13.

Table 13 — Results of impact load test

Impact load test	Requirements for pass	Disclosure format
Seat	• The seat will not rip when you flop into the chair.	pass/fail
Backrest	• The backrest will hold you when you fall back against it.	pass/fail
Drop test	• The chair will still open and roll if someone drops it while unloading it from the boot (trunk) of the car.	pass/fail
Rolling – wheels and/or castors	• The front wheels or castors will not deform when the wheelchair hits a kerb or pothole in the pavement.	pass/fail
Footrest	• The footrest will not bend when you hit a kerb.	pass/fail
Armrest drop	• The armrest will still fit on the chair after it is dropped on the floor.	pass/fail
Loaded drop	• The rear wheel will not bend if the chair is dropped off a kerb onto one wheel.	pass/fail

If the wheelchair passes all the static load tests, it will probably not fail under the conditions listed in Table 13, and the wheelchair components will still be adjustable and removable. If the wheelchair passes all the impact tests, you know that there was no change in its structure or function after the impacts.

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7.2.8 Flammability

7.2.8.1 Will the wheelchair go up in flames if I smoke in my chair?

If you, your friends, or co-workers smoke, you should not overlook the results of this test. A cigarette dropped onto the wheelchair upholstery could ignite the chair.

7.2.8.2 Determination of flammability

A test procedure is given in ISO 7176-16:1997, *Wheelchairs — Part 16: Resistance to ignition of upholstered parts — Requirements and test methods*.

The test procedure is performed in accordance with ISO 8191-1:1987, *Furniture — Assessment of the ignitability of upholstered furniture — Part 1: Ignition source: smouldering cigarette*, and ISO 8191-2:1988, *Furniture — Assessment of ignitability of upholstered furniture — Part 2: Ignition source: match-flame equivalent*. These are pass or fail tests.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Resistance to ignition	pass/fail

See Figure 45.

Figure 45 — Smoking in your wheelchair could lead to a hazardous situation!

7.2.8.3 Interpretation of results — Flammability

This test applies only to upholstery supplied by the wheelchair manufacturer, not to any cushions that you add to the chair. A lit cigarette should not ignite the upholstery. Cushions and supports added after purchase may not have been subjected to the flammability test. If you are a smoker or you spend time with people who smoke, you should choose a wheelchair that passes this test.

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7.2.9 Battery chargers

7.2.9.1 How safe is the battery charger?

The safe operation of battery chargers is an important issue, since you must recharge your batteries regularly. You will want to know if the charger could be damaged if you or the person helping you accidentally hooked up the battery cables backward. It is important to use the appropriate charger with your batteries; some chargers are capable of charging both lead acid and gel cell batteries. The following test determines whether the battery charger meets certain safety requirements so that neither you nor your battery charger are harmed during normal operation.

7.2.9.2 Battery chargers test

A test procedure is given in ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods.*

A comprehensive set of test procedures is performed on battery chargers for lead acid batteries. All of these tests are pass/fail. See Table 14.

Table 14 — Tests on battery chargers

Requirements for pass	Disclosure format
Battery chargers shall meet IEC standards to ensure electrical safety.	pass/fail
For battery chargers having more than one rated d.c. output voltage, it shall not be possible to change the voltage setting without a tool.	pass/fail
For battery chargers with outputs suitable for more than one type of battery (e.g. lead acid and gel cell), the selection device shall be conspicuously marked on the outside of the case with the type of battery selected.	pass/fail
The charger shall clearly indicate when it is correctly connected to batteries	pass/fail
Reverse polarity connection of the output to a battery shall not damage the charger and it shall not be possible to energise the output circuits.	pass/fail
Circuit protection devices will need to be reset or replaced before the charge will operate normally after reverse polarity connection.	pass/fail
There shall be a delay of not less than 0,5 s before the output circuit is energised when connection to the battery is made after the charger has been switched on.	pass/fail
Chargers shall clearly indicate the rated capacity of the batteries that they will charge to 80 % of rated capacity in a period not exceeding eight hours and shall demonstrate that capacity.	pass/fail

Disclosure format (as reported by manufacturers)

Name of test	Test result
Overall battery charger requirements	pass/fail

See Figure 46.

