行政院及所屬各機關出國報告
（出國類別： 其他 ）

赴英參加人道屠宰暨家禽屠宰加工等相關議題研討會

服務機關：行政院農業委員會動植物防疫檢疫局
出 國 人 職　　稱：技士
姓　　名：阮甫寬
出國地區：英國
出國期間：九十一年十一月九日至十二月十五日
報告日期： 九十二年二月十七日

系統識別號: C09200724

行政院及所屬各機關出國報告提要

出國報告名稱：赴英人道屠宰暨家禽屠宰加工等相關議題研討會

頁數 20　　含附件：是

出國計畫主辦機關/聯絡人/電話

農委會動植物防疫檢疫局/周佳蓉/02-3343-2052

出國人員姓名/服務機關/單位/職稱/電話

阮甫寬/農委會動植物防疫檢疫局/技士/02-2343-1467

出國類別：□ 1 考察□2 進修□3 研究□4 實習■5 其他

出國期間：91 年 11 月 09 日 91 年 12 月 15 日　出國地區：英國

報告日期：92 年 2 月 17 日

分類號/目：F7/農產品檢疫及家畜保健 F7/農產品檢疫及家畜保健

關鍵詞：人道屠宰、動物福利、家禽屠宰加工

內容摘要：(二百至三百字)

英國素來以嚴格的動物福利政策聞名，尤其面對強大的民間動物保護團體等壓力，相關產業亦不得不思考其應對與改善動物福利之措施。其中，來自學術單位的資源更是重要的支援後盾，舉凡動物倫理及道德論戰、動物福利設施的研發及設計、員工訓練與動物福利的管理等資源，均極為完備以配合社會對動物福利的合理要求。由於英國布里斯托大學之研究領域及所舉辦之動物福利與家禽屠宰加工相關議題研討會兼具英國法規之適用性與現場之實用性，故深得好評。

本次人道屠宰暨家禽屠宰加工等相關議題研討會係以動物福利督察員訓練課程與家禽福利督察員訓練課程為主體，結合該校研究所肉品科學課程共約五週，參加學員主要來自英國官方駐場獸醫師、肉品檢查員、屠宰場管理人員、屠宰場經理與一般研究生等共約十七位。研討會課程內容重點包括動物福利、人道屠宰、人道屠宰技術指導、家禽產品加工、家禽福利、家禽人道屠宰等項目；此外，亦安排口頭及論文報告、屠宰場參觀、實驗室實習等實際觀察與演練，使學員更能深切體會與認知動物福利與家禽屠宰加工等相關議題與並能適時提出討論與建議。

適值我國法規對人道屠宰之要求，經由參與本次研討會，除對動物福利之基礎背景、觀念與技術有初步認識外，並建立人道屠宰與家禽屠宰加工技術相關研究人員之聯繫管道，有助於將來取得該等經驗與技術之資訊。

赴英參加人道屠宰暨家禽屠宰加工等相關議題研討會

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赴英參加人道屠宰暨家禽屠宰加工等相關議題研討會

壹、緣起與目的

英國素來以嚴格的動物福利政策聞名，尤其面對強大的民間動物保護團體等壓力，相關產業亦不得不思考其應對與改善動物福利之措施。其中，來自學術單位的資源更是重要的支援後盾，舉凡動物倫理及道德論戰、動物福利設施的研發及設計、員工訓練與動物福利的管理等資源，均極為完備以配合社會對動物福利的合理要求。我國畜禽屠宰管理，自民國八十七年由行政院農業委員會植物防疫檢疫局（以下簡稱本局）接辦後，依據「畜牧法」及「屠宰場設置標準」與「屠宰作業規範」等相關子法，與屠宰場人道屠宰之相關規定亦有所提。鑒於英國在動物福利推動方面具有豐富的經驗，經台灣動物社會研究會於去（九十）年七月主動發文告知行政院農業委員會與本局，英國布里斯托大學對於有關農場動物福利與人道屠宰技術的研究具有三十餘年豐富之經驗，是相當值得我國派員前往進一步了解其推動動物福利之技術背景與新進技術的地方，經過去年行程之籌畫，於本（九十一）年十一月成行。

我國目前在動物福利相關技術的研究報告發表及新進資料不多，動物福利課程，尤其經濟動物，在一般大專院校亦極其罕見。相較於英國，許多大學對於動物福利的研究頗具水準，尤其布里斯托大學之研究領域及舉辦之動物福利相關課程研討會更是集結英國法規之適用性與現場之實用性，故深得英國動物保護協會之好評。有關本次人道屠宰暨家禽屠宰加工等相關議題研討會係以動物福利督察員訓練課程與家禽福利督察員訓練課程為主體，結合該校研究所肉品科學課程共約五週，參加學員主要來自官方駐場獸醫師、肉品檢查員、屠宰場管理人員、屠宰場經理與一般研究生等共約十七位。

研討會課程內容重點包括動物福利、人道屠宰、人道屠宰技術指導、家禽產品加工、家禽福利、家禽人道屠宰等項目；並安排口頭及論文報告、屠宰場參觀、實驗室實習等實際觀察與演練，使學員更能深切體會與認知動物福利等相關議題與並能適時提出改進建議。

另同期學員亦有來自英國肉品衛生檢查體系，藉此亦私下訪談目前英國肉品衛生檢查體系相關訊息，並互相交換討論各國人道屠宰與肉品檢查制度。英國肉品衛生署原由農業部門於八十四年成立，主要業務為動物福利與肉品衛生檢查，於八十九年經過一番變革，已由農業部門移撥至食品標準局，業務也由地方轉為中央接管（北愛爾蘭例外）。雖然英國肉品衛生檢查體系剛變革不久，部分措施亦值得我國借鏡與參考研究，尤其我國屠宰衛生檢查制度向來仿效美國系統，歐洲體系亦有部分優點相當值得探討

整體而言，為迎接世界貿易與全球化的未來，多一份對其他地區的了解，對於未來肉品檢查政策之策劃、推動與執行，將更具深遠之意義。

爰由本局李前局長金龍核派及舉薦肉品檢查組阮甫寬技士參加本次研討會。

貳、行程

本次人道屠宰暨家禽屠宰加工等相關議題研討會自九十一年十一月十一日至十二月十二日為期共三十二天，上課地點為英國布里斯托大學臨床獸醫學系，該系位於英國英格蘭地區布里斯托Langford鎮，該研討課程全部由布里斯托大學臨床獸醫學系主導，其中人道屠宰方面的主持人為Haluk Anil教授，家禽屠宰加工方面的主持人為Ian Richardson教授。課程結束後，隨即前往倫敦拜會世界動物保護協會，並於次日十二月十四日晚間搭機返國。全部行程共三十六天，茲列舉如下：

十一月九日（六）

於台北時間十一月九日上午9:00由台北中正國際機場（TPE）搭乘長榮航空BR0067班機啟程，途經泰國曼谷國際機場（BBK）停機載客加油約四十分鐘後，繼續飛往英國。

經長達十八個小時左右的時間終於在英國當地時間十一月九日下午7:10抵達倫敦希斯羅國際機場（LHR），隨即搭乘市區旅館公車（Hotel hoppa）至假日飯店（Holiday Inn Ariel）住宿一晚。

十一月十日（日）

上午與世界動物保護協會蘇佩芬小姐約見於倫敦，解決鐘老師在英國之開銷等費用並諮詢研討會相關訊息。下午16:00搭火車前往布里斯托，下午17:25抵達布里斯托車站，隨即搭乘計程車前往Langford鎮，於18:30抵達布里斯托大學臨床獸醫學系，並解決住宿問題。

十一月十一日（一）

確認宿舍並拜訪Peter Sheard教授。Peter Sheard教授為本課程總主持人。

研討課程主題與教師：

1. Welfare assessment methods（福利評估方法）: Paul Warris
2. Assessment of welfare at abattoir（屠宰場福利的評估）: Raman Coore（PhD student）
3. Recognition of pain & distress in farm animals（農場動物疼痛與不適的認知）: Avril Waterman-Pearson
4. Ethics & animal welfare（倫理與動物福利）: Sue Haslam
5. Welfare during transport of poultry（家禽運輸時的福利）: Claire

Weeks

十一月十二日（二）
Haluk Anil提供論文報告題目供學員選定，並訂於十一月廿五日發表口頭報告，十一月廿九日繳交書面報告。本人題目為"Assess the restraint of GOAT/SHEEP before stunning, slaughter or killing as defined in the legislation and evaluate the available methods"（評估法規所定義羊隻致昏、屠宰或殺死前之保定與可用之方法）
電腦網路測試成功，可以接收並傳輸資料回台灣。
研討課程主題與教師：
1. Introduction to course work （課程介紹）: Haluk Anil (Module Organiser)
2. Welfare aspects of sheep production（綿羊生產的福利觀點）: Jeff Wood
3. Animal and poultry behavior and Welfare(家畜禽行為與福利): Claire Weeks
4. On farm welfare assessment（農場福利的評估）: David Main
5. Welfare of pigs（豬的福利）: Mike Mendl

十一月十三日（三）
研討課程主題與教師：
Transport of meat animals（肉用動物的運輸）: Paul Warris
Improving welfare（改善福利）: Paul Warris
Physiological principles 1（生理 1）: Haluk Anil
Casualty animals and casualty slaughter（傷病動物與緊急屠宰）: Andy Butterworth
Writing skills 6 Critique of essays（論文寫作技巧 6）: Peter Sheard

十一月十四日（四）
研討課程主題與教師：
Welfare problems in broilers（白肉雞的福利問題）: Sue Haslam
Welfare on farm animals（農場動物福利）: John Webster
Welfare on red meat species（肉用家畜福利）: John Webster
Physiological principles 2（生理 2）: Haluk Anil
Fish welfare（魚的福利）: Haluk Anil

十一月十五日（五）
研討課程主題與教師：

Tutorial（口頭報告與討論之講解）: Haluk Anil
Welfare at Slaughter & public health（福利及屠宰與公共衛生的關係）: Haluk Anil
The OVS approach to animal welfare（官方獸醫師對動物福利的處理方式）: Alison Small

十一月十六日（六）
假日休息暨整理資料
熟悉校園並由鐘老師的朋友林先生（目前在牛津大學攻讀博士學位）開車前往巴斯（Bath spa）參訪

十一月十七日（日）
假日休息暨整理資料
參訪布里斯托（Bristol）與位於市中心的布里斯托大學（University of Bristol）
整理資料

十一月十八日（一）
十一月十八日至二十日接連三天的課程為動物福利督察員訓練課程，並有新進參加的學員二位來自肉品衛生署，為屠宰場內的肉品檢查員。
研討課程主題與教師：
Stunning/Slaughter of red meat species（肉用家畜之致昏與屠宰）：Steve Wotton、Paul Whittington、Haluk Anil

十一月十九日（二）
研討課程主題與教師：
Stunning/Slaughter of red meat species（肉用家畜之致昏與屠宰）：Steve Wotton、Paul Whittington、Haluk Anil

十一月二十日（三）
由Haluk Anil帶領前往Southern Counties Fresh Foods 牛/羊屠宰場現場參訪，了解屠宰場動物福利設施與運作方式。
研討課程主題與教師：
Depart 9 am to Southern Counties Fresh Foods：Haluk Anil

十一月二十一日（四）
研討課程主題與教師：
Stunning methods demonstration (DFAS lab)（致昏方法的講解）: Haluk

Anil/Justin McKinstry
Religious slaughter（宗教屠宰）: Haluk Anil

十一月二十二日（五）
口頭報告論文主題，本人的論文主題為" Assess the restraint of GOAT/SHEEP before stunning, slaughter or killing as defined in the legislation and evaluate the available methods"（評估法規所定義羊隻致昏、屠宰或殺死前之保定與可用之方法）
研討課程主題與教師：
Oral presentation of essay topics（口頭報告論文主題）: Haluk Anil/Raman Coore

十一月二十三日（六）
假日休息暨整理資料
前往牛津（Oxford）參訪，並利用機會至坊間傳統市場（covered market）了解市售肉品之環境。

十一月二十四日（日）
假日休息暨整理資料
回布里斯托大學臨床獸醫學系。

十一月二十五日（一）
由Steve博士帶領鐘老師與我前往豬隻屠宰場測試致昏器，隨行的還有Justin博士，並蒐集相關電學資料，以備分析。
研討課程主題與教師：
Visit a abattoir for pig and make tests of electrical stunning（參訪豬隻屠宰場，測試電擊致昏器）：Steve Wotton、Justin

十一月二十六日（二）
進一步蒐集論文相關資料並開始論文書面報告之寫作。

十一月二十七日（三）
分析十一月二十五日帶回的電擊資料，了解頻率、電壓與電流的關係。

十一月二十八日（四）
繼續分析電擊資料
繼續論文書面報告之寫作

十一月二十九日（五）
完成本次研討課程之註冊手續
討論電擊資料分析結果
完成論文書面報告

十一月三十日（六）
假日休息暨整理資料
前往Weston-super-Mare參訪

十二月一日（日）
假日休息暨整理資料
前往布里斯托（Bristol）參訪

十二月二日（一）
研討課程主題與教師：
Introduction & overview - World poultry（簡介-世界家禽產業）: Ian Richardson
Poultry meat and egg production/nutrition（禽肉及蛋的生產與營養）: Ian Richardson

十二月三日（二）
研討課程主題與教師：
Waterfowl（水禽）: Ian Richardson
Factors affecting yield and composition（影響產量與成分的因子）: Ian Richardson
Evisceration to chilling（內臟掏取至預冷階段）: Ian Richardson

十二月四日（三）
研討課程主題與教師：
Muscle structure, myopathies（肌肉構造與肌病）: Ian Richardson
Appearance, colour, flavour and taints（外觀、顏色、味道與腐味）: Ian Richardson

十二月五日（四）
十二月五日至六日接連二天與十二月十一日的課程為家禽福利督察員訓練課程。
研討課程主題與教師：
Poultry welfare course（家禽福利課程）: Steve Wotton/ Lindsay Wilkins

十二月六日（五）
研討課程主題與教師：
Poultry welfare course（家禽福利課程）: Steve Wotton/ Lindsay Wilkins

十二月七日（六）
假日休息暨整理資料
由Steve開車帶領前往Weston-super-Mare參訪

十二月八日（日）
假日休息暨整理資料
前往布里斯托（Bristol）參訪

十二月九日（一）
研討課程主題與教師：
Anatomy & physiology（解剖與生理）: Andrew Butterworth
Broiler disease affecting production（影響生產的家禽疾病）: Andrew Butterworth
Strategies of extending shelf life（延長產品保存期限的策略）: Ian Richardson
Functional properties of poultry meat（禽肉的功能性特徵）: Ian Richardson
Environment and thermoregulation（環境與溫度調控）: Claire Weeks

十二月十日（二）
研討課程主題與教師：
Poultry meat products（禽肉產品）: Ian Richardson
Processing of spent hens（淘汰產蛋母雞的加工）: Peter Sheard

十二月十一日（三）
由Steve Wotton博士帶領前往Webbs Country Foods, Sutton Benger 家禽屠宰場現場參訪，了解屠宰場動物福利設施與運作方式。
研討課程主題與教師：
Visit to Webbs Country Foods, Sutton Benger: Steve Wotton
Practical (DFAS processing area) : Steve Wotton/ Ian Richardson/ Lindsay Wilkins

十二月十二日（四）

研討課程主題與教師：
Pathogens in poultry &their control（家禽病原性疾病及控制）: Tom Humphrey

十二月十三日（五）
前往倫敦，拜訪世界動物保護協會（World Society for the Protection of Animals, WSPA）。

十二月十四日（六）
於當地時間21:30由倫敦希斯羅國際機場（LHR）搭乘長榮航空BR0068班機返台，因機場旅客眾多，班機延遲起飛。

十二月十五日（日）
班機途經泰國曼谷國際機場（BBK）停機載客加油約一小時後，繼續飛往台灣。經長達十六個小時左右的時間終於在台北時間十二月十五日21:30抵達台北中正國際機場（TPE）。

參、研習紀要與心得

本次很榮幸參加英國布里斯托大學為期約五週的人道屠宰暨家禽屠宰加工等相關議題課程研討會。本研討會係結合研究所課程所舉辦的討論、實務技能與參訪活動，參加學員除來自英國本國外，亦有來自美國、西班牙、義大利、希臘、越南與印度等世界各國，相信所得資料有助於作為提升我國人道與家禽屠宰軟硬體作業與設置之參考。

布里斯托大學獸醫學院臨床獸醫學系所在地位於布里斯托, Landford鎮，幅員相當廣闊，除農場動物科學部門(為最大部門，包括動物福利及行為、農場動物醫療、食品安全與食品科學等四大領域)外，亦有伴侶動物醫學與獸醫病理傳染病及免疫學等三大部門，另亦有小動物醫院、大動物醫院與屠宰場等設施，可以說是相當健全且龐大的研究教學組織，相當令人羨慕。說起該校對動物福利的研究與技術的開創，其成果亦極其斐然，著名的動物五大自由論倡導者就是該系Webster博士，其對於過去許多年來動物福利與畜產品科學的論戰具有相當豐富的經驗與獨特的看法，其所累積的實力與資訊亦絕非一朝一夕，相當值得醒思。

本次研討會課程主要分為動物福利與人道屠宰技術研討課程及家禽屠宰與加工研討課程兩部份。除平常課程研討會與屠宰場參觀討論外，並於課後與學員交換討論英國等國肉品衛生檢查體系。本次研討會期間，除了

課堂各節的講師豐富精采的講授外，課程的安排及參觀活動都非常緊湊，雖然時間長達約五週，但是學員的學習精神都很高昂。

動物福利與人道屠宰技術

動物福利

有關倫理與動物福利議題，會中提及學術界在定義動物福利與人道屠宰的探討與歷程，大抵以哲學思想為根基加以社會接受度進行可行性評估，並尋求理論之平衡點，發展實用技術與管理計畫，俾便推廣並訂諸於法規之中。倫理是一種道德的科學，可以提供並強化解釋社會對事件的論點，但不一定可以給予正面而迅速的解答。在社會案件中，許多議題係起源於應該、必須或適當性之議題討論點，動物福利就是一個相當明顯的例子。最早有關動物福利的記載，係來自於印度地區的一位公主，她鼓吹族人不殺生。近代在英國則有五種動物福利相關哲學理論，分別為猶大-基督哲學（Judaeo-Christian Philosophy）、康德學說（Kantianism, Deontological theory）、實用主義者（Utilitarianlism, Consequentialism)、權利學說(Right Theory, Liberal individualism)及倫理與一般道德的原則(Principle based ethics and common morality)等理論。猶大-基督哲學主要係討論應由誰來主宰世界萬物。康德學說則認為動物並不包含在道德社會的討論內容內，但是對動物殘忍也會促使人類同樣殘忍對待人類。實用主義者則在討論成本與價值的分析。權利學說指出任何人都有自由主張的權利。至於，倫理與一般道德的原則係將原則分為自我管理、應該做的善事、不應該做的傷害與公平正義原則等四項，用以評估並作出適當的倫理行為。因此，當討論到”我們應不應該畜養並宰殺家畜作為我們的食物?”。康德學說認為只要不殘忍對待動物，是可以接受的，這一部份的支持者主要為消費者；實用主義者則認為人類營養或動物飼養相關有利價值應該超過動物福利所付出的成本，這一部份的支持者主要為農民，以及部分消費者。至於，權利學說的支持者，例如一些動物保護組織，認為使用動物作為食物的來源就是明顯違反他們的權利。此外，倫理與一般道德的原則方面，支持者則是來自關心動物福利的中間派人士，他們指出，利用動物作為食物必須要有原則，應該盡力保護動物，並設計良好的系統與操作模式飼養及屠宰動物。

目前使用動物的倫理架構係由動物五大自由論與一九八六年動物（科學操作）法案所構成，動物五大自由論係由 Webster 博士所提出，並於一九七九年為農場動物福利委員會(FAWC)採納，作為動物福利衡量指標。動