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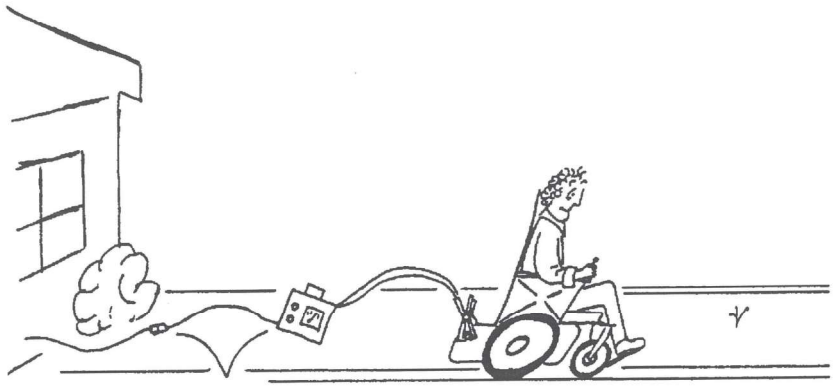

Figure 46 — For obvious safety reasons it shouldn't be possible to drive your powered chair with the charger plugged in ...

7.2.9.3 Interpretation of results — Battery chargers

If the manufacturer reports that the wheelchair passes the battery charger test for lead acid batteries, the battery charger meets the requirements listed in Table 14.

If you plan to travel in a country in which the standard voltage is different than that of your country, your charger may not work. In the United States, the standard voltage is 110 V; in Europe the standard is 220 V. To use a 110-V charger in Europe, a transformer is required to convert the 220 V down to 110 V. To find a transformer, you will need to know the amount of current that your charger draws so that a transformer of the appropriate size is located. The ideal situation is to obtain a 220-V charger compatible with your wheelchair. Battery chargers are also available that can be switched from 110 V to 220 V.

7.3 Dimensions

7.3.1 General

Dimensional information determined by the test procedures is very different from wheelchair measurements currently reported by most manufacturers. Using the test procedures, chairs are measured with a test dummy sitting in the chair, which more accurately represents the true dimensions of the wheelchair when it is occupied. The biggest problem with the dimensional information provided by manufacturers has been that the size of the wheelchair frame was measured using different methods, resulting in information that could not be compared among manufacturers. If you have not already done so, you may want to read Clause 5, "Incorporating personal body characteristics", for information on seating dimensions.

The following three subclauses provide dimensional information and explain how these measurements relate to you and your environment in connection with

a) overall dimensions,

b) seating dimensions, and

c) mass.

7.3.2 Overall dimensions

7.3.2.1 How big is the wheelchair or scooter?

If you live in an apartment with a small bathroom, or if there are narrow doorways in your home or office, you will need to consider the overall size of the wheelchair when you make your selection. In such situations three- and four-wheeled scooters have a distinct advantage. Scooters are generally narrow and can usually make

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very sharp turns. This test also provides information that is important if you need to put your chair or scooter on a wheelchair lift or get the wheelchair into your van or car (automobile) for transport. You want your wheelchair to fit into your environment, or at least not significantly hinder access to your home, office or car. See Figure 47.

Users of full-sized powered wheelchairs have a choice between a standard folding cross-frame and a power-base configuration. If there is a possibility that you will need to increase the width of your seat in the future, you may want to consider a full-sized power-base chair. A power-base chair can accommodate an increase in seat width without increasing the overall width of the chair, up to a certain point. Obviously, if your seat is wider than the base itself, an increase in seat width will increase the overall wheelchair width.

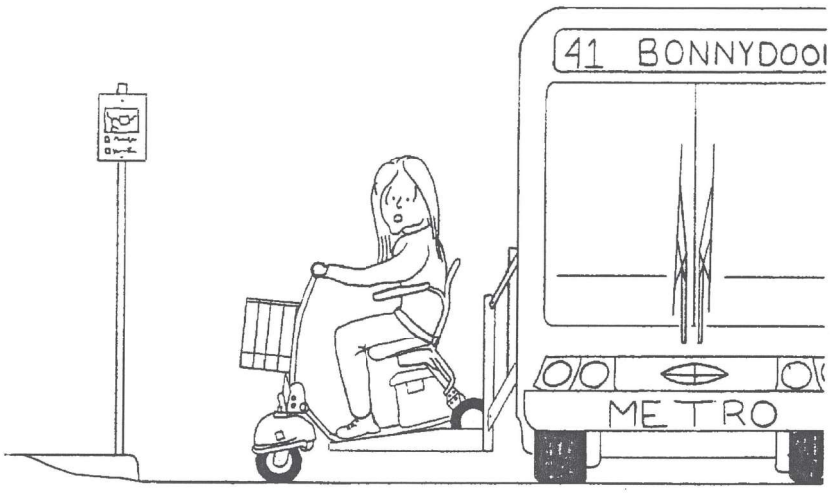

Figure 47 — Three- and four-wheeled scooters, while more manoeuvrable, tend to have longer wheelbases. Make sure the overall dimensions of your powered wheelchair will be compatible with your lifestyle.

7.3.2.2 Determination of overall dimensions

A test procedure is given in ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space.*

A wheelchair is measured in the fully opened and folded positions. These dimensions essentially represent the maximum size box that would be required to contain the wheelchair in a given configuration.

Disclosure format (as reported by manufacturers)

Name of test	**Test result**
Overall length without leg support and footrest	___ mm (___ inches)
Overall width	___ mm (___ inches)
Minimum folded length	___ mm (___ inches)
Minimum folded width	___ mm (___ inches)
Minimum folded height	___ mm (___ inches)

For a list of additional information not required for disclosure in the product literature, see Annex A.

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7.3.2.3 Interpretation of results — Overall dimensions

This test discloses the dimensions of a chair in both the open and folded positions. Since all of the chairs are measured using the same method, you will be able to make true comparisons between chairs from different manufacturers. The overall dimensions will give you the size of the wheelchair with no parts removed, which will help you determine whether the wheelchair will fit through doorways, get around in your home or office, and fit on your wheelchair lift. Using the results of this test in conjunction with the manoeuvrability results, you will be able to select a chair to enhance your independence.

The folded wheelchair dimensions can help you determine whether the wheelchair will fit in the storage space available in a car or aeroplane.

7.3.3 Seating dimensions

7.3.3.1 Will the wheelchair fit me?

If you have ever sat in a poorly fitted wheelchair, you know why this information is critical. Not all wheelchairs are designed to fit every body shape, size and proportion. An improperly fitted wheelchair can result in discomfort, medical complications, and a decrease in your functioning. To understand how to choose the best fit, see Clause 5, "Incorporating personal body characteristics."

Before you set your mind on a particular wheelchair based on its performance, examine the seat dimensions and adjustability to make sure it will fit. If you do not fit correctly in the chair, all the other features and benefits may be useless.

7.3.3.2 Determination of seating dimensions

A test procedure is given in ISO 7176-7:1998, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions.*

Because the dimensions of a wheelchair seat may vary from an unloaded state to a loaded state, a reference loader gauge is placed in the wheelchair during the measurement process. For wheelchairs with adjustable features, each measurement is made with variations in adjustments such that the minimum and maximum measurements are obtained.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Seat plane angle	___ degrees
Maximum seat width	___ mm (___ inches)
Seat depth	___ mm (___ inches)
Seat surface height at front edge (to floor)	___ mm (___ inches)
Backrest angle	___ degrees
Backrest height	___ mm (___ inches)
Headrest height above seat	___ mm (___ inches)
Footrest to seat distance	___ mm (___ inches)
Leg to seat surface angle	___ degrees
Armrest height	___ mm (___ inches)

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Front of armrest to backrest	___ mm (___ inches)
Armrest length	___ mm (___ inches)
Distance between armrests	___ mm (___ inches)
Front location of armrest structure	___ mm (___ inches)

See Annex A for additional dimensional information that is not required to be disclosed in the technical product literature.

See Figure 48.