物五大自由論，係指出農場動物應具有下列自由 1)免除口渴、飢餓與營養不良；2)免除不舒服；3)免除疼痛、受傷與疾病；4)自由表現正常行為；5)免除恐懼及心理不適。至於，動物（科學操作）法案，則是用來規範並保護脊椎動物（含章魚）的科學用途，對於動物房舍、育種及畜養與動物的健康與福利均列有指導方針，此外亦規範任何可能造成動物的疼痛、不適、持續性的傷害等任何實驗或科學性操作，另人們也應依據 3Rs 的原則擔負減少使用動物的道德義務。3Rs 係指減少（Reduction），精確（Refinement）與取代（Replacement），例如，減少使用動物的數量（減少），比較不敏感動物種類的使用（精確），止痛等藥劑的使用（精確）、體外系統（取代）與電腦模擬（取代）等。

豬、牛、羊與雞、火雞，在英國是最為常見的經濟動物種類，相關的動物福利亦常被提及。一般所關切的重點包括育種、飼養環境、飼養時的管理運作與屠宰時所潛在的恐懼及痛苦。不良的動物福利常會造成包括死亡率、物理性傷害與動物不正常行為等現象。根據一九九二年 Warriss et al.的報告指出，雞隻經四小時內的運輸，會有 0.156%的死亡率，較長時間的運輸則會有 0.286% 的死亡率，故愈長時間運輸所代表的動物福利環境較差，其死亡率也愈高。有關動物的骨頭斷裂、脫臼或受傷，人們可相當明確地以實際經驗了解此物理性傷害，甚至可以推測其原因，例如雞隻在收集準備運輸的過程中，工作人員的操作方式若單腳抓雞，特別容易造成雞隻骨頭斷裂，尤其雞隻多在七週齡左右屠宰供食用，此時部分雞隻骨頭仍未發育完全，特別容易因操作不當，造成骨頭斷裂或脫臼。雖然動物飼養空間狹小，不但容易傳染疾病，亦容易使動物有不正常行為發生或發生打架等物理性傷害情事，然為減少成本，農民仍較偏好於提供較小的空間用於飼養動物，根據一九八七年 Edwards et al.的報告指出，豬隻維持生長與飼料轉換效率所需最小飼養空間為 0.59m^2/100kg，並應擴增 0.4 m^2 至 1 m^2 的空間提供豬隻躺下休息；英國目前已導入歐洲聯盟規定於一九九四年的家畜福利法規中規定，豬隻體重介於八十五至一百一十公斤者，其最小飼養空間為每頭豬 0.65 m^2。至於，雞隻則應提供容許站立的空間每隻 475 cm^2。

有關經濟動物福利的監督與執行，在英國農場係由來自環境、食品及城鄉事務部(DEFRA)的分部獸醫管理員（DVM, Divisional Veterinary Manager ）負責管理，運輸途中則根據貿易標準（Trading Standard）由委員會組織負責管理，屠宰場內則由食品標準局（FSA）所派駐的官方獸醫師（Official Veterinary Surgeon）管理負責。因為制度的不同，在英國，當業者違反動物福利相關法規時，係先進行書面改善通知，若通知後仍未於時限內完成改善，則係採法院裁決方式處理。而我國目前則僅於屠宰場

有動物福利相關作為，係採行政管理與罰緩方法處理，並透過屠宰場軟體與硬體輔導與查核。

台灣在動物倫理方面的研究不多，許多資料均來自國外，相關學術討論亦相當罕見。普遍而言，台灣佛教人口不少，因此許多人將素食的戒律推演為動物保護的具體作為。另值得注意的是，近幾年台灣動物社會研究會持續以人道屠宰、流浪犬問題、動物實驗等議題推動動物保護相關社會運動，使社會各界開始關心並省思動物福利相關問題，尤其隨著網際網路與電子郵件的發達，民眾的關切函亦如雪片般飛來，無形中也加重處理郵件等行政上的負擔。而英國在動物福利議題被提起前，原本亦極其紛擾，然隨著農場動物福利委員會（FAWC）的成立並根據動物五大自由論之倫理觀點處理相關問題，引領學術界朝動物福利方向研究發展相關設施與管理方式，動物福利問題算是在英國有了解套，並且建構英國學術界在動物福利研究領域上的地位。

人道屠宰

一般人常將符合屠宰場內動物福利的設施設備、運作技術與管理方法統稱為人道屠宰。人道屠宰技術之教育與訓練為本次研習重點之一，討論的範圍係以人道屠宰技術為中心，配合屠體品質、食品安全、公共衛生、工作人員安全與法規的解釋等項目，提供產業解決方案。尤其人道屠宰管理側重機器保養與工作人員訓練，係推動家畜禽人道屠宰不可或缺的部分，機器運作的完美有賴於工作人員的技能與工作態度，故類似研討會的開辦對於動物福利相關技術推展，有莫大的助益。

為使屠宰場達到人道屠宰之水準，首先就要先了解動物行為、動物對不適及疼痛的認知、人道屠宰設備、人道屠宰技術與人道屠宰管理等各項議題。有關動物行為，因動物的不同會有不同的行為表現，以豬為例，因為行動笨拙且只會呈現鬆散隊形移動。所以最好一次處理大小適當的豬群。另外，如果前方豬隻停止不動，用趨趕器具趨趕後面的豬隻，通常無法達到移動的目的，所以當豬隻停止不動時一定要查明原因再作適當的處理，而不是一昧的強加趨趕；至於牛，因具有逃離區（flee zone）的行為特性，趕牛時可利用此項特性，順利地驅使牛隻往正確的方向前進；。然而牛隻具有形成群體的習性，且牛隻的體型及力量均比一般人大，為了安全，工作人員除應了解牛隻行為外，亦不可試圖一次移動大群牛隻。有關動物對不適與疼痛認知，雖然在現場很難由人類依據感官來認知，但部分仍具有科學上的證據，例如，可由緊迫型賀爾蒙、生理與病理（長期）等方法監測。當動物受到不適或緊張時，血液中的腎上腺素會急劇升高，心

臟與血壓也會上升，長期而言，胃潰瘍、血管壁增厚、腎上腺擴大、脾臟萎縮與心臟擴大等亦為動物受到不適或緊張時的反應。至於人道屠宰設備、技術與管理方面，主要為家畜在卸運、繫留、致昏（或致死）、放血等階段。卸運方面必須考慮光線的刺激、地板高低差距、地面防滑等設計，操作時亦應利用動物行為溫和驅趕動物；繫留方面則應給予充足的飲水與通風的環境，對於動物的活動空間亦應採取專家或相關建議；致昏（致死）方面則應使用撞擊、電擊、槍擊、頸椎脫臼（適用於禽類）、混合氣體（適用於豬與禽類）等方法，並應配合適當的保定欄提升致昏準確性與保護工作人員作業安全。根據英國法規規定，牛應於三十秒內完成放血作業，豬與羊則應於二十秒內，而雞與鴨則應於九十秒內，鵝為二分鐘內；為保證放血過程中動物處於失去知覺之狀態並符合法規規定，英國專家建議，豬、羊應於致昏後十五秒內放血，牛則應於致昏後十秒內放血。

有關家畜的有效致昏判定，根據英國農場係由來自環境、食品及城鄉事務部(DEFRA)對屠宰工作人員發照與訓練的指導要點（Guidance Note on the Licensing and Training of Slaughtermen）所述：

1. 使用穿透型撞擊式致昏器（Captive bolt）或非穿透型撞擊式致昏法（Concussion）達有效致昏時，家畜應該會出現以下現象：
   1）立即倒下，伴隨身體與肌肉僵直。
   2）沒有試圖起身的現象。
   3）沒有正常的節律性呼吸。
   4）眼球凝視不動。
2. 使用電擊式致昏器，以頭部電擊有效致昏時，家畜會出現以下現象：
   1）全身僵直。
   2）停止呼吸。
   3）眼球凝視不動。
   4）頭部抬起，後腿往身體方向屈縮。
   5）前期前腿可能會屈縮，之後則通常會出現伸直現象。

以上現象大抵會延續 15-20 秒鐘，之後會開始有蹴踢，也會緊接著開始發生呼吸現象。同樣的，頭身電擊係使心臟也停止，其有效致昏之初始現象亦類似上述頭部電擊之現象。此外，上述指導要點並無法律強制性，僅供參考建議用，一般現場大抵會以眼瞼反射與呼吸現象為主要判斷標準。

目前我國對有效致昏的判斷標準則為，動物有效致昏時，不應出現眼瞼反射、眨眼、節律性呼吸、吼叫聲與試圖起身的現象。本標準係參考美國、澳洲、紐西蘭、英國等國及專家建議，與現場觀察後所訂出之標準。目前，並未見世界各國將致昏標準定入法規的案例，且多以建議或要點方式進行非強制性判定，主要係因以生理現象判定有效致昏仍有實務上的困

難與誤差，真正判斷致昏的有效性係以腦波圖的判定為最具科學根據與準確性的方法。我國近年已委託台灣動物科技研究所楊研究員天樹，積極建立以腦波圖判定有效致昏之研究計畫，俾便用以改良致昏器，使合乎有效致昏之水準，亦能兼顧屠體品質。

此外，英國一九九五年動物（屠宰或殺死）福利法規，則為評估屠宰場內動物福利之最低限度的圭臬。有關人道屠宰技術之教育與訓練，主要係配合英國法規（如，動物（屠宰或殺死）福利法規）要求，以現有科學證據與動物行為之研究，剖析現行動物人道屠宰技術的原理與方法。在英國，要成為一位官方駐場獸醫師（Official Veterinary Surgeon），必須先修習本課程並取得認證，此外，屠宰場受法規規定與為迎合消費者需求建立產業形象亦經常派遣管理人員前來參加並編撰動物福利及政策隨時提醒工作人員注意相關事項。至於，隨著人道屠宰所衍生的公共衛生問題，根據一九九五年 Lancet 的報導，使用氣動穿刺型撞擊式致昏器擊昏牛隻會造成腦組織殘留於肺動脈後，目前英國已經禁止使用該型致昏器於牛隻的致昏並嚴禁致昏後脊椎穿刺動作。最新實驗亦開始進行有關羊隻使用致昏器與公共衛生課題關係的調查。

另有關宗教屠宰因取決於信仰因素，目前歐洲許多國家是禁止未經致昏放血的屠宰，而在英國則允許未經致昏放血的宗教屠宰，此類宗教屠宰在國際間較有名為回教屠宰（Muslim（Hala）slaughter）與猶太教屠宰（Jewish（Kosher）slaughter），其中一些回教地區的回教屠宰可以接受電擊致昏；而猶太教屠宰亦可以接受致昏，但必須是放血動作後。為防止牛隻放血後所產生的激烈動作，確保工作人員安全，使用上述宗教屠宰最需要注意到的是其保定設備，目前已有商品化產品可提供使用。

有關動物人道屠宰技術的演進，過去在台灣仍有豬肉外銷市場時，許多大型電動屠宰場因為國外市場要求，並無人道屠宰問題。然而內銷市場主要包括指定屠宰場或肉品市場附設屠宰場並未導入人道屠宰觀念，加上管理問題與缺乏學術支援等因素，小型屠宰線長期以來放血前未致昏或以棍棒敲擊代替致昏器致昏豬隻等問題，造成人道屠宰管理的困難。比較我國與英國，我國人道屠宰的執行，目前並無專法，而在英國則有一九九五年所頒布的動物（屠宰或殺死）福利法規，並隨著科學技術的演進提供許多輔助規定與建議，因此在制度管理面上，我國仍較之落後。在我國動物保護或動物福利相關規定仍未有進一步規定前，人道屠宰觀念的建立與人道屠宰技術推廣是邁向日後全面推行的重要步驟，目前也是產業調整人道屠宰策略時機的重要轉捩點。未來人道屠宰管理的成熟有待產業界的配合、政府的健全法規與強制要求、學術界堅強的技術與研究支援後盾。

為因應研討會的要求與近年我國羊隻屠宰場的設立，亦於研習中發表一篇有關動物福利相關口頭報告與書面報告："**Assess the restraint of goat/sheep before stunning, slaughter or killing as defined in the legislation and evaluate the available methods**"（評估法規所定義羊隻致昏、屠宰或殺死前之保定與可用之方法），主要內容係比較使用不同致昏器於羊隻之各種保定方法的利與弊，評估顯示，羊隻不論使用電擊或撞擊式致昏器，V 型致昏夾欄均是最佳選擇，另近年亦研發出雙軌輸送致昏欄（一九八八年經 Temple Grandin 博士改良為商業化產品）亦為不錯的選擇，此外，聯合國農糧組織亞太分部（FAO）與國際人道社會（HSI）亦針對亞太地區環境建議使用致昏箱（不具輸送功能）。

	致昏圍欄	V 型 致昏夾欄	致昏箱	雙軌輸送 致昏欄
穿透型撞擊式致昏器致昏法 （Captive bolt）	*	***	***	***
非穿透型撞擊式致昏法 （Concussion）	*	***	***	***
電擊式致昏法 （Electronarcosis）	*	***	**	***
槍擊法 （Free bullet）	**	*	*	*
電擊致死法 （Electrocution）	*	***	**	***

*** = 理想
** = 可接受
* = 效果不佳

致昏圍欄係將動物以圍欄固定其活動範圍，並使動物自然站立（如打獵）或於圍欄內以人力方式固定動物。鑒於動物使用致昏圍欄時，身體與頭部仍可任意移動，因此致昏或致死的準確率相對也就較為不佳。使用致昏圍欄致昏羊隻的優點不外乎因其方法簡陋便宜及適合打獵等經濟性與便利性，然而所造成的勞力增加與致昏或殺死的準確性卻是主要缺點。

使用 V 型致昏夾欄是目前使用撞擊式或電擊式致昏法最佳的保定方式，尤其當羊隻遭受電擊時，身體會隨之倒下，影響電擊的時間，造成電擊致昏無效或不完全致昏。因此，V 型致昏夾欄保定羊隻的優點在於支撐羊隻，

減少無效電擊或不完全致昏的情形發生，然出血點的產生與夾欄對腿部關節會產生壓力則為其缺點。為改善 V 型致昏夾欄的缺點，一九八八年 Temple Grandin 博士利用一九七七年 Geiger et al 與一九七六年 Westervelt et 所發明的雙軌輸送致昏欄原型機，改良其致昏通道設計並調整動物體型大小，設計出新型雙軌輸送致昏欄，解決了出血點的產生與夾欄對腿部關節產生壓力等問題，目前本致昏欄已完成商業化設計。

至於致昏箱，在使用撞擊式致昏法係不錯的保定方式，不僅可以降低致昏無效的機率，操作亦極其方便，唯一的缺點是本項保定方式是專為屠宰速率較低的屠宰場所設計，高速運作之屠宰場並不適用。

至於軟體管理方面，亦為重要的措施之一，屠宰場應自行依據相關動物福利法令與方案，例如，英國一九九五年動物（屠宰或殺死）福利法規、動物五大自由論與 Temple Grandin 博士所建立的動物福利原則，參考建立場內標準作業程序（Standard Operation Procedure, SOP）與自我管控措施，並加強員工教育訓練，俾便符合動物福利原則。

由於羊隻屠宰場的設立，在我國目前正方興未艾，提供最新人道屠宰技術訊息，對於產業界係一項相當重要的工作。為充實屠宰場對人道屠宰場的觀念與技術，應即刻加強對屠宰場的技術服務與輔導，而非於屠宰場設施設備都完成後，方進行改造或修正，徒增業者負擔。

家禽屠宰與加工

家禽福利

目前家禽福利的議題主要發生在農場，例如近年籠飼產蛋雞問題甚囂塵上，目前英國已經禁止籠飼產蛋雞。事實上，雞隻並不喜歡空曠的地方，根據研究觀察顯示，將雞隻置於空曠處，雞隻會往掩蔽的地方移動，例如，灌木叢等。因此，藉由動物保護團體的推廣及學界與業者的努力，目前已發展出禽籠外設置小通道，供作母雞站立用，禽籠內則供母雞下蛋與休息。至於因為家禽福利未落實亦會造成嚴重的經濟損失，例如死亡、腳力衰弱、接觸性皮膚炎等。

家禽人道屠宰

在家禽人道屠宰議題方面，目前亦為該校研究重點之一，舉凡家禽之收集、運輸、繫留、吊掛、致昏技術剖析、人道屠宰管理均是。在英國，部分家禽的運輸時間相當的長，部分家禽難免受禽籠所堆疊位置的不佳而飽受緊迫，有關運輸車輛的設計及通風與溫度控制的考量便成為研討會中的重點項目。另家禽人道屠宰最重要的一環係位於吊掛區，根據研究顯示，

吊掛區使用藍光可以大幅減少雞隻不穩定之狀況；此外，工作人員的訓練亦相當重要，尤其前電擊效應（導致翅尖出血點）、腿骨斷裂與裂傷等等，常為吊掛不當所造成。至於致昏亦為人道屠宰重點之一，在英國，家禽的致昏判定係以呼吸現象為判定標準之一，由於家禽電擊致昏器係採直流電過水型設備（為並聯式供電），通過家禽的電流大小隨著家禽本身的導電度或電阻有些許差別，目前相關研究正在進行與改善中。

農場家禽的收集，目前主要分為人工收集與機器收集，其中人工收集最容易造成緊迫，尤其工作人員的心理狀態更是主要原因，至於機器收集因為可以減少人的接觸及家禽的緊張與緊迫，因此是較為被建議使用的。一般而言，收集操作所造成傷害，包括裂傷、骨頭斷裂、脫臼與死亡等。機器收集係將橡膠指頭安裝於收集車的滾輪上，藉由滾輪的轉動將家禽收集至禽籠內，但此類機器收集車以於大規模農場運作為最適當。至於人工收集，若收集時只抓住一隻腳時，家禽特別容易振翅並有想逃離的行為，此時最容易造成傷害，所以在收集時務必保持家禽處於安靜狀況，並應於收集時同時抓住雙腳，減少緊迫。

一般而言，因為運輸過程中，限飼、限水、溫度與溼度等因子往往會影響到家禽的生理與心理，故會產生一定的緊迫，如何減少緊迫便成為研究的重點，尤其是運輸車的設計，當考量空氣動力學，發現雞籠所在位置所受的溫度與風速係有極大的差異，也直接影響到家禽所受緊迫的程度。例如，運輸車行走時，會從運輸車後被動地撩起一陣風，使運輸車後的家禽感受較強的風速，甚至因為風速的增加而降低該位置的溫度，至於位於運輸車前方的位置因通風不佳，反而容易造成溫度過高的現象。另家禽在繫留場時亦應注意噴水作業，以降低溫度。

工作人員的訓練、吊掛速度與暗室藍光的提供對於家禽的吊掛有重要的影響。有關翅尖出血點、腿骨斷裂、脫臼與裂傷等等，常為吊掛不當或吊掛速度太快所造成。此外，根據研究顯示，吊掛區應以暗室處理並提供藍光，其對於穩定家禽的心理狀況具有不錯的效果。

目前家禽致昏係以採直流電電擊的過水型設備（為並聯式供電），通過家禽的電流大小隨著家禽本身的導電度或電阻有些許差別，因此容易產生部分家禽通過電流過高，部分家禽則因電流不足，造成無效致昏，目前相關研究正在進行與改善中。根據英國的建議，通過雞隻電流的大小應為 0.105 安培以上，鴨與鵝則為 0.13 安培以上。此外，根據研究，直流電電擊的有效性與電擊波的波型亦有相關性。至於氣體致昏（殺死）家禽，為近年歐洲所推廣的另一項選擇，主要係以氬氣或二氧化碳為主要混合氣

體，經由呼吸系統，導致家禽昏厥或死亡。根據英國一九九五年動物（屠宰或殺死）福利法規，可以使用的混合氣體性氣體與濃度分別為 1）2% 氧氣+90% 氬氣+空氣；2）25-30% 二氧化碳+60% 氬氣+空氣。