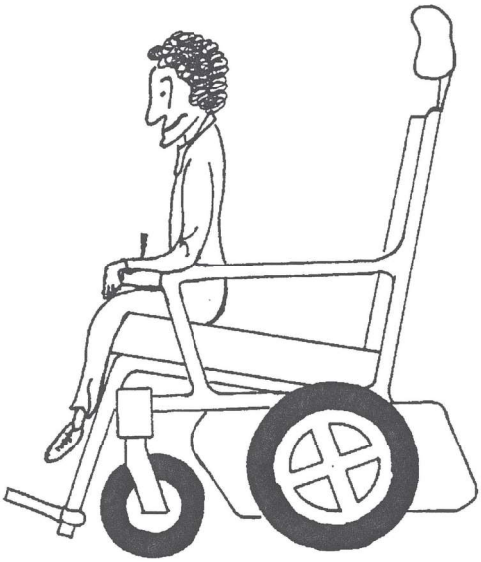

Figure 48 — Don't buy a wheelchair that doesn't fit properly!

7.3.3.3 Interpretation of results — Seating dimensions

If you know what seating dimensions are appropriate for you, the results of this test will provide the information you need to determine which wheelchairs will fit you. A range of values indicates that the wheelchair is adjustable.

7.3.4 Mass (weight)

7.3.4.1 How heavy is the chair?

Powered wheelchairs are very heavy. However, weight does not affect the performance of a powered chair as it does for a manual chair. Nor will you be tossing the wheelchair into the back of your car single-handedly. So why do you need this information? Some models of powered chairs are considered transportable. It is important to see how much the "transportable" components weigh and how much you will have to disassemble to get to the lightest component. Three- and four-wheeled scooters generally are more transportable than full-sized wheelchairs because a scooter usually disassembles into seat, base, steering tiller and batteries. A full-sized powered wheelchair disassembles into: frame, battery box, and controller. Power-base chairs disassemble in the same way and usually have a removable seating system.

See Figure 49.

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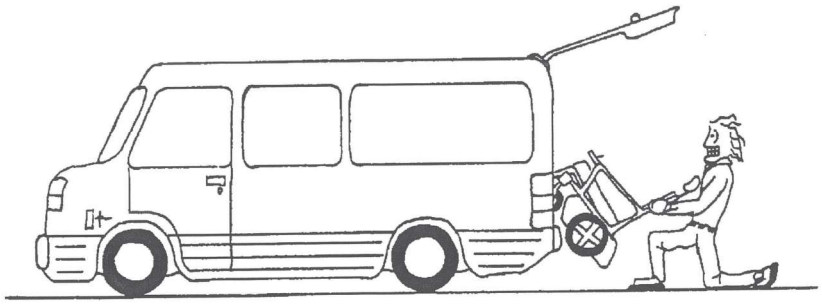

Figure 49 — The weight of a powered chair is a significant issue if you don't have a lift ...

7.3.4.2 Determination of mass

A test procedure is given in ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space.*

The total mass of the wheelchair equipped with standard armrests, legrests, wheels and castors is measured.

Disclosure format (as reported by manufacturers)

Name of test	Test result
Total mass of wheelchair and accessories	___ kg (___ lb)

Additional information not required for disclosure in the product literature:

Mass of each removable component of the wheelchair	___ kg (___ lb)

7.3.4.3 Interpretation of results — Mass

Manufacturers are required to disclose only the total mass (weight) of the wheelchair, including all accessories, in the pre-sale product literature. The mass of each removable component is not required for disclosure, but is available upon request. If you travel in your powered wheelchair, you may encounter a situation in which your wheelchair must be disassembled and loaded into a small vehicle for transport. The mass of the components may be useful information to have to determine how many items will need to be disassembled and whether the person assisting you will be able to lift each component. The batteries are usually the heaviest removable component. Many airlines require that batteries be removed from a powered wheelchair during travel. A single wheelchair battery weighs anywhere from 30 lbs to 50 lbs. If the batteries are housed in a single battery box, the person assisting you must be able to lift about 100 lbs. If the batteries are housed in two separate boxes, transporting them will be easier.

If you travel, another important consideration is the time required to disassemble and reassemble your wheelchair, including removal and reinstallation of the batteries, and whether tools are required.

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Annex A
(informative)

Additional information not required for disclosure in the manufacturer's technical product literature

NOTE If the wheelchair manufacturer claims to be in compliance with International Standards on wheelchairs, the results of any of the tests below should be provided to you upon direct request to the manufacturer. If the manufacturer is not willing to provide the information listed below, the manufacturer is not in compliance with the ISO test procedures.

For terms and definitions, see ISO 6440:1985, *Wheelchairs — Nomenclature, terms and definitions*.