有關家禽的有效致昏判定，根據英國農場係由來自環境、食品及城鄉事務部(DEFRA)對屠宰工作人員發照與訓練的指導要點（Guidance Note on the Licensing and Training of Slaughtermen）所述：

1. 使用電擊式致昏器，達前期癲癇時，家禽會出現以下現象：
   1）頸部彎屈伴隨頭部成垂直下垂。
   2）眼睛張開。
   3）翅膀舉起靠近身體。
   4）腿部僵直性伸直與身體持續性快速顫抖
2. 前期癲癇持續時間相當地短，當引起心臟停止時，家禽會出現以下現象：
   1）屠體完全鬆垮。
   2）沒有呼吸。
   3）沒有眼瞼反射。
   4）瞳孔放大。

以上述指導要點並無法律強制性，僅供參考建議用，一般現場大抵會以呼吸現象為主要判斷標準。目前我國針對家禽有效致昏並無判斷標準。由於目前家禽致昏狀況的腦波圖仍未有相關研究報告報導，主要是因為不易判別，當致昏時測量其腦波會出現以下四點反應：1）當鳥類致昏時，並無癲癇階段，也無安靜階段；2）高頻多起伏活動；3）低頻多起伏活動，無安靜階段；4）低頻多起伏活動，出現安靜階段。因此，有關家禽有效致昏的科學證據仍待進一步的研究與發展。

放血的訓練在家禽也是相當重要的，雖然目前家禽大多以電動屠宰線操作，但是一旦屠宰線緊急停止運作，許多剛受電擊的家禽是必須立即施以人工放血。至於放血位置，根據研究報告顯示，雞隻心臟停止至腦部失去反應的時間為 90 秒；斷頭至腦部失去反應的時間為 136 秒；切斷兩條頸動脈至腦部失去反應的時間為 163 秒；切斷頸動脈與頸靜脈各一條至腦部失去反應的時間為 302 秒；切斷兩條頸靜脈至腦部失去反應的時間為 332 秒；切斷一條頸靜脈至腦部失去反應的時間為 349 秒。由於頸動脈的位置較深層，所以為確保人道屠宰，避免雞隻未完成放血即甦醒，因此工作人員的放血熟練度相當重要。

目前我國家禽屠宰場係以電動屠宰為主，所使用的機械設備大多來自國外知名廠商，在致昏方面都使用過水型直流電電擊方法，只要經常維修並經過適當調校，都能符合國際間人道屠宰原則。至於吊掛與放血則大多

涉及員工訓練問題，家禽屠宰場應自行訓練與管理，鑒於不良的吊掛與放血不僅不符合人道屠宰，亦會造成屠體品質的下降，屠宰場為求成本與利潤，亦應關心良好的吊掛操作。至於吊掛環境，過去並未特別要求，屬設施等硬體部分，如吊掛區應以暗室處理並提供藍光，主要改善重點係在於穩定家禽的心理狀況，俾便減少環境對家禽影響或刺激。

參訪報告

本次研討會中，亦參觀牛隻屠宰場與家禽屠宰場各一家，此外亦利用假日時間自行前往牛津坊間傳統市場了解市售肉品環境。

Southern Countries Fresh Foods（牛隻屠宰場）

在參訪牛隻屠宰場時，發現該場人道屠宰方面之設計係採 Temple Grandin 博士所建議之設計，繫留欄並設有二十四小時監視器，藉以管控牛隻繫留與趨趕之情形。除上述人道屠宰設計外，亦發現該場相當注重工作人員的安全維護與食品安全。凡是需要持刀的員工，包括屠宰衛生檢查員，都必須帶上不鏽鋼網防護手套；刀柄亦有隨著切割部位而有顏色之區分。此等防護與食品安全的考量，相當值得我國參考。另外，該場使用高電壓電擊刺激技術（High Voltage Electrical Stimulation, H.V.E.S., 1000 伏特/分鐘）於牛隻屠體，藉以加速肌肉僵直、防止屠體失水與加速預冷時間，對於牛隻的屠體品質的改善與維持具有不錯的效果與正面的效益，目前可用於豬、牛、羊等家畜屠體。高電壓電擊刺激技術台灣目前仍未引進，而本屠宰場在英國亦是少數使用本項先進設備的公司之一。

本場係採危害分析重要管制點（Hazard Analytic Critical Control Point, HACCP）管控，並設有標語提醒工作人員隨時注意採取正確的作業方式。

Webbs Country Foods（雞隻屠宰場）

參觀雞隻屠宰場時發現，有關雞隻吊掛、電昏及放血均考量到動物福利，尤其吊掛區燈光環境及吊掛不良常引起腿骨斷裂、裂傷及前電擊效應（導致翅尖出血點）等屠體品質下降，故吊掛人員均經肉品技術員或屠宰場經理的訓練與指導。至於家禽人道屠宰的管理最令人印象深刻的還包括，當屠宰作業因故停止，放血人員必須立即以最快的速度將剛電昏但未放血的雞隻立即施以人工放血作業。此外，參訪屠宰場時發現，其進出管制嚴格，必須紀錄參訪人員健康狀況並嚴禁訪客拍照或攜帶相機、錄音機等措施，令人印象深刻。過去，在指定屠宰場屠宰時期，我國屠宰場之人

員進出管制並不嚴格，閒雜人等的進出造成許多負面影響，食品衛生安全問題亦備受疑慮。未來我國屠宰場亦應嚴格管制進出，不僅可以防止閒雜人等進入屠宰場滋事鬧場亦可以防止動物防疫方面之漏洞，對於畜禽屠宰管理更能有效地強化並維護消費者食肉衛生安全。

Meat shop, Covered Market（傳統市場）

為了解英國傳統市場市售肉品環境，於十一月廿三日（六）利用參訪牛津的時間，自行前往 Covered Market 觀察了解，該市場約有五至六間肉攤，肉品除非強制性檢查部分外，均以真空包裹，並於店內拆封分切銷售，店內販肉櫃用於儲存分切好的鮮肉，所觀察的肉攤其販肉櫃均未見冷藏設備，另亦可發現肉品裸露隨處吊掛於店內或門口。比較台灣，一般台灣傳統市場肉攤並無販肉櫃，且光照環境不佳，內臟隨處吊掛等等，有待省思。

肆、建議

藉由研習及參訪之心得，謹提出建議如下：

一、由於人道屠宰為新進議題，國內相較於英國方面的研究報告，在國際期刊上並不多見，英國無論在動物福利方面的探討及人道屠宰技術方面的科學性研究均具有豐富的資源，尤其針對動物福利所舉辦的課程，更是結合政府機關、業界與大學等研究單位，相當值得我國仿效。由於國內對於動物福利觀念（尤其人道屠宰）並未如英國等國普及，因此在推動上常受制於資訊之不足與動物保護團體之責難，未來我國若能經常舉辦動物福利教育訓練並成立技術服務團提供人道屠宰技術等相關資源，相信將可有效提升我國人道屠宰觀念與技術。

二、目前有關動物保護方面的法規仍未健全，使人道屠宰的推動工作陷入膠著，此外，學術或研究單位所提供的資源亦極其有限，建議上級單位儘早規劃人道屠宰相關措施與建議，俾便管理並免除動物保護團體之責難，以提昇產業形象。

三、日後如我國財政許可，宜積極派員參與英國人道屠宰研討會或類似其他國際性討論活動，而簡任、薦任主管或具潛能之同仁均應鼓勵赴會以為開擴視界與觀摩比較。

四、宜加強國內屠宰場門禁管制措施，避免閒雜人等進入屠宰場滋事鬧場亦可以防止動物防疫方面之漏洞，對於畜禽屠宰管理更能有效地強化並維護消費者食肉衛生安全。

伍、誌謝

感謝本局李前局長金龍、江局長益男與各級長官保舉推薦，以及肉品檢查組裡的長官及同仁於本人出國的這段期間，分擔的該辦的業務及戮力協助原經辦業務的持續推動，特別是本組各位同仁的鼎力協助。

陸、附錄

攜回人道屠宰暨家禽屠宰加工等相關議題研討會教育訓練用講義、資料及相關參考網站網址，內容名稱詳如下列：

1. Assess the restraint of goat/sheep before stunning, slaughter or killing as defined in the legislation and evaluate the available methods（評估法規所定義羊隻致昏、屠宰或殺死前之保定與可用之方法）：研討會書面報告。
2. Animal Welfare Officer (AWO) Training Course, Animal Welfare Training, University of Bristol.
3. Poultry Welfare Officer (PWO) Training Course, Animal Welfare Training, University of Bristol.
4. The Welfare of Animals (Slaughter or Killing) Regulation, 1995, 英國一九九五年動物（屠宰或殺死）福利法規：http://www.legislation.hmso.gov.uk/si/si1995/Uksi_19950731_en_1.htm
5. Meat and Meat Hygiene, 英國食品安全局 (Food Standards Agency)：http://www.food.gov.uk/foodindustry/meat/
6. Guidance Note on the Licensing and Training of Slaughtermen, 英國環境、食品及城鄉事務部 (DEFRA)：http://www.defra.gov.uk/animalh/welfare/farmed/slaughter/guidance.htm
7. Dr. Temple Grandin's Web Page：http://www.grandin.com/index.html
8. Guidelines for Humane Handling, Transport and Slaughter of Livestock, 聯合國農糧組織亞洲暨太平洋分部（RAP, FAO）：http://www.fao.org/DOCREP/003/X6909E/x6909e00.htm#Contents

MSc Meat Science

Animal Welfare Module

Assess the restraint of goat/sheep before stunning, slaughter or killing as defined in the legislation and evaluate the available methods

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2002/11/29

Contents

Introduction

The policy of animal industry in Taiwan had been under a revolution after outbreak of the first case of FMD, Foot-and-Mouth Disease, in 1997, the government had to reform their management systems on the industry. Abattoirs for Livestock, including pigs, cattle, goat or other livestock or poultry soon became targets to govern centrally. The abattoirs for goats or sheep should meet the Establishment Standards for Slaughterhouse, ESS, and the Requirements for Slaughter Operation, RSO, in Taiwan presented in Animal Industry Act, AIA.

As we know, abattoir is always the most important point to ensure hygiene and safety of meat or poultry meat. In UK, United Kingdom, or Other countries, especially, the European countries, abattoir is also a part of critical points for animal welfare. In Taiwan, some standards and requirements for animal welfare in abattoir have been mentioned on ESS and RSO.

The goat meat is very popular in Taiwan and other countries in Asia recently. More and more farmers are interested in raising goats as their careers in Taiwan for dual utilization, dairy and meat, but they face problems, abattoir establishment and slaughter operation, especially to meet the animal welfare. Nowadays, the restrainers for goat are still not available in research, but for sheep. Are the restrainers for sheep suitable for goat? We need to evaluate and compare the available methods of restraint both for sheep and goat to meet the legislation and animal welfare for the industry not offending the law or being blamed as inhumane. As the legislation of UK about animal welfare is the most considerate and developed in the world, herein, we will take it as definition for an example to assess the restraint before stunning, slaughter or killing.

In this essay, it will divide two parts to discuss. The first one is hardware, the restraint facilities, by taking stunning methods as bases to evaluate the restrainers, meet to the legislation of UK, if ideal or not. For example, the V restraint conveyor for sheep or goat, meets to the legislation of UK, is suitable whilst using electronarcosis. The second one is software, the restraint notes, by offering guidelines for industry to settle standard operation procedures to meet the legislation.

Restraint facilities

There are various restrainers designed for holding animals before stunning, slaughter or killing, such as stunning pen (fence), V restraint conveyor, Stunning box and Double rail conveyor restraine, etc. They should be evaluated to make sure which are suitable for the restraint of sheep and goat to meet the legislation and animal welfare by the factors of animal species, animal behaviour, stunning methods, and other issues of animal welfare or operation by stockmen.

As Garndin (1994) said, improvements in the design of restraining devices will enhance animal welfare and reduce stress and injuries. The needs of restraint of animal should be stressed on the issues of giving animal effective stunning or killing, reducing stress and injuries, and the safety of operators.

Legislation

According to The Welfare of Animals (Slaughter or Killing) Regulations 1995 – WASK Reg. 1995, "...No person shall stun, slaughter or kill, or cause or permit to be stunned, slaughtered or killed, any animal without restraining it in an appropriate manner in such a way as to spare it any avoidable pain, suffering, agitation, injury or contusions."

What is the interpretation of restraint in WASK Reg. 1995? Does "the wire fence surrounding a field in which a deer is shoot" constitute the restraint of that animal? The use stunning pens to enable manual stunning of freestanding animals would therefore, qualify as appropriate restraint. All the legislation requires clarification and that is provided by MAFF in Code of Practice. Ultimately, until legislation is tested in a Court of Law, interpretation must rely on O.V.S.

Behaviours

The behaviours of sheep and goat are similar but get little different by their species, human contact and environments. Such as the utilization of animals may affect their behaviours. Generally, they have a well-defined flight zone, good eyesight and will go for any opening. Meanwhile, they have acute hearing and gentle noise is useful to help them move but loud sound will stress them. Furthermore, they have very strong flocking instinct and move easily as a group.

Facilities

According to the discussions of needs of restraint, legislation and behaviours of seep and goat above, we make four examples of common restraint methods to evaluate if they were suitable to use different methods of stunning as followings and discuss their advantage and disadvantage for restraint of sheep and goat.

Evaluation

	Stunning Pen (fence)	V Restraint Conveyor	Stunning box	Double rail conveyor restrainer
Captive bolt	*	***	***	***
Concussion	*	***	***	***
Electronarcosis	*	***	**	***
Free bullet	**	*	*	*
Electrocution	*	***	**	***

*** = Ideally

** = Acceptable

* = Poor

Whilst stunning applied on sheep or goat by captive bolt or concussion using mechanical methods, restrainers, such as V Restraint Conveyor, Stunning box and Double rail conveyor restrainer, would be the ideal facilities for operating accurately on the site of stunning position. According to WASK Reg. 1995, head fasten is only allowed on adult bovine animal to enable it to be stunned without the infliction of avoidable excitement, pain or suffering.

V restraint conveyor is much more successful, whilst sheep stunning applied by electrical means, such as electronarcosis or electrocution. Sheep have a "fleece cushion" that enables them to ride the V restraint conveyors without stress. Also, Sheep have a strong flocking instinct that provided other sheep are present, will result in them following each other into the conveyor. Restraint is essential when head-to-back stunning/killing system is employed, as the animal will fall away from the electrodes if they are unsupported.

According to Thornton et al. (1979) and Lambooy (1986), standard V restraint conveyors may cause petechial haemorrhages during electrical stunning. For the occurrences of blood splash and pressure on leg joint, Researchers at the University of Connecticut developed a laboratory prototype double rail restrainer for calves and

sheep (Geiger et al 1977, and Westervelt et al 1976). They determined that it was a good low stress method for holding an animal. Grandin (1988) developed an improved entrance and animal size adjustment mechanism for this system and installed it in a commercial calf and sheep slaughter plant. With the double rail conveyor animals are supported under the brisket and belly while straddling the conveyor so that even large wild calves will ride quietly. The double rail requires less space than a V conveyor restrainer and it is compatible with existing shackling and bleeding systems.

Free bullet is also a method to stun animals and the stunning pen (fence) should be used while applied. For the direction of bullet depends on the operator, the safety of the operation procedure is very important. In Taiwan, free bullet is prohibited for the safe consideration by legislation.

Meanwhile, According to WASK Reg. 1995, the method of gas killing is only for pig and poultry. If it were possible use for sheep and goat, the stunning pen (fence) would be the ideal choice to restraint animals.

1. Stunning pen (fence)

Stunning pen is a field confined by fence for animal stunning or killing. The main point is that the animal should free standing. This restraint method can only use in hunting or manual restraint of animal by labour whilst using free bullet or captive bolt.

The advantages of this facility are as followings:

1) Cheaper.
2) Suitable for using free bullet.

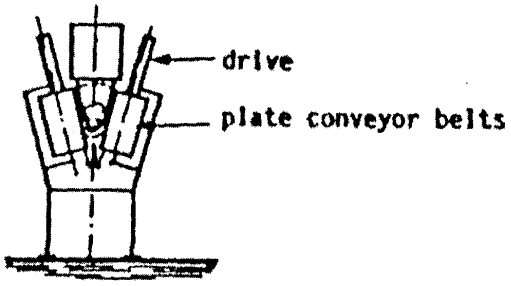
The disadvantages of this facility are as followings:

1) Labour increasing.
2) Misapplication of stunning or killing increasing.

Mechanical and electrical stunning systems require the physical application of devices to the animal's head or head and body. Effective mechanical stunning relies on the placement of the gun in a prescribed position that will ensure a concussion and also result in physical damage to a region of the mid-brain. Electrical stunning systems should be applied such the electrodes span the brain. Misapplication of electrodes will result in ineffective stunning and the potential

for compromising the welfare of the animal is high. Restraint, yolk, etc. are measures that should be taken if they improve the accuracy of the technique without, in themselves, compromising the welfare of the animal.

2. V restraint conveyor



For the last decades, large beef slaughter plants have been using the V restrainer system for restraining cattle during stunning and shackling. It was invented by Edwards (1972), Schmidt (1972) and Willems and Markey (1972). The V restrainer was a major humane and safety improvement over old style knocking boxes.

The advantages of this facility are as followings:

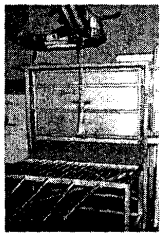
1) Support the animal whilst fall away from the electrodes.
2) Misapplication decreasing.

The disadvantages of this facility are as followings:

1) Blood splash.
2) Pressure on the leg joint.

For those disadvantages, the other facility, Double rail conveyor restrainer, had been developed later in1970s and modified in 1980s.

3. Stunning box



This device is recommended by FAO (RAP) and HIS whilst using restraint of sheep/goat.

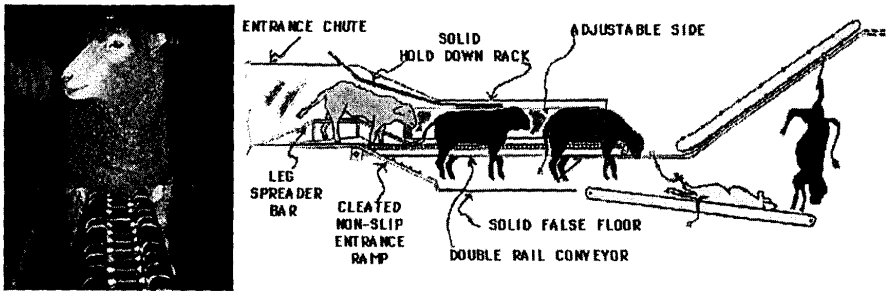
According to *Guidelines for Humane Handling, Transport and Slaughter of Livestock* published by FAO (RAP) Food and Agriculture Organization of the United Nations (Regional Office for Asia and the Pacific), and HSI, Humane Society International recommend, A properly constructed metal stunning box is appropriate as a restraint device.

The advantages of this facility are as followings:

1) Misapplication decreasing.
2) Operate easily.

This facility is always using whilst apply the captive bolt on the head of animals but electrical stunning. This device is special designed for low throughput abattoir, and sheep or goat can be restrained manually quite satisfactorily.

4. Double rail conveyor restrainer



For the problems with V restraint conveyor, animals would balk at the entrance and the stunner operator had to reach excessively to place the stunner in the animal's forehead. Researchers at the University of Connecticut developed a laboratory prototype double rail restrainer for calves and sheep (Geiger et al 1977, and Westervelt et al 1976). They determined that it was a good low stress method for holding an animal. Grandin (1988) developed an improved entrance and animal size adjustment mechanism for this system and installed it in a commercial calf and sheep slaughter plant.

A double rail (centre track) conveyor restrainer system was designed by the author is based on research by Geiger et al. (1977) and it is adjustable for a wide variety of animal sizes. Baby calves, sheep and large 225 kg calves can all be

handled in the same restrainer. As mention above, the double rail conveyor restrainer system also can be used for the restraint of goat after adjusting their size.

The advantages of this facility are as followings:

1) Support the animal whilst fall away from the electrodes.
2) Misapplication decreasing.
3) Reduce blood splash.
4) Prevent pressure on the leg joint.

Restraint notes

According to the observations by Grandin (1988) in more than 100 slaughter plants in the United States, she indicate that the attitude of management is the single most important factor that determines how animals are treated. Abattoirs with good animal welfare practices have a manager who acts as their conscience, but the abuses such as excessive prodding, dragging downed crippled animals, or running animals over the top of a downed animal, often occur when management is lax. In a few poorly managed abattoirs, up to 10% of the cattle must be shot more than once with a captive bolt to render them insensible. It is the responsibility of manager to enforce high standards of animal welfare.

Good managers take the time to improve livestock handling. But usually the perfect handling techniques can take several months of sustained effort, even there have been great improvements in equipment to handle and stun livestock in abattoirs. The advance of facilities has not been paralleled by similar advance in management.

As mention above, the standard operation of animal welfare should be settled on the abattoir, and the training is also important portion to teach operators in the abattoir the concepts of animal welfare. Hereby, the abattoir would not offend the legislation and be blamed as inhumane by public.

Legislation

According to The Welfare of Animals (Slaughter or Killing) Regulations 1995 – WASK Reg. 1995, "...No person shall tie, or cause or permit to be tied, the legs of any animal." "...No person shall suspend, or cause or permit to be suspended, any animal before stunning or killing." and "... The occupier of a slaughterhouse or knacker's yard and any person engaged in the stunning or killing of any animal shall ensure that any animal which is to be stunned or killed by mechanical or electrical means applied to the head is presented in such a position that the equipment can be applied and operated easily, accurately and for the appropriate time."

Under good restraint of animal, the electrical or mechanical stunner can be applied on the stunning position easily and accurately.

Notes

The five freedoms are useful references for managers, stockmen or operators to evaluate if their actions meet the animal welfare or not. By the way, it also provides to meet the legislation above.

The five freedoms are as followings. (FAWC 1979)

1. Freedom from thirst, hungry and malnutrition. By easy access to fresh water and a diet to maintain full health and vigour.
2. Freedom from discomfort. By providing an appropriate environment including shelter and a comfortable resting area.
3. Freedom from pain, injury and disease. By prevention or rapid diagnosis and treatment.
4. Freedom to express normal behaviour. By providing sufficient space, proper facilities and company of the animals own kind.
5. Freedom from fear and distress. By ensuring conditions and treatment which avoid mental suffering.

For low stress of restraint of animals, Grandin (1995) has developed for pig and cattle as following principles, some of which can help to evaluate procedures of operation if meet the animal welfare or not.

1. Solid sides or barriers around the cattle to prevent them from seeing people deep inside their flight zones. This is especially important for wild or excitable cattle.
2. To prevent lunging at the head gate, the bovine's view of an escape pathway must be blocked until it is fully restrained. This principle does not apply to pigs.
3. Provide non-slip flooring for all species of animals.
4. Slow steady motion of a restraint device is calming, while sudden jerky motion excite.
5. Use the concept of optimal pressure. Sufficient pressure must be applied to provide the feeling of restraint, but excessive pressure that causes pain or discomfort must be avoided.
6. The entrance of the restraint device must be well lighted, however, lamps must not glare into the eyes of approaching animals. All species must be able to see a place to go.
7. Livestock will remain calmer if they can see other animals within touching distance.
8. Engineer equipment to minimize noise. High-pitched noise is more disturbing to livestock than a low-pitched rumble.
9. Restraint devices must be designed to avoid uncomfortable pressure points on the animal's body.

10. Restrain livestock in an upright position.

The company or abattoir should take actions to schedule their program of animal welfare to settle the standard operation procedure (SOP), like the principles above by themselves to meet the requirement of animal welfare and legislation. Meanwhile, the training system is also important. The advance device should correspond to excellent operation.

Conclusion

The restraint methods of goat and sheep are similar, and depend on the animal behaviour, stunning methods, and other issues of animal welfare or operation by stockmen. The electrical stunning or killing is popular applied in sheep and the double rail conveyor restrainer is an ideal facility to meet animal welfare and the legislation. If using captive bolt, the double rail conveyor restrainer is also suitable to use. The double rail conveyor restrainer takes many advantages, such as Support the animal whilst fall away from the electrodes, Misapplication decreasing, Reduce blood splash and Prevent pressure on the leg joint, and it is worthy to expend the device to the industry.

Management is a very important factor in determining the restraint of animals if meet the animal welfare or not. The industry should take actions to settle the standard operation procedure (SOP) to meet animal welfare and the legislation. As saying, Good equipment provides the tool that make maintaining welfare easier, but such equipment is worthless unless good management is concurrent.

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Red & White Meat Welfare

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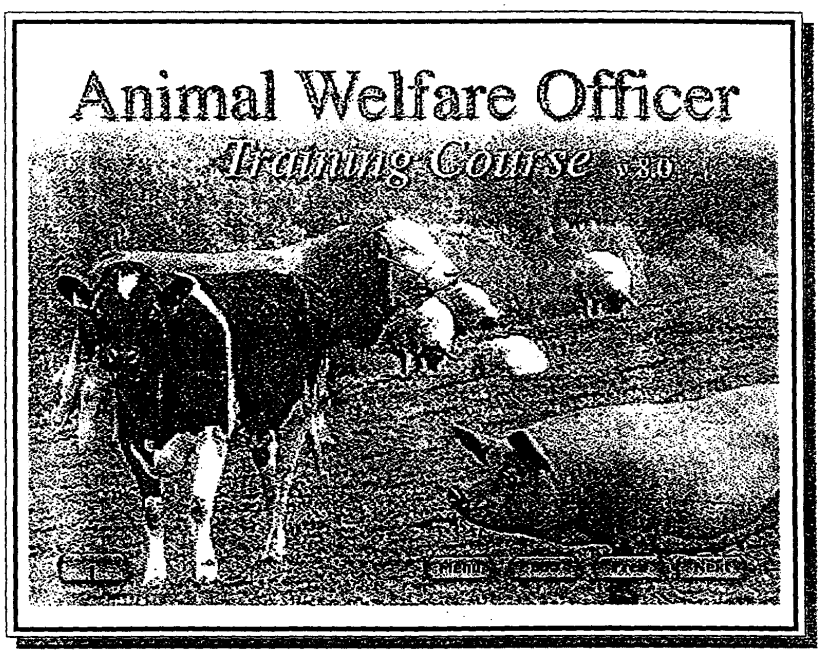

Notes

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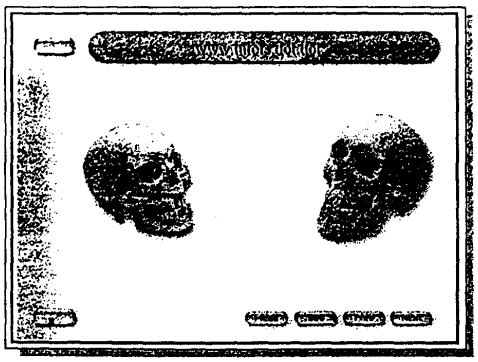

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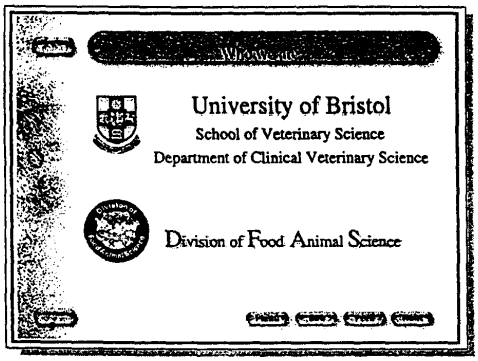
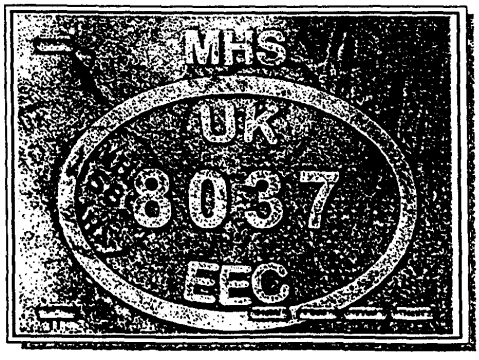


EEC licence



A unique facility amongst research groups in the UK is our EEC licensed red meat abattoir which allows many research programmes within the group to be developed and tested at a commercial level. It is used to demonstrate aspects of slaughter procedures to a wide audience including the veterinary science degree course run by the University.

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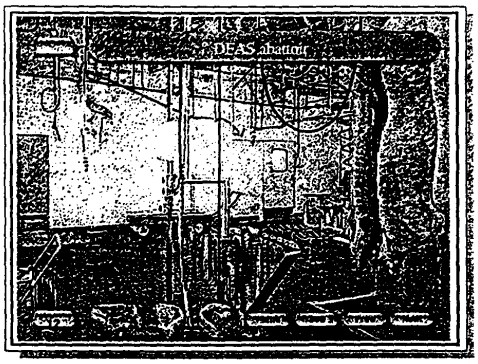
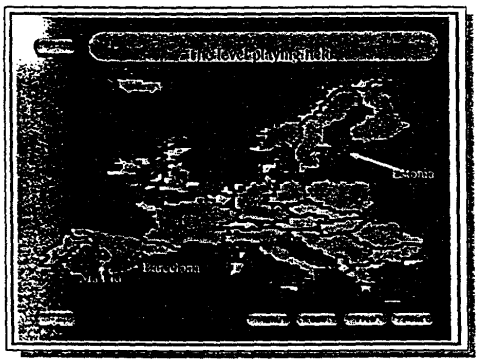
EEC licenced reasearch abattoir

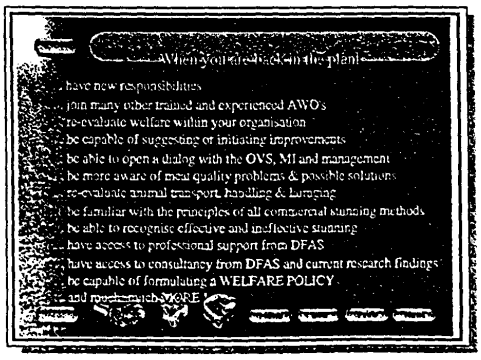


The abattoir was designed to enable slaughter of all three primary red meat species to be carried out. Annual slaughterings are small in commercial terms, depending primarily on experimental requirements for slaughter. Many collaborative projects with both research and industrial partners utilize the facility and the ability to control the slaughter operation is a valuable one. In conjunction with the taste panel expertise within the group the abattoir allows much work into eating quality of meat and meat products to be undertaken

The Level Playing Field



As part of the EU, the UK is leading the way for Animal Welfare legislation enforcement. Training on animal welfare has been received by over 1K delegates from the meat industry but very few Europeans have been trained on this or similar courses. Our long term objective is to train trainers from other countries to enable a level playing field in welfare knowledge and enforcement to take place. To date we have run courses in Estonia, Spain and at Langford for delegates from many European countries.



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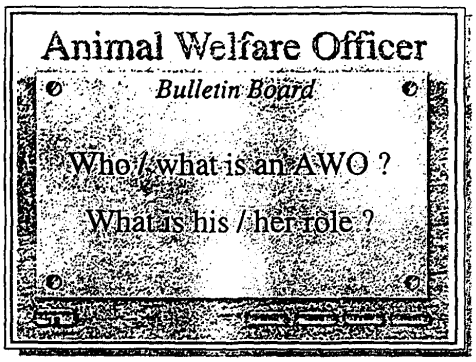
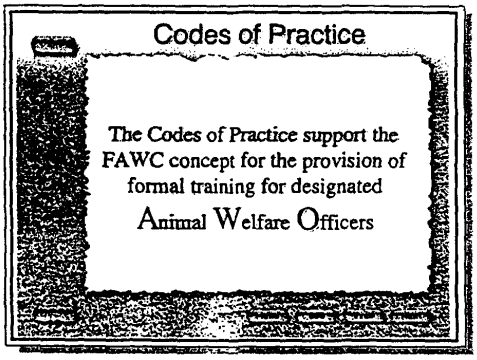
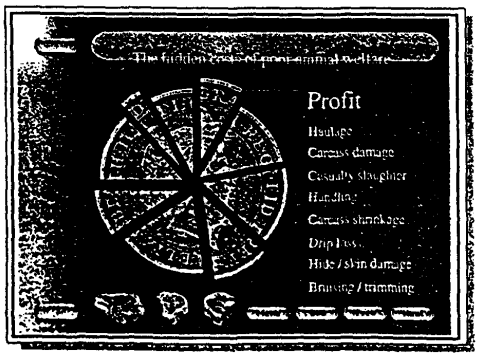
The Role of the AWO training course



From its inception, the aim has been the dissemination of relevant training material gained from research on animal welfare, experiences from industry and the views of welfare organisations to personnel within the Red Meat Industry. The AWO course, promoted through the Meat Training Council Excellence Network, has established itself within the Industry both as an effective Training package and a product of high quality.



The hidden costs of poor animal welfare



Poor welfare is invariably linked to poor quality in its widest sense. Therefore abattoirs that address the problems associated with maintaining a high degree of welfare both within their supply chain and within the plant will be rewarded by improvements in product quality. Such quality defects can have a major influence on overall profitability .

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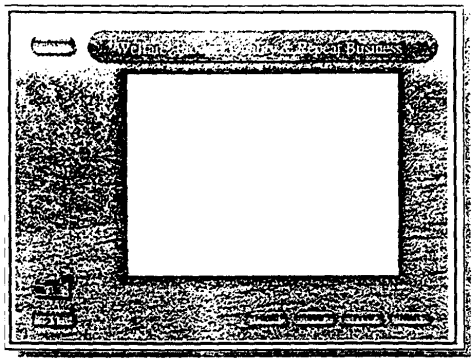
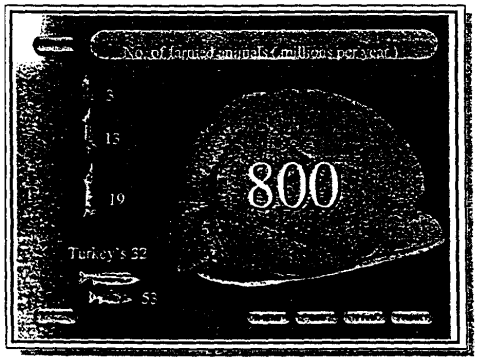
Welfare, product quality & repeat business



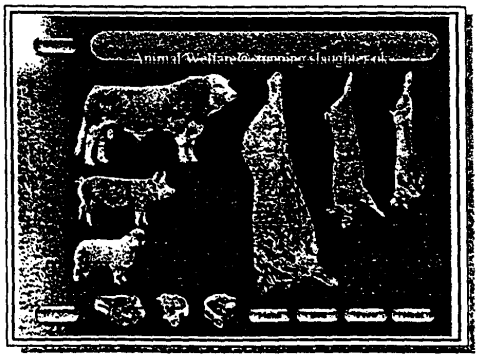
The link between animal welfare and resultant product quality has been well established in a wide range of handling practices involved in the transport, lairage and slaughtering operation. At all stages of the process, care and consideration are important. To maintain the economic viability of the operation there is a continuing need for repeat business and this is facilitated by maintenance of constant, high standards of product quality. The influence that individual operatives can have on the effectiveness of animal handling procedures should not be underestimated and the maintenance of high standards should be encouraged and rewarded

Number of farmed animals slaughtered / year in the UK



This LCD gives an indication of the size of the red meat slaughtering industry. The figures show approximate numbers of animals slaughtered per year. The numbers of cattle , sheep and pigs have remained almost constant for a number of years. In addition the LCD gives an indication of the scale of some competing meat industry products such as chicken, turkey and farmed fish. The absolute numbers involved are of course considerably greater but more importantly those numbers are increasing year on year. The future for the red meat industry must be linked to production of high quality products rather than simply high volume production of animal protein, which in the case of poultry meat is increasingly utilized in further processed products.

Animal.Welfare@stunning.slaughter.ok



The aim of the course is to consider the means by which the live animal is transformed into a saleable meat product with particular reference to consideration of live animal welfare and potential consequences for resultant quality.

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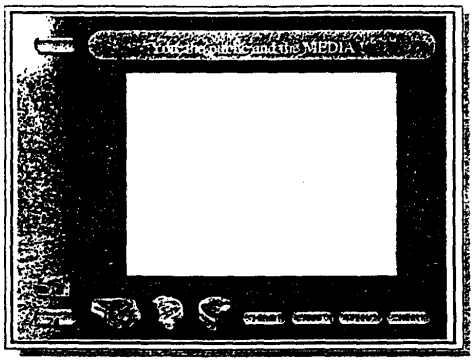
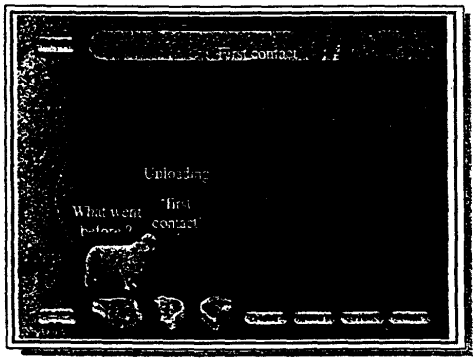
You, the public & the media



Public perception is an area of increasing importance, particularly following the expose type Channel 4 programmes that have affected the red meat industry. Your operatives should work in such a way that they could be filmed for Channel 4 and be happy with the result. If this is not the case, then improvements are required.

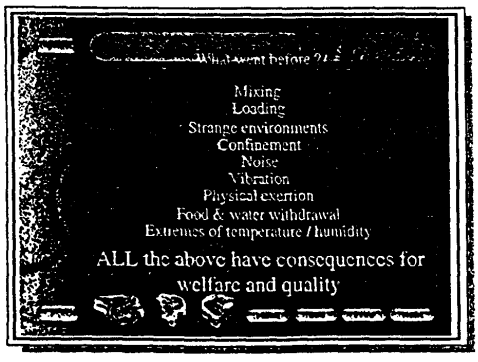
The important points to be made will have been discussed within the group session addressing this 'documentary'. An overriding message from all the previous discussion groups on this subject is that one should not attempt to defend the indefensible. Rather, one should emphasize the correct and positive practices which are established within your own plant with reference to company policy documents.

First contact



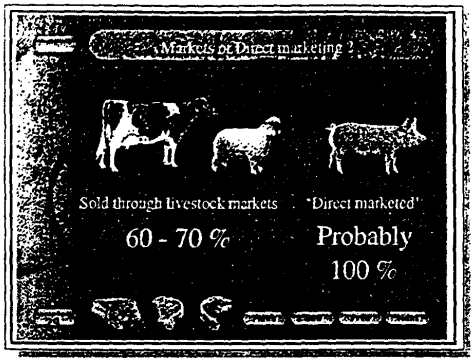
The production of a quality meat product is dependent on control of all aspects of the procedures involved in conversion of the live animal into the finished carcass. We have already emphasized the importance of good welfare strategies as a prerequisite for maintenance of good quality but for the purposes of this AWO course we cannot always exert control over all aspects of the process. First contact is invariably at the time that animals are unloaded into lairage and it is clear that poor practice prior to this first contact can have major consequences for both welfare and quality which you now have to deal with.

What went before ?