The following is a list of International Standards that apply to both manual and powered wheelchairs, giving additional information that can be requested from the manufacturer.

ISO 7176-1:1999, *Wheelchairs — Part 1: Determination of static stability*

- Includes brakes off, wheels blocked

ISO 7176-5:1986, *Wheelchairs — Part 5: Determination of overall dimensions, mass and turning space*

- Dimensions and mass of each removable component of the wheelchair
- Dimensions and mass of each wheelchair component
- Minimum turning radius
- Overall height with backrest in the upright position
- Minimum volume
- Minimum dimensions of largest component
- Dimensions of nonfolding wheelchair prepared for storage
- Dimensions of a folded wheelchair for accommodation in a car

ISO 7176-7:1998, *Wheelchairs — Part 7: Measurement of seating and wheel dimensions*

- Effective seat width
- Backrest width
- Headrest in front of the backrest
- Footrest clearance
- Footrest length
- Footrest-to-leg angle
- Armrest width
- Armrest angle
- Vertical location of wheel axle

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ISO 7176-8:1998, *Wheelchairs — Part 8: Requirements and test methods for static, impact and fatigue strengths*

Manufacturers may choose to disclose the degree to which their wheelchairs perform beyond the minimum recommended values in the following areas:

Static strength

Armrest downward

Footrest downward

Tipping levers downward

Hand grips

Armrest upward

Footrest supports upward

Push handles upward

Impact strength

Seat impact load test

Backrest impact load test

Drop test impact load test

Rolling impact load test wheels and/or castors

Handrim impact load test

Footrest impact load test

Armrest drop impact load test

Loaded drop impact load test

Fatigue strength

Double drum test

Kerb drop test

ISO 7176-15:1996, *Wheelchairs — Part 15: Requirements for information disclosure, documentation and labelling*

ISO 7193:1985, *Wheelchairs — Maximum overall dimensions*

The following is a list of those test procedures that apply to powered wheelchairs only:

ISO 7176-2:2001, *Wheelchairs — Part 2: Determination of dynamic stability of electric wheelchairs*

- Starting uphill, one or more wheels lift from the test plane
- Lifting or tipping of wheelchair during maximum turning manoeuvre

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ISO 7176-3:2003, *Wheelchairs — Part 3: Determination of effectiveness of brakes*

- Wheel lock lever force
- Forward horizontal and automatic braking distance
- Reverse horizontal minimum braking distance and automatic braking distance
- Force required to operate dynamic braking lever

ISO 7176-4:1997, *Wheelchairs — Part 4: Energy consumption of electric wheelchairs and scooters for determination of theoretical distance range*

- Indoor and outdoor energy consumption
- Watt hours per kilometre

ISO 7176-6:2001, *Wheelchairs — Part 6: Determination of maximum speed, acceleration and deceleration of electric wheelchairs*

- Maximum acceleration forward
- Maximum acceleration rearward
- Maximum retardation forward

ISO 7176-14:1997, *Wheelchairs — Part 14: Power and control systems for electric wheelchairs — Requirements and test methods*

- Force necessary to operate joystick
- Force necessary to operate pushbutton, rocker, and keypad switches
- Force necessary to operate toggle switches
- Force necessary to operate pneumatic switches (positive and negative)

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1) Available through PAX Press, a division of Beneficial Designs, Inc., Santa Cruz, California, United States, <paxpress@beneficialdesigns.com>, (831) 429-8746, (831) 423-8450 fax.

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Books and pamphlets

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[20] WILSON, A. BENNETT. *How to Select and Use Manual Wheelchairs*. Topping, VA: Rehabilitation Press, 1992

Other resources

International Standards on wheelchairs can be obtained from your country's member body (for example, RESNA, BSI).

Copies of the complete ANSI/RESNA Wheelchair Standards can be purchased from:

RESNA
1700 N. Moore Street, Suite 1540
Arlington, VA 22209
(703) 524-6686, (703) 524-6630 fax

Publications available through ABLEDATA include:
Wheelchairs for Children
Manual Wheelchairs
Powered Wheelchairs
Informed Consumer Guide to Wheelchair Selection

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Silver Spring, MD 20910
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Paralyzed Veterans of America
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Phoenix, AZ 85016-4702
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