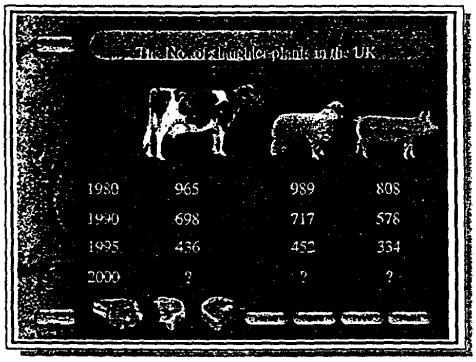
The practice of selecting animals for slaughter, and transfer to the abattoir exposes them to a wide range of physical, physiological and psychological stresses. Examples of some of these stresses are shown in the accompanying figure. The relative importance of these stresses varies between species and in relation to the conditions encountered during operations such as loading and transport. Importantly they may all affect both welfare and potential quality before your first contact.

Markets or direct marketing ?



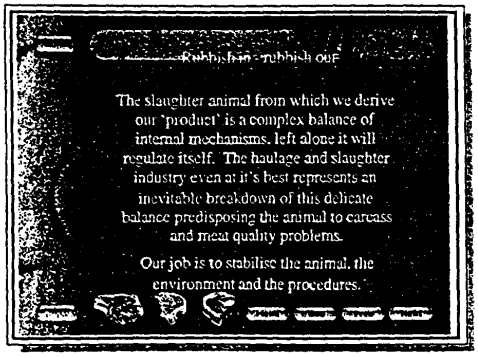
We have established that the sequence of events involved in marketing of animals for slaughter invariably subjects them to a wide range of stresses. Ideally the duration and severity of such stresses should be minimized to protect both welfare and meat quality. However, where animals are marketed via livestock markets potentially stressful operations such as loading and unloading are imposed more than once and indeed the overall social disruption and disturbance is amplified.

The number of slaughter plants in the UK



While annual slaughterings in the UK remain approximately constant the last two decades have seen a marked reduction in the number of licensed slaughter plants. This has the effect of concentrating the slaughter operation into bigger, higher throughput plants which are often associated with the imposition of higher operating stresses. In addition it is likely that animals will need to be transported greater distances.

Rubbish in . . rubbish out



It is important to recognise that poor management strategies employed at any stage of the marketing process will have a negative impact on both animal welfare and possibly product quality. To enable your plant to produce a quality product it is essential that the animal presented to the slaughter line is in the best possible condition since any deviation from this will be reflected in ultimate product quality. The maxim of 'rubbish in - rubbish out ' is a useful overriding view. You cannot produce a quality product if the quality of the raw material presented to you has already been compromised.

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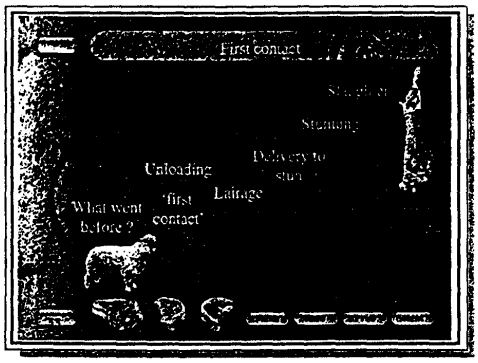
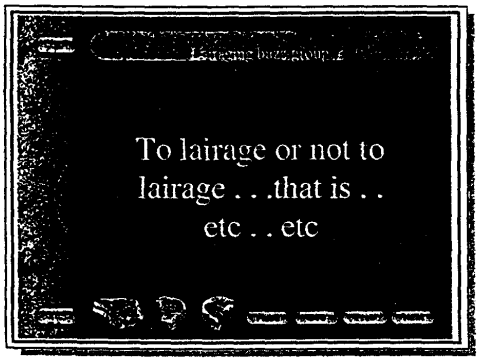
First contact



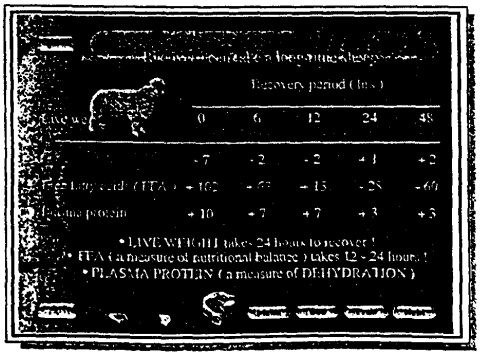
For the purpose of this Animal Welfare Training Officer course we have identified unloading of the animals at the entry to lairage as first contact with the raw material which you have to work with to produce your quality product. We have said that what went before can have a major bearing on the likelihood of producing a quality product because of the range of stresses to which animals are exposed. Arrival at the lairage does not necessarily have an immediate beneficial effect on the animals and indeed the way that we manage the handling of them through the lairage to the point of stun may maintain or even increase the stress levels experienced.

Lairaging ?



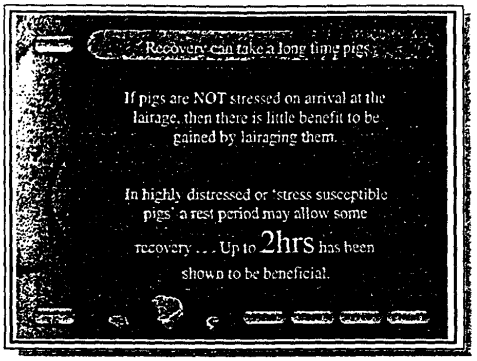
The aim of this discussion group is to consider the primary function of lairaging animals prior to slaughter. The lairage acts as a 'magazine' for the slaughter line to ensure a constant supply of animals, but do fixed periods of lairage provide any benefits to either the animals well-being or subsequent quality of the resulting carcass and lean meat ?
What are the important considerations when answering this question ?

Recovery can take a long time (sheep)



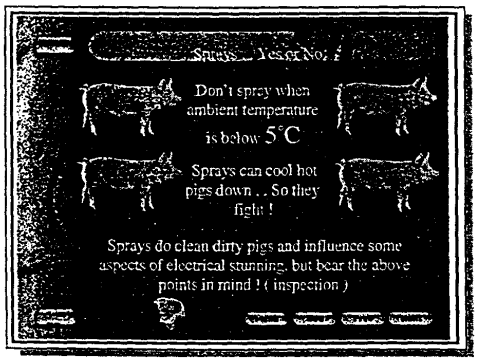
It is widely believed that a period of lairaging prior to slaughter is beneficial to the animal since it allows recovery from the stresses imposed during transport. However, recovery can take a very long time. An illustration of time taken for sheep to recover is given in this LCD. Liveweight is only recovered after 24 hr, while metabolic balance is only achieved after 12-24 hr. In the case of spring lambs the situation is much worse since they are commonly reluctant to feed or drink following transport.

Recovery can take a long time (pigs)



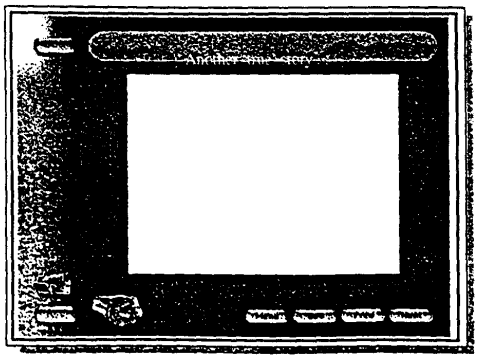
Pigs are particularly susceptible to the stresses incurred during the whole marketing process and where animals are slaughtered in a stressed condition severe meat quality problems can arise. These will be described in detail in the section of the course concerned with the mechanism by which muscle is converted to meat.
In general, if pigs are not stressed on arrival there is little benefit in holding them in lairage prior to slaughter and indeed there may be a disadvantage in terms of subsequent quality. However in practice the majority of pigs will have undergone a degree of stress and a rest period may be beneficial.

Sprays . . Yes or No



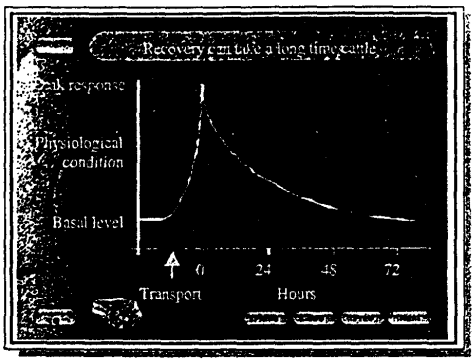
The use of water sprays in lairage has been advocated as a means of reducing fighting between pigs awaiting slaughter. Their use has an additional advantage in that they clean dirty pigs and thus reduce contamination being taken into the slaughterhall. They may also improve the effectiveness of electrical stunning. However sprays should not be used when the ambient temperature is below 5°C since they will cause hypothermia. In addition, recent findings suggest that where hot pigs arrive in lairage, sprays may cool the animals and facilitate fighting between individuals.

Another true story



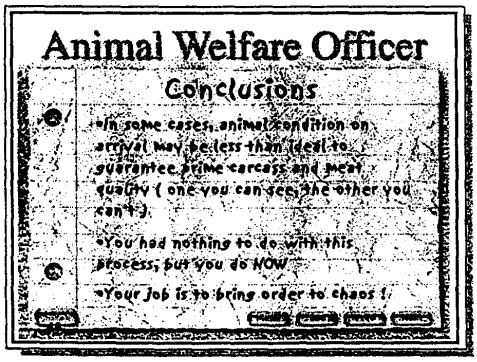
This video gives a graphic illustration of the nature of the " what you have to deal with" scenario and emphasises the difficulty of imposing fixed periods of lairage designed to promote recovery of the animals prior to slaughter. This is an example of how not to load cattle ! Almost everything about the strategies employed is wrong. The animals involved were in fact young bulls which had been mixed prior to loading, an action which triggered major fighting and mounting activities. This would necessarily have made the animals much more difficult to handle with major consequences for subsequent meat quality.

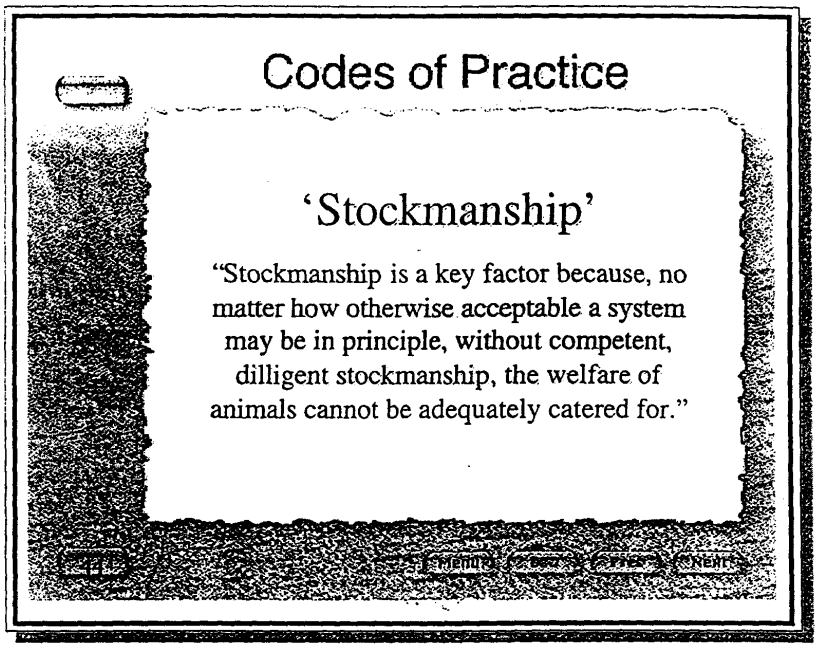
Recovery can take a long time (cattle)



It is widely believed that a period of lairaging prior to slaughter is beneficial to the animal since it allows recovery from the stresses imposed during transport. However, recovery can take a very long time. An illustration of the time taken for cattle to recover is given in this schematic LCD. The take home message is that whatever index of metabolic stress one uses to assess animal condition, recovery following an extended period of transport or other chronic stress can take a long time.

If animals have experienced severe, chronic stresses prior to arrival at the abattoir as we saw in the previous video, meat quality problems are likely to result whatever measures are possible in lairage and indeed returning such animals may be an option.

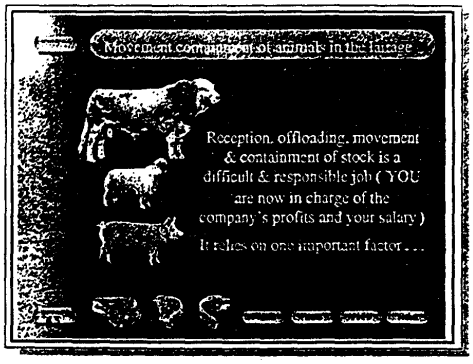




Notes

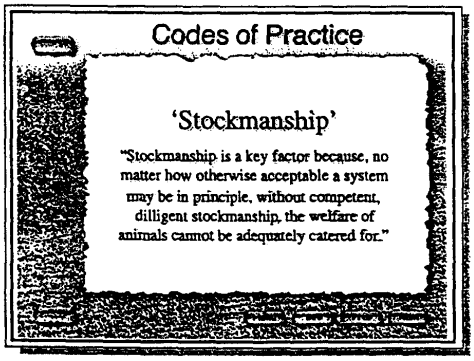
A well designed lairage equipped with level unloading facilities and structures appropriate to the species being slaughtered can facilitate passage and movement of animals to the point of slaughter . However the most important factor in ensuring a calm, smooth operation of the lairage is the stockmanship practiced by the operatives. Good stockmanship can often compensate for poor design and indeed the advantages conferred by good design can be negated by poor stockmanship. The importance of good stockmanship has been recognised in the Codes of Practice.

Movement / containment of animals in the lairage



We have established that a prerequisite to the production of a quality product is delivery of the animal to the point of slaughter in the best condition possible. Management strategies employed within the lairage in the immediate pre slaughter period can have a major bearing on animal condition and subsequent carcass and meat quality. It is important that consideration is given to both the design and operation of lairages to optimise holding conditions and ensure delivery to the point of stun is achieved with the minimum of difficulty.

Code of practice (stockmanship)



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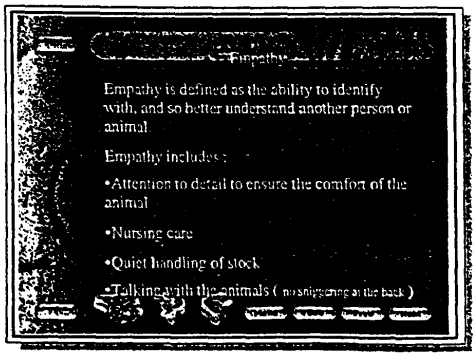
Empathy



An essential element to good stockmanship is empathy between the lairage operative and the animals being handled. It is clear that individuals vary widely in their ability to manage stock and the best operatives are able to carry out their job with the minimum of disturbance and stress. Conversely, others should not be allowed to work with live animals because they have no natural empathy with them. One approach adopted by a number of plants is to employ only women in the lairage since it is thought that their overall approach to handling animals results in significantly reduced levels of stress.

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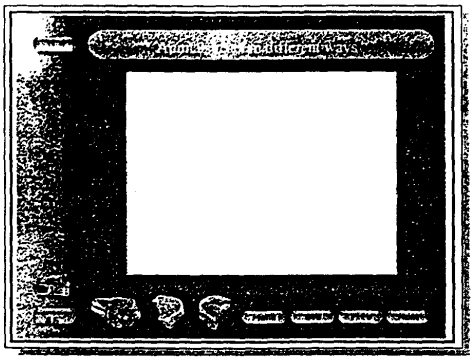
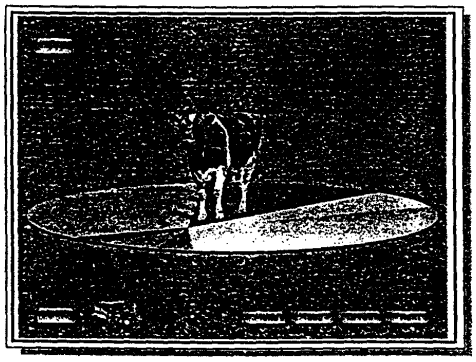
Animals react in different ways



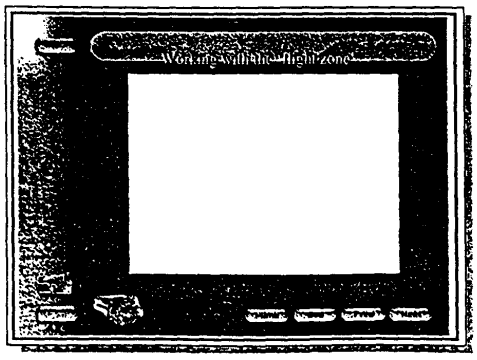
A natural empathy with the animals being handled is the basis for the development of sympathetic handling strategies. It is obvious that the different species react to similar situations in totally different ways. We need to be aware of the differences and understand the basis for them since effective movement of animals through the slaughter system is best achieved by utilising their natural behaviour patterns and modifying their responses to working situations.

The visual field of cattle



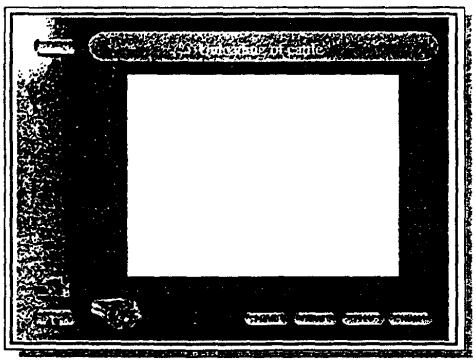
The flight zone is the 'personal space' that an animal will try to maintain. A knowledge of this can be useful in moving and turning animals. Different types of cattle will have different flight zones- a dairy cow may allow complete approach. Cattle have almost all-round vision. They see best directly in front but have poor depth perception and will baulk at anything which presents a strong contrast. They will jump at loud noise but can be encouraged to move with gentle noise. They have a good sense of smell and will investigate the new and unusual with their noses. Cattle will try to remain as a group and this can be used when moving them. Don't try to move too many at once. Cattle are bigger and stronger than you. Use your knowledge of their behaviour to move them steadily and calmly.

Working with the flight zone



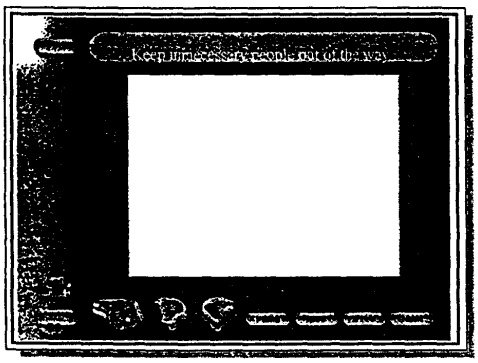
Practical use of the flight zone principle is demonstrated by the calm manner in which this animal is not only moved forward but is controlled in terms of distance and direction In the lairage cattle can be moved along raceways using the principles of fight zone and the point of balance

Unloading of cattle



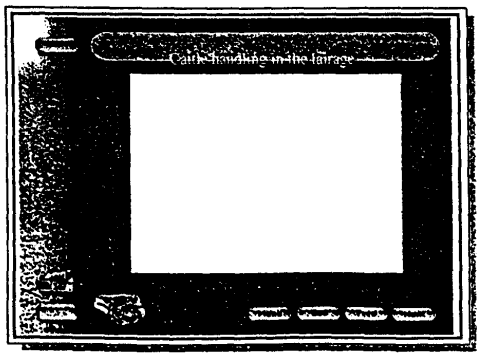
Unloading of cattle is an important aspect of the lairage operation which can often frighten and provoke panic reactions in the animals leading to stress and the possibility of injury to both the animal and the operatives. They are unsure on unsteady surfaces and it is important that the unloading ramp is well secured to prevent 'bouncing' since this can lead to animals leaping from the lorry increasing the likelihood of slipping and injury. The unloading area should be well lit to minimise shadows including the ground area underneath the ramp.

Keep unnecessary people out of the way



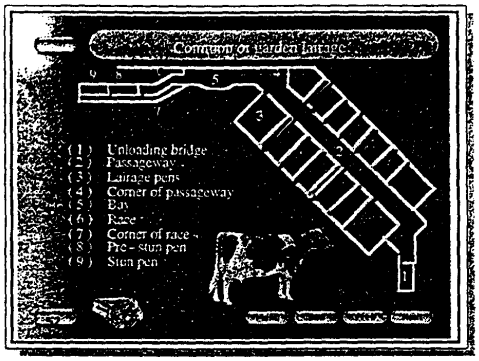
Having achieved a safe and largely stress free unloading of cattle from the lorry cattle need to be moved into the confines of the lairage pens. An overriding principle is that once the animals have been encouraged to move towards the pens their movement should be largely unrestricted. This makes the operation easier for both the cattle and the operatives. For all species this is best achieved by keeping unnecessary people out of the way. Establish routes of passage through the plant which ensure that human interference cannot restrict forward movement of the animals.

Cattle handling in the lairage



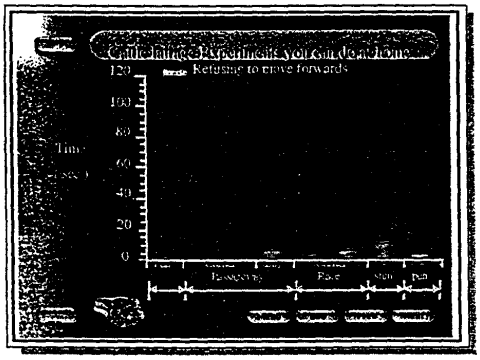
It is obvious that persuasion is a better mechanism than force when it comes to moving large animals through our lairages. Trying to force or hurry movement will result in the animals becoming distressed and in some circumstances even more difficult to handle. If animals pause for instances, avoid the temptation to rush them. If animals consistently baulk at the same place examine the spot for the presence of hoses, drains or metal gratings and if present take appropriate action. The use of sticks may be useful to make yourself look bigger to the animal but should not be used to hit the animal except in emergency.

Lairage showing cattle holding facilities



This LCD illustrates a typical UK lairage designed to hold adult cattle. Its usefulness is that it allows you to identify particular features of the overall design in terms of their effect on facilitating movement of animals through the system to the point of slaughter with the minimum of imposed stress. Observation of the lairage in use allows you to identify problem areas and features which impede animal movement.

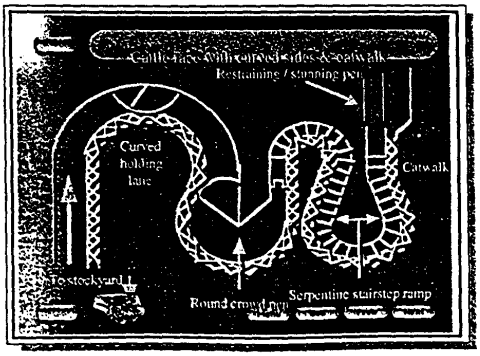
Time spent by cattle at each location of the handling facilities



In this example a researcher has monitored the passage of cattle through the lairage and noted the points at which animals were seen to baulk. The points at which cattle became most difficult to move in this system were at the entrance to the stunner race and at the entrances to the pre-stun and stun pens.

Where do most problems arise within your system? Can they be changed and improved? This approach allows you to inspect potential problem areas.

Cattle race with curved sides and catwalk

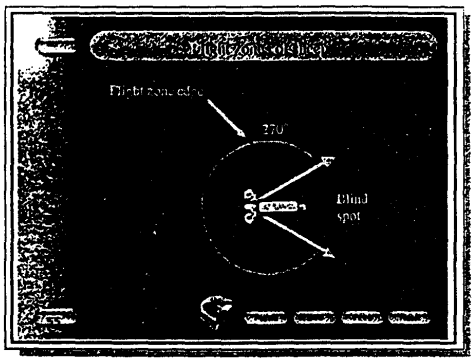


This cattle race uses many aspects of cattle behaviour to ease handling. The cattle can move side-by-side to the crowd pen. The gentle curve encourages following and the high solid sides of the race focus the animals forward.

The raised catwalk allows the handler to move quickly behind cattle that are slow and often his presence is enough to move them on.

Within the single file stunner raceway where cattle are more likely to stop there is a stair-stepped gradient to encourage forward movement.

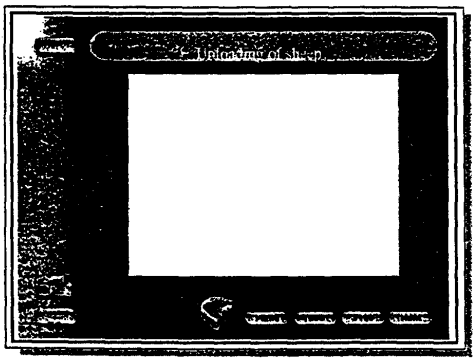
The visual field of sheep



Sheep should be the easiest animals to move. They have a well defined flight zone, good eyesight and will go for any opening. If the way ahead is clear and well lit they will move. They have acute hearing and gentle noise is useful to help them move but loud noise will stress them. They have a very strong flocking instinct and move easily as a group, the last thing any sheep wants, is to be left alone. However, if frightened, sheep may become stubborn and turn and stand their ground.

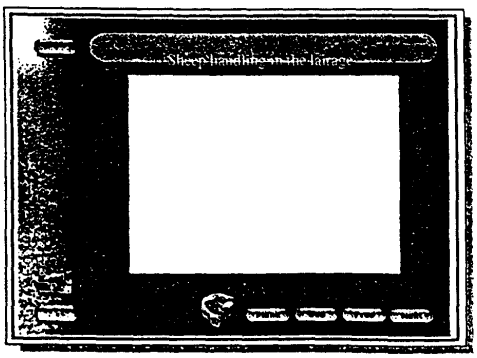
Do not hold them by their fleece. If you have to handle them hold them under the chin or by a horn and guide the rear using the other hand low down on the flank.

Unloading of sheep



Because of their adaptation to hilly, often rocky environment, sheep have little difficulty negotiating unloading ramps and are usually sure footed. even though they may leap relatively large distances and drops they are unlikely to injure themselves as long as conditions are adequate. These should include good lighting within the lairage, cleats on the ramp itself and a covering of straw.

Sheep handling in the lairage



Movement of sheep within the lairage is relatively easy since their motivation to follow lead sheep is strong. The most important principle to observe is that the way ahead must be kept clear particularly of human presences. If they are impeded they can baulk, become stubborn and very difficult to move.

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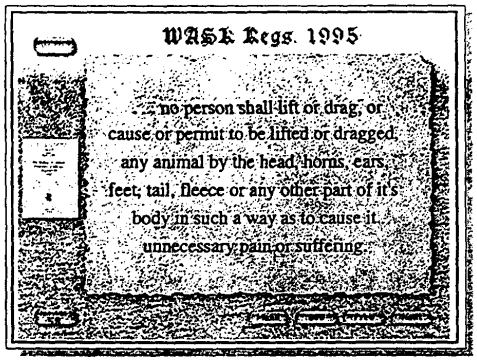
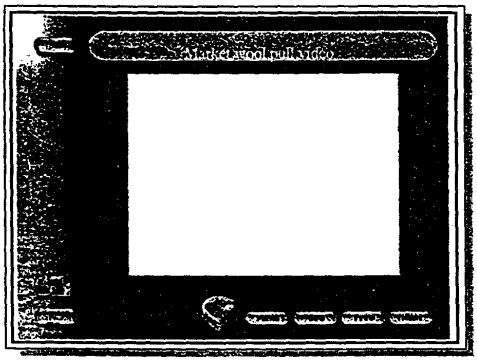
WASK Regs. (handling)



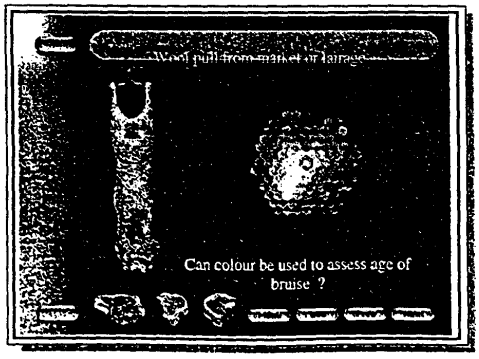
The Welfare at Slaughter regulations are clear. The correct handling of sheep must ensure that no unnecessary suffering is inflicted. Although the holding of animals by the horns is specifically mentioned in the legislation it is accepted that adult sheep may be restrained in this manner. Neither is it permitted to restrain or drag sheep by the fleece since this action may inflict pain and distress.

Bad handling in market (sheep)



All operatives working in livestock markets and lairages know that handled correctly sheep are the easiest of the three species to manage. I am sure that they are equally aware that careless handling, such as grabbing the fleece to restrain and direct movement of the sheep not only inflicts pain but can result in carcass damage. Unfortunately it is all too easy to adopt poor practices as seen in this video and staff need reminding of the consequences.

Wool pull from market or lairage ?



Holding and moving sheep by grabbing the fleece not only inflicts pain on the animal but can also result in carcass damage which takes the form of haemorrhaging in the subcutaneous fat and underlying muscle tissues. It has been suggested that the time at which the damage was inflicted can be gauged by the colour of the bruise post mortem since it is known that the haem pigments involved change colour during gradual degradation. However the time course of these changes means that it is not possible to differentiate between events occurring in less than perhaps an 18 to 24 hour period pre slaughter.

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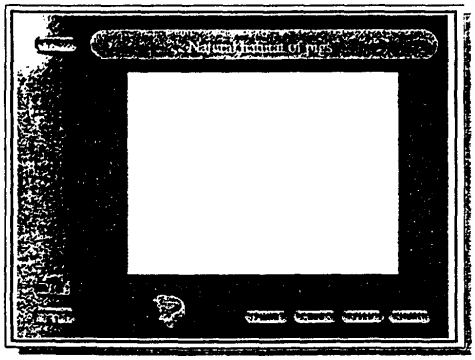
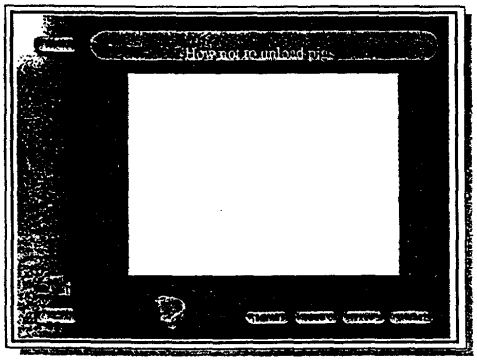
The visual field of pigs



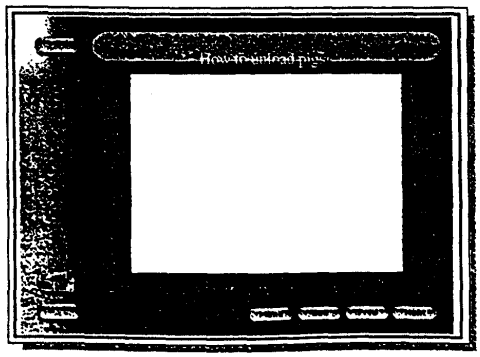
Pigs are the most awkward animals to move. Patience and understanding are essential in their handling. They have a wide field of view but are a little short sighted. Their snout is sensitive and they will want to explore with it. They are very communicative and vocal. Loud noise will make them start but gentle noise is useful to encourage them. They only move as a loose group and will not follow one another as well as cattle or sheep. Handle them in groups of a manageable size. If animals at the front of the group stop it is useless, and illegal, to goad animals at the back. Pig boards are useful for driving, turning and blocking their path. Pig boards are a good example of the use of behaviour being used to ease handling.

How not to unload pigs



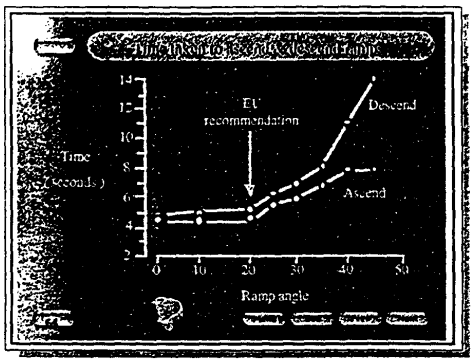
The mistakes demonstrated in this video are obvious and need little explanation. Some actions can be deliberately cruel and there is no excuse for these. Others are simply poor handling strategies which demonstrate a lack of knowledge and expertise. This is demonstrated where pigs are being unloaded in too big a group so that the driver cannot influence the behaviour of the pigs at the front and pigs are trying to return back to the lorry. An obvious hindrance is the use of transport which is not suitable for the species being transported.

How to unload pigs



As with all operations involving live animals consideration and common sense are the first priorities. Pigs are not easy to either load or unload using ramps and so where possible they should these operations should be carried out on the level. This can be achieved by installing a sloping unloading bay or by the increasing use of lorries fitted with hydraulically operated floors which minimise ramp angle. Obvious good practices would be to ensure that the exit is well lit to encourage exploratory behaviour. The group size should be appropriate that the drover can influence the behaviour of the pigs nearest to the exit from the lorry and aids such as pig boards should be used.

Time taken to ascend and descend ramps of different angles

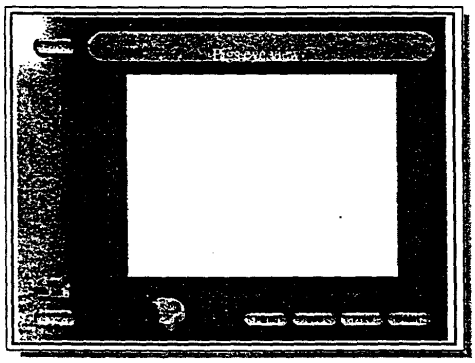


Animals, cattle and pigs especially, are slowed down by ramps. Ramps cause an increase in heart rate and lead to stress in the animals. Animals are much more likely to slip or fall and damage themselves when negotiating ramps.

Always use vehicles which have internal or external lifts in preference to those which have ramps.

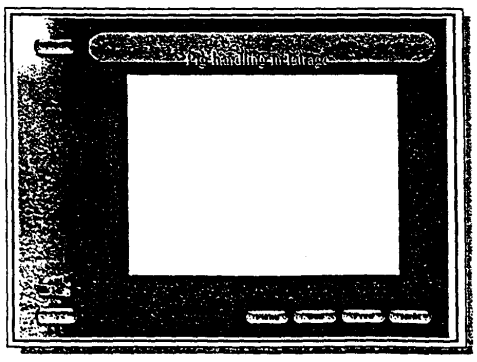
The present legal maximum ramp slope is 30 degrees for an external ramp and 35 degrees for an internal vehicle ramp. There is a suggestion that these may both be reduced to 20 degrees by future EC legislation.

Pigs eye view



As a general rule lairages have been designed from a human perspective rather than the animals. If animals are seen to baulk at particular points during movement through the lairage it can be useful to investigate possible causes by viewing the situation at the same level as would be experienced by the animal. This will often reveal potential causes which would not be obvious at human eye level.

Pig handing in the lairage



Pigs are the most awkward animals to move. Patience and understanding are essential in their handling. They can be very difficult to handle and even with considerable applied force they will not be hurried. Pigs will move forward at a pace sufficient to satisfy the demands of the highest throughput slaughter plants if left to their own devices. Allow the lead pigs to dictate the speed of the operation. As with all species, the immediate environment should be bland and free from distractions which might cause the pigs to baulk. Group size is again important as is the use of pig boards.

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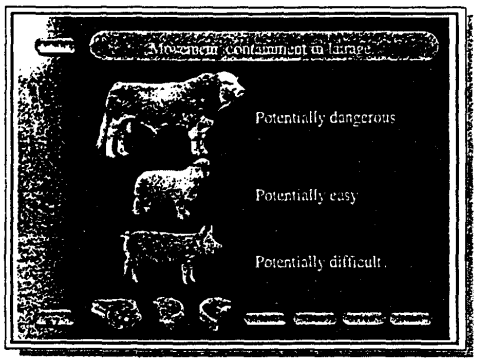
Movement / containment in lairage



This LCD makes what are obvious statements regarding the likelihood of problems arising during movement of all three species through the lairage to the point of stun. Operatives working with live animals will be only too aware of the potential problems highlighted. Nevertheless care and consideration should not be compromised since correct handling and management will help to reduce potential problems.

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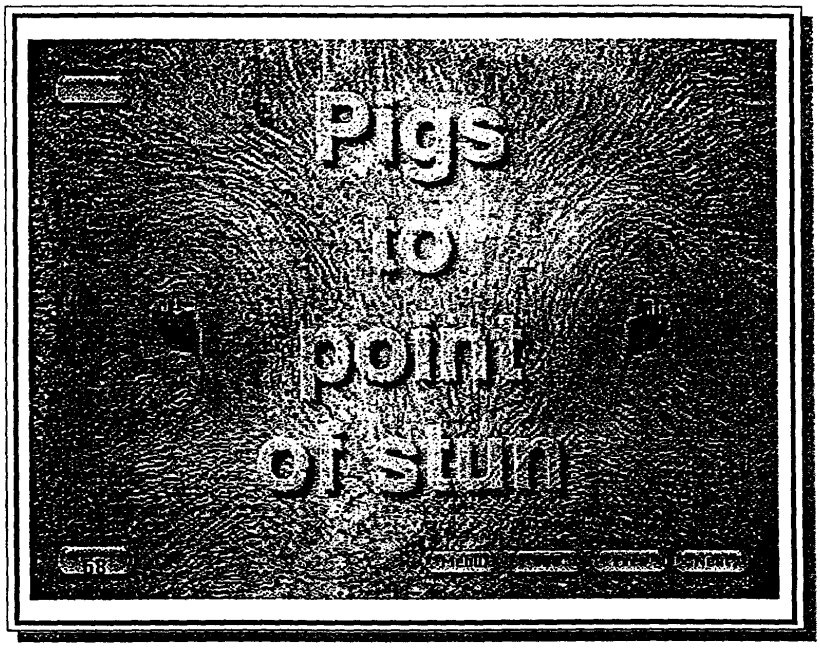

Notes

The difficulty encountered by slaughter plants in presenting pigs to the stunning point warrants an examination of this process as a separate topic. The need to supply the stunning and slaughter operations with ever increasing throughput rates creates an impression that the major obstacle to calm, relatively low stress, movement of pigs is simply the requirement for faster rates. In practice these faster rates do appear to result in hugely increased amounts of coercion and general distress to the animals which is detrimental to both their welfare and subsequent meat quality.

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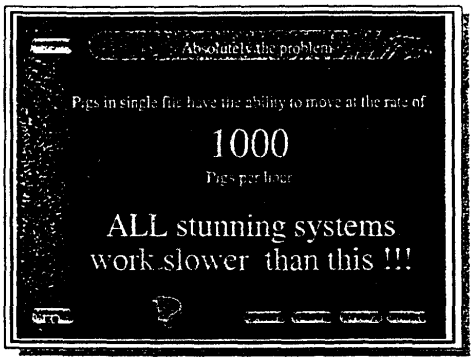
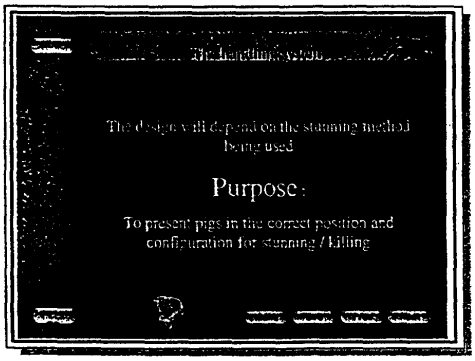
Absolutely the problem



Paradoxically, it is not the ability of pigs to move at the throughput rates required by even our fastest operations which creates the problems which we encounter. Left to their own devices pigs have the ability to move at the rate of 1000 pigs per hour which exceeds the requirement of all stunning systems. Rather it is more to do with the design of the systems used to deliver pigs to the stunning and slaughter point, the stop - start nature of many operations, and HUMAN INTERFERENCE !

The handling system



The nature of the handling system employed to deliver pigs to the point of stun will depend on the nature of the stunning system in operation. For instance, where pigs are automatically stunned while restrained in a moving conveyor, a requirement of the delivery system will be to reduce pigs to single file and deliver them to the conveyor entrance at a speed compatible to the operating speed of the conveyor . Regardless of the stunning method in use it is essential that pigs are presented in the correct manner to achieve effective stunning.

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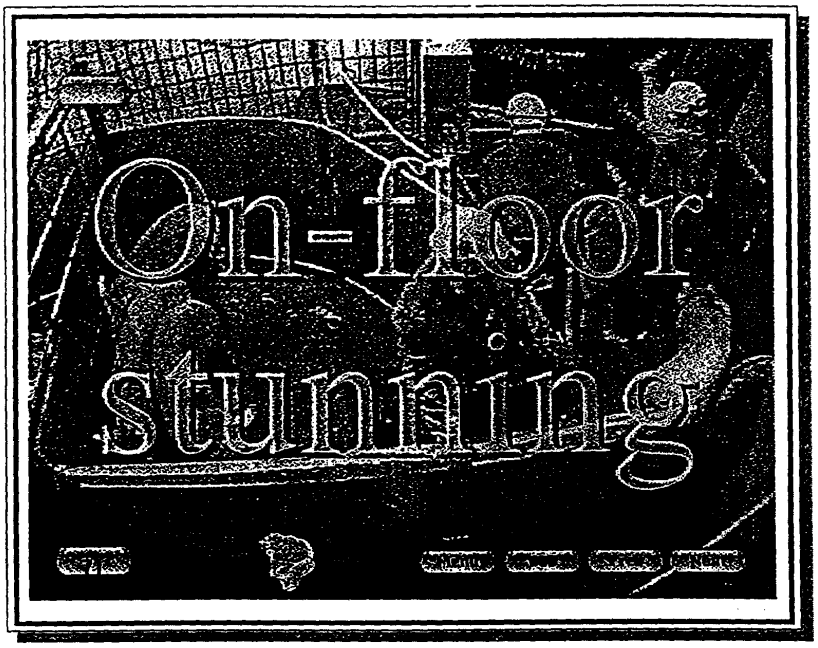
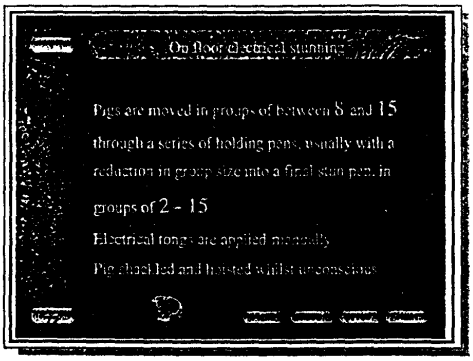


Notes

The most common mode of stunning employed involves stunning of pigs, free standing in the stunning pen, and this is particularly appropriate for lower throughput plants. Pigs are presented to the operative for stunning using hand held tongs which are placed on the pigs head in such a position so as to span the brain. The major difficulty is correct placement of the tongs on what is essentially a moving target.

On floor electrical stunning

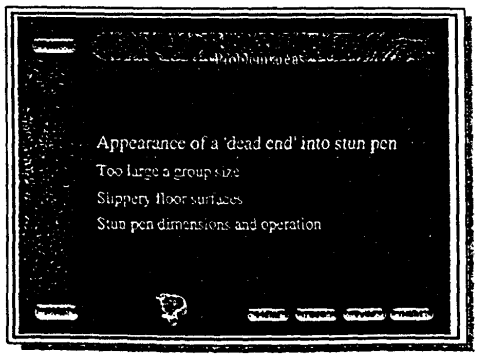


The characteristics of the operation are summarised in the next LCD's. Ideally groups of pigs should be moved through a number of pens with the aim of reducing the size of the group which enters the stunning pen. Traditionally, large numbers have been driven in to the stunning pen in a single operation where stunning is effected by applying electric tongs to the head of the individual pigs following which the animal is shackled and hoisted for bleeding. A critical competent of the operation is the need for accurate placement of the stunning tongs.

Throughput requirement

Although manual, on floor stunning is appropriate for low throughput plants the smooth operation achieved with minimal stress inflicted on the pigs allows the system to achieve throughput rates of 180 to 220 pigs per hour.

Problem areas



The essential element of this operation is the efficient passage of pigs into the stunning pen in such a manner as to facilitate the stunning operation. Pigs will baulk at the appearance of a dead end and this emphasises the need for the pens to employ curved walls. If group size is too large the operative can lose contact with the leading pigs and movement of the group can stall. The design and construction of the stunning pen must of course be suitable and reflect the group numbers intended to enter the pen in each operation.

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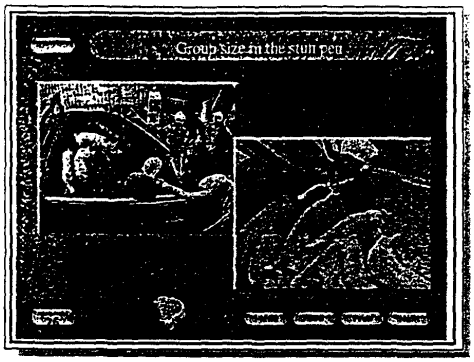
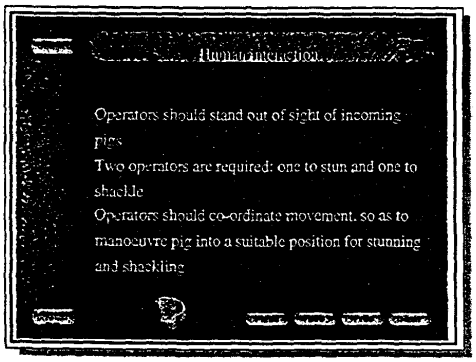
Group size in a stun pen

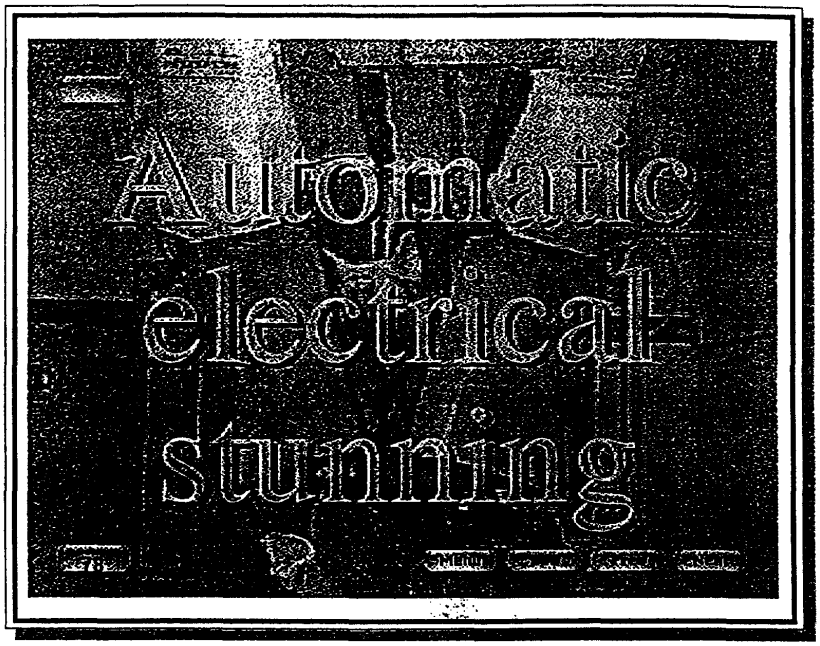


This LCD illustrates the potential problems which can arise when larger groups of pigs are driven into the stunning pen even where the size of the pen is adequate to contain them. The greater numbers make accurate placement of the tongs more difficult to achieve and in addition when numbers have been reduced the opportunity for escape from the stunner operative is increased. This can result in the imposition of unnecessary stress to both the slaughter pigs and the operatives .

Human interaction



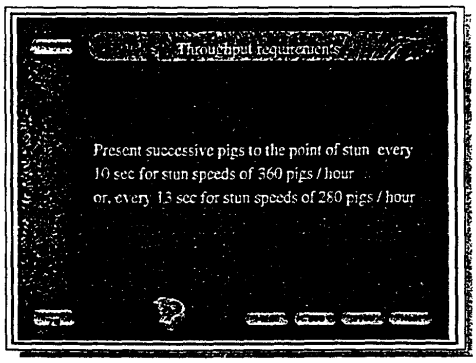
To prevent baulking of the pigs at the entry to the stunning pen the operatives need to stand out of the direct line of sight of the pig. Two operatives are employed within the pen and the man shackling the pigs always positions himself to facilitate presentation of the pig for stunning.



Notes

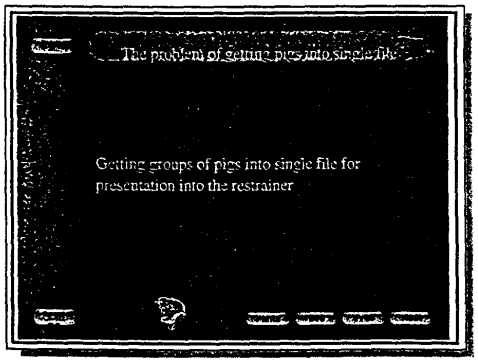
Where higher throughputs are required automatic stunning systems have been developed. These have a number of potential advantages in terms of animal welfare since they ensure correct presentation of the pig to the point of stunning and allow the use of considerably higher operating voltages than are considered safe where hand held tongs are used. Such higher operating voltages should ensure the effectiveness of the stunning process.
There use however involves a number of operations which are potentially difficult to manage and likely to inflict stress on the animals immediately prior to slaughter.

Throughput requirements



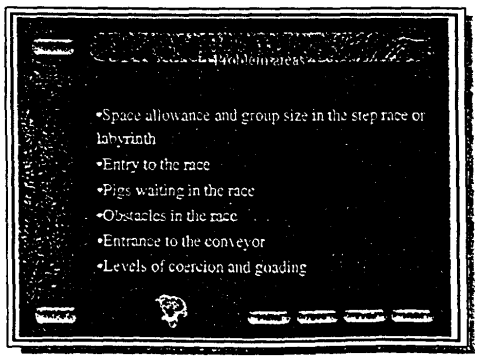
The logistics of the operation are such that presentation of the pigs to the point of stun every 13 or 10 seconds will achieve killing rates of 280 and 360 pigs per hour. However operation of the conveyor is simply an engineering problem an in theory the conveyor could run at much higher speeds. The major problem encountered is in presenting pigs to the conveyor at the same rate as the conveyor presents them for stunning

The problem of getting pigs into single file



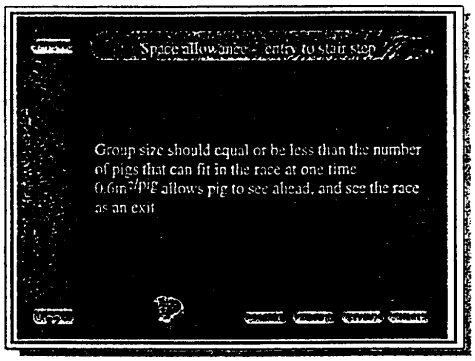
This operation is the main threat to welfare during passage of pigs through the plant. It is necessary to take groups of pigs which are randomly orientated and transform them into single file for entry to the restrainer and this operation has in the past been a major welfare problem. It should be noted that it is not a a consequence, necessarily, of restrainer design, nor is it a consequence of the mode of application of the stun.

Problem areas



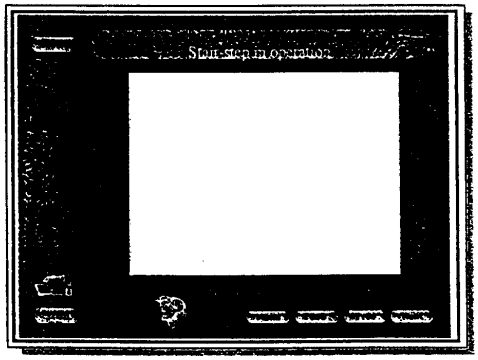
This LCD examines the particular features which make entry to the race such a problem. The overriding principle common to all aspects of animal movement is that the route intended should be clear of all obstruction and obstacles. Whether a stepped race or a labyrinth is used to get pigs into single file initial group size must be controlled and the system must be batch filled. An obvious aim should be to keep the levels of coercion, particularly goading, to a minimum.

Space allowance - entry to stair step

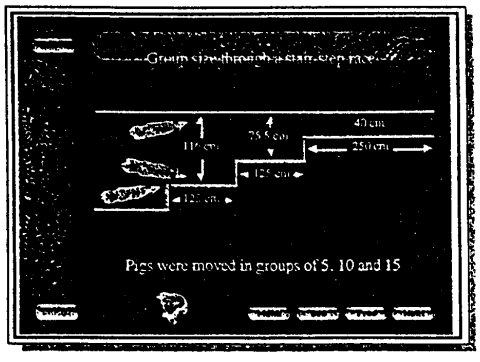


Where stair-step races are employed, group size should not exceed the absolute number of pigs that can be contained within the race. It is important that the race is allowed to empty before the next batch are introduced since pigs remaining will obstruct movement of the lead pigs in the following group.

Stair-step in operation

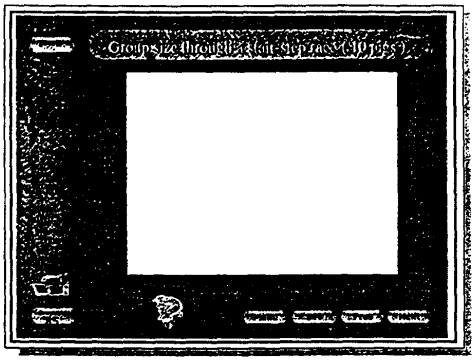


Group size through a stair-step race

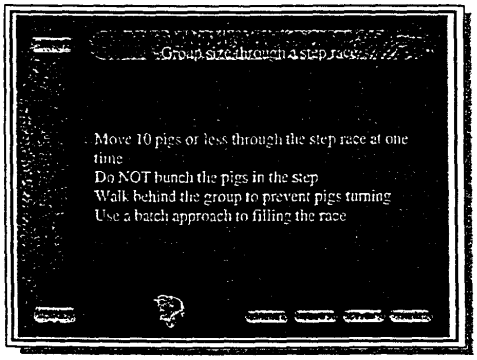


In an experimental situation, the effect of group size on ease of movement of pigs through a step race was examined. Pigs were introduced in groups of 5,10 or 15. The dimensions of the race are shown in the diagram and are specific to the size of pigs being handled.

Group size through a stair-step race (10 pigs)

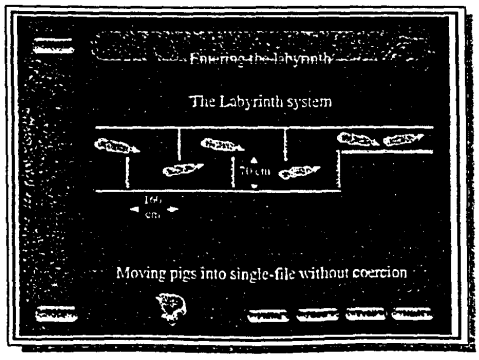


Group size through a step race



In the experimental situation it was found that a group size of 5 was the easiest to manage but that a group size of 10 was possible and thus 10 or less was recommended. The operation was most readily achieved if pigs were not forced into bunching within the race and if the stockman followed behind the group to prevent pigs turning round. This action facilitates the batch filling approach to the operation.

Entering the labyrinth



An alternative to the stair-step race is the labyrinth shown in this diagram. Again the aim is to transform groups of pigs into single file to facilitate loading into an automatic race. The dimensions shown are appropriate to the size of pig employed.

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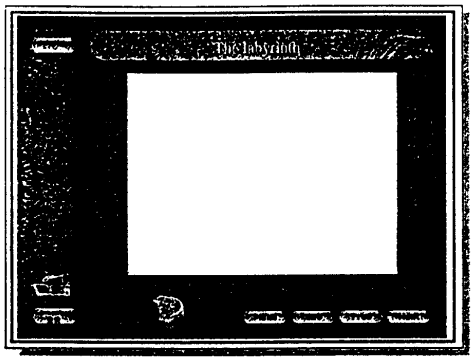
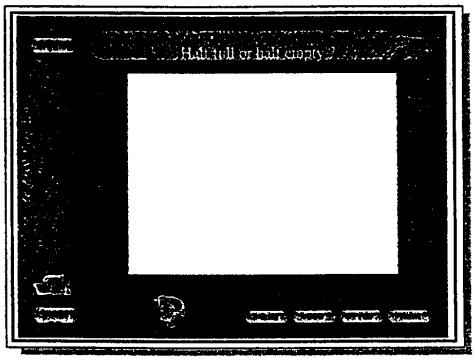
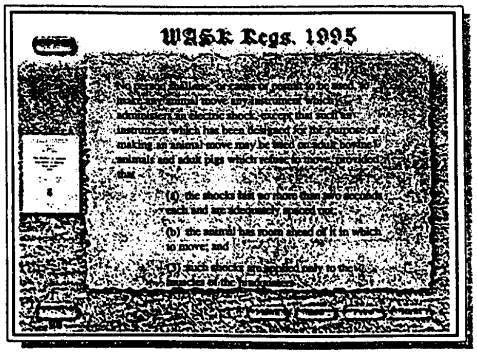
The labyrinth



Half full or half empty ?



Legislation



The legislation accepts that where problems arise with movement of pigs to the point of stun it may, in some cases, be necessary to apply some coercion in the form of electric shocks (goading). However, the legislation is very clear in defining exactly what form the shocks may be applied. Importantly, it also makes a crucial observation that application of electrical shocks is pointless unless the animal has somewhere to go. What the legislation doesn't define is the voltage, current or, duration of the electrical energy that can be applied to an animal. It has been suggested, that equipment that is used in the abattoir with live animals should be independently inspected and bear a "Welfare Kite Mark."

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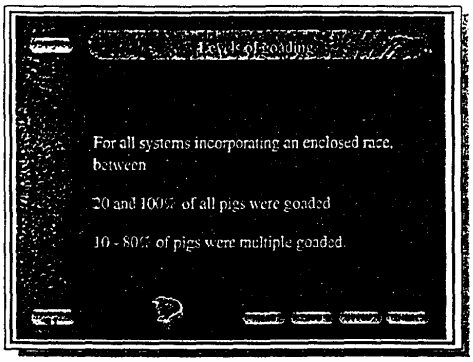
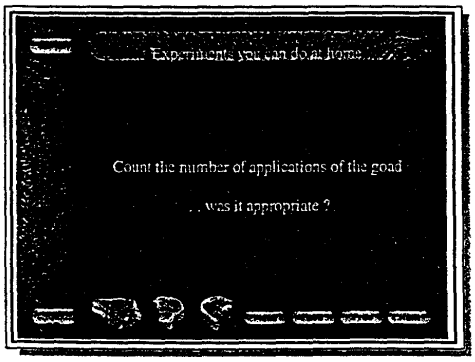
Levels of Goading



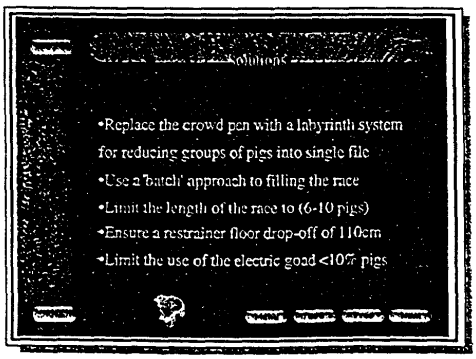
A recent survey of pig slaughtering plants in the UK showed that where pigs were being delivered in an enclosed race system either to an automatic conveyor or direct to a gas stunning unit between 20 and 100 % of all pigs were goaded. In addition between 10 and 80 % of these pigs were shocked more than once. In those plants where levels of goading were high were they operating within the UK legislation ?

Experiments you can do at home



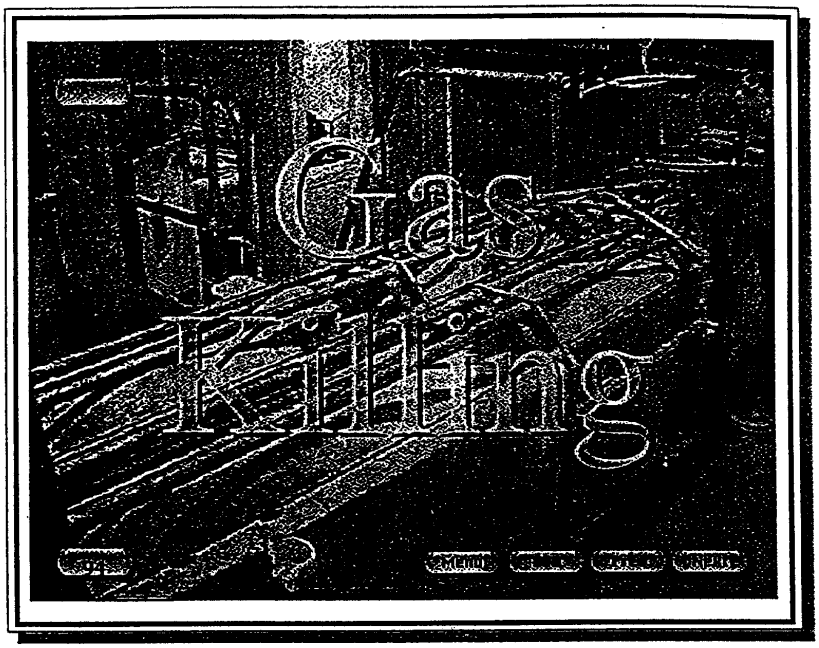
Given the wide range of pigs that are goaded once or more than once, the use or misuse of electric goads can be a useful indicator of potential problems within the lairage. Simply observe pig movement through your lairage and record the number of times the goad is applied and at what location within the system. Other methods of coercion should be tried e.g. pig boards, flappers, rattles, etc. before resorting to the electric goad. The use of goads can be considered an 'admission' that either the stockman doesn't understand his job or, the design of the pig handling system is seriously flawed. Analysis of your observations should point to ways to improve your animal handling system.

Solutions



The results from research carried out by Tracey Jones has led to the five recommendations shown. Pigs can walk in single file and at a rate that is in excess of the fastest throughputs seen in this country. What is required with pig handling systems, is careful design based upon a realistic assessment of the throughput required and a knowledge of animal behaviour.

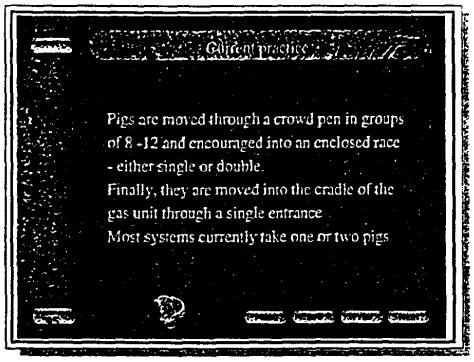
The lairage should be a place where animals can recover from the rigors of transport. Noisy, wet, cold, badly designed lairages manned by inadequately trained personnel, will have serious consequences for both animal welfare and carcass and meat quality.



Notes

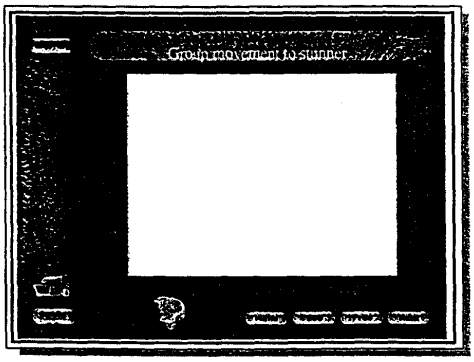
The major welfare advantage of a gas killing system is that very little restraint is required because, nc physical contact with the animal is required. Pigs can remain in small groups and be exposed to the gas mixture in a specially designed pen. Traditionally, pigs were loaded individually into a carousel-style gas stunner that once loaded, moved down stage by stage, into a well containing the gas mixture. Entry into the gas is via a concentration gradient as the carousel turns. Many of the controls of the supply of gas were very basic, such that CO_2 often flowed out of the entrance. Consequently, pigs were being driven, single-file, towards an entrance that leaked a gas that has been shown to be aversive to pigs. Improvements in the design of gas control equipment should have overcome this potential problem.

Current practice

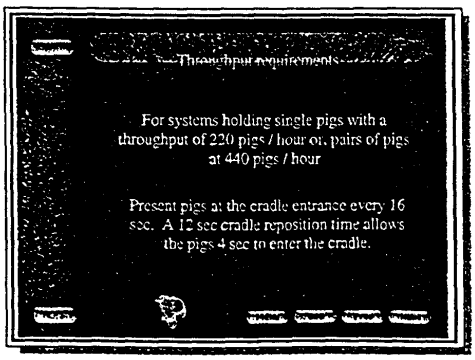


The major problem with current pig handling systems is the practical requirement to separate groups of pigs down to single or double-file to enable a stunning or killing treatments to be applied. In the case of gas systems the potential welfare advantage of a non-invasive system is often negated by the excessive use of coercion to maintain a desired throughput. Carousel style gas stunners are stop-start by design. Once pigs are separated their forward movement is continuously halted once each cradle is filled. Double races control the flow of pigs through a flip-flop gate which again imposes further impedance to their steady flow.

Group movement to stunner



Throughput requirements



The throughput requirements of a modern pig abattoir can result in a demand for animals at the entrance to the stunner every 16 s (for 220 pigs per hour). Based on a cradle reposition time of 12 s, only 4 s are allowed to load the animals into the cradle. The pigs will be stationary as the entrance is opened therefore, with the time constraint, it not surprising that electric goads are heavily used at this point in the system. Where a double race is used, an improvement would be envisaged if the entrance to the stunner was enlarged to two pigs wide, to enable animals to move forward whilst maintaining contact with a con specific.

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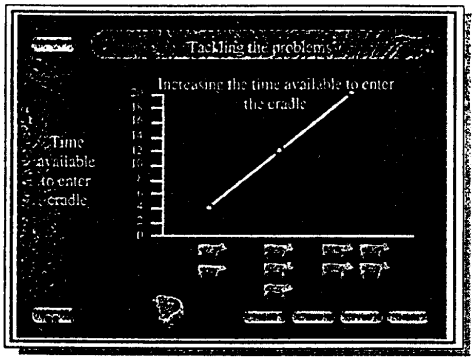
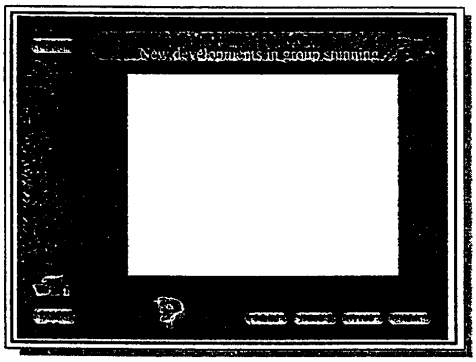
Tackling the problems

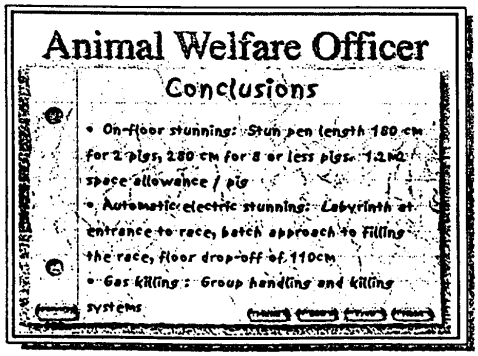


The demand for higher throughputs cannot simply be met by increasing the speed of the carousel which would produce a reduction in the exposure time and result in pigs surviving the stun/killing method. the use of a side-loading, group stunning system will enable more time to become available to allow pigs to enter the cradle. The graph demonstrates that for two pigs 4 s; for three pigs 12 s; and for four pigs 20 s is available to load the animals into the cradle. The Danes have developed as system that uses a labyrinth to separate groups of 15 pigs into 3 subgroups, which are moved automatically into a group stunner where the pen of 4 - 6 animals are immersed in carbon dioxide at high concentration.

New developments in group stunning



Conclusions



Pigs are probably the most difficult animals to handle within the lairage and up to the point of slaughter. Research has concentrated on pig movement through the lairage and various recommendations have been made. Careful design of raceways, crowd and stunning pens can reduce the amount of stress inflicted on pigs and the ease of animal movement, both of which will reduce the stress imposed on lairage staff. Where possible, automatic systems should be used to replace operatives and stop-go raceways should be replaced with continual flow or, group handling systems. The use of a labyrinth has been shown to improve pig handling and the rate of flow through a labyrinth is in excess of the demands for throughput.

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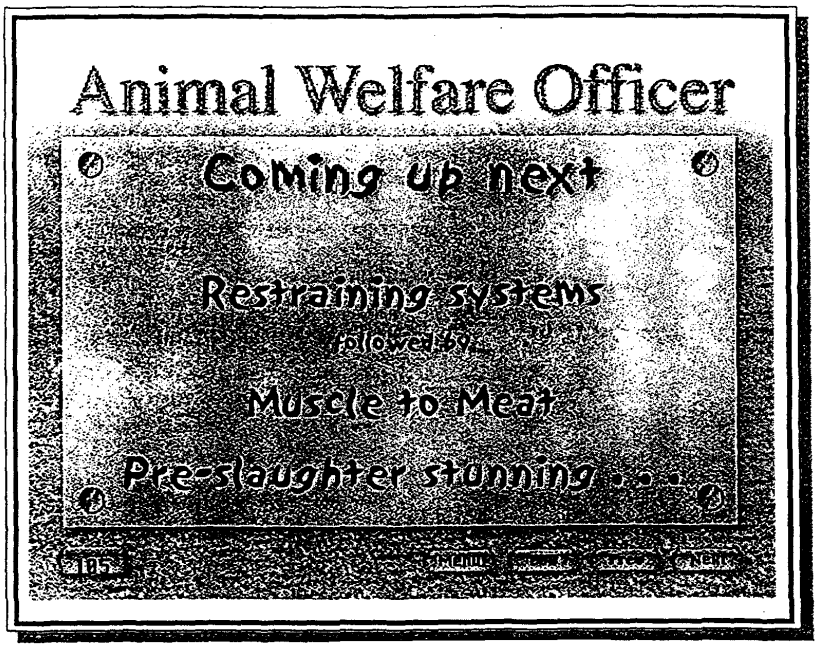
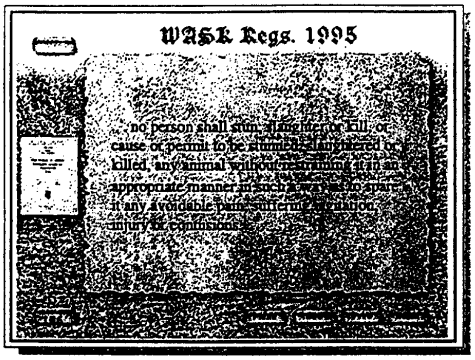


Notes

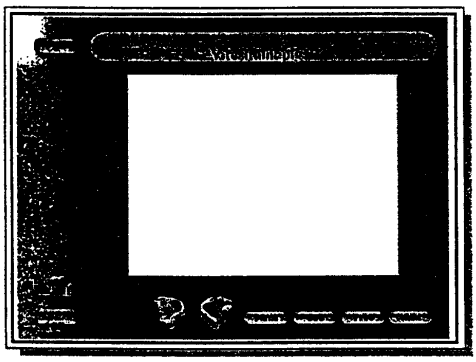
Animal Restraint is the next stage in the process of taking the live animal that is delivered to the lair and producing the carcass on the hook. We have examined ways of using animal behaviour to as lairage staff in the handling process and in the design and layout of lairages and this ethic should continued to the point of restraint prior to stunning and slaughter.
Muscle to Meat is a process that involves all aspects of animal handling, stunning and slaughter. T effect of adverse animal welfare will be reflected in poor carcass and meat quality.
Pre slaughter stunning is another key area or, critical control point in the system. The physical nat of the process is such that when mishaps occur, the results for welfare can be catastrophic.

WASK Regs. 1995 - Restraint



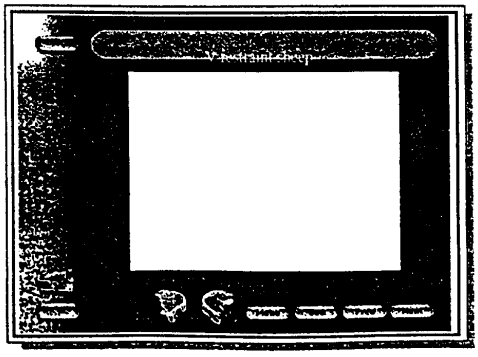
The legislation suggests that physical restraint of each individual animal is required before they can be stunned, slaughtered or killed. The interpretation of this clause is such that "the wire fence surrounding a field in which a deer is shot" constitutes the restraint of that animal. The use stunning pens to enable manual stunning of free-standing animals would therefore, qualify as appropriate restraint. All legislation requires clarification and that is provided by MAFF in Codes of Practice. Ultimately, until legislation is tested in a Court of Law, interpretation must rely on the O.V.S.

V Restraint pigs



The use of two reciprocating belt conveyors has been used by abattoirs for the physical restraint of pigs. The conveyors are arranged in a V - shape, such that the animal's body is supported by the belts as the floor falls away. The belts are usually constructed of a hard, unyielding plastic material, that pick up an animal from a single-animal race and deliver it to the point of stun. Research at Langford has demonstrated that pigs tend to 'fight' V-restraint and the restraint system itself can increase the levels of stress inflicted on pigs.

V restraint sheep



The use of V-restraint with sheep is much more successful. Sheep have a 'fleece cushion,' that enables them to ride the V-restraining conveyors without the stress generated with pigs. Sheep have such a strong flocking instinct, that provided other sheep are present, will result in them following each other into the conveyor. Restraint is essential when head-to-back stunning/killing systems are employed, as the animal will fall away from the electrodes if they are unsupported.

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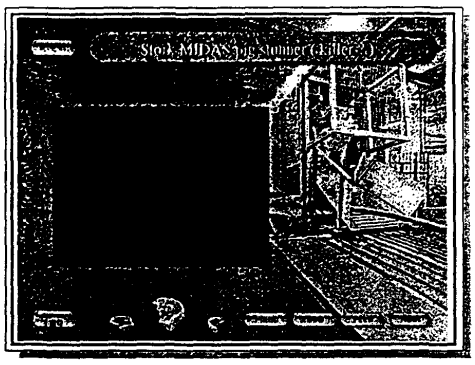
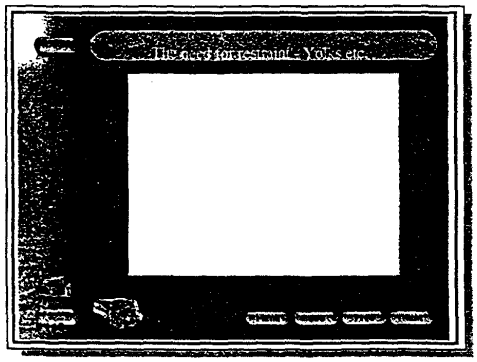
Stork MIDAS pig stunner (killer?)



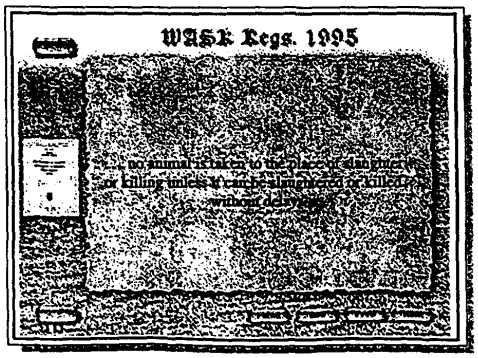
The MIDAS pig stunner consists of a special single conveyor belt, which supports the belly of the pig while transporting the animal to the stunning section. The low-noise conveyor system is claimed to ensure stress-free transport and easy entrance of the animal into the installation. The monorail or single conveyor rises-up from the centre of a single-pig race which, when pigs are following each other closely, offer no visible moving parts. When the pig walks onto the single conveyor the floor falls away, leaving the animal riding astride the shaped belt. The principle of this form of restraint produced less stress in pigs that other forms of restraint. A new double rail conveyor restrainer system designed by the Temple Grandin is available for a wide variety of small calves, sheep and large 225 kg calves. For adult cattle, a slightly wider conveyor is used.

The need for restraint - Yolks etc.



Mechanical and electrical stunning systems require the physical application of devices to the animal's head or head and body. Effective mechanical stunning relies on the placement of the gun in a prescribed position that will ensure a concussion and also result in physical damage to a region of the mid-brain. Electrical stunning systems should be applied such that the electrodes span the brain. Misapplication of electrodes will result in ineffective stunning and the potential for compromising the welfare of the animal is high. Restraint, yolks, etc. are measures that should be taken if they improve the accuracy of the technique without, in themselves, compromising the welfare of the animal.

Legislation



WASK (1995) regulations specify that when an animal is placed in restraint or, led into a stunning pen, it is slaughtered without delay. It is important that where restraint (e.g. head restraint) is employed, the slaughterman is ready to stun the animal as soon as the restraint is applied. All stunning methods with the exception of cardiac arrest stunning or gas killing systems, are designed to stun the animal for sufficiently long for it to be slaughtered before it recovers consciousness. The legislation requires the slaughterman to be ready to ensure that the interval between stunning and sticking is kept to a minimum.

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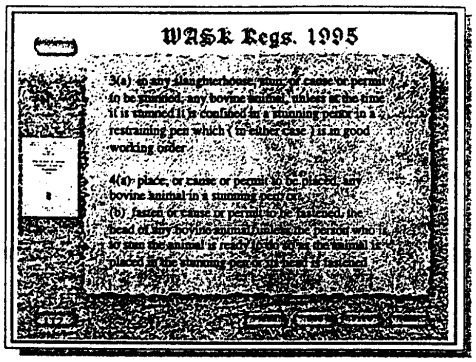
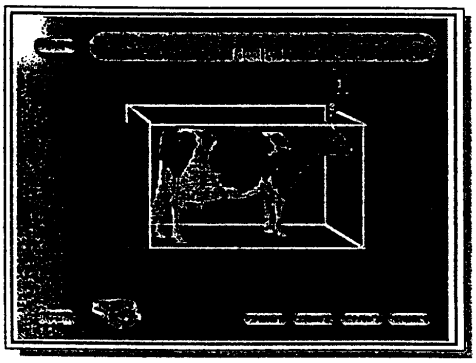
Legislation



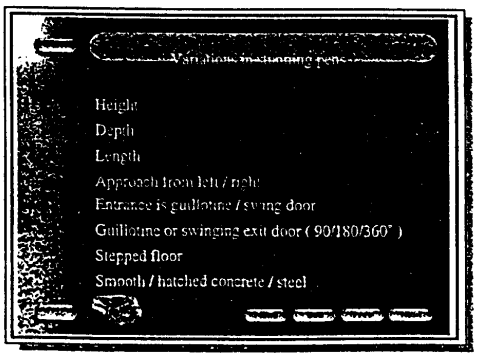
The legislative requirements for the restraint of cattle specify the use of a specially designed pen. It is not permitted for cattle to be stunned free-standing in a pen whether by mechanical or electrical methods. Clause 4 (b) recognises the effect that head restraint can have on cattle that are not stunned immediately the head restraint is applied. When cattle first enter a stunning pen there is usually an instant when they raise their heads and present the target area in an ideal shooting position. If the slaughterman is in position and awaiting the animal, he will be ready to shoot it at this time. Any delays can result in increased levels of stress in animals and increased effort for the slaughterman.

Ideally!



In an ideal world, the dimensions of the cattle stunning box would exactly mirror the size of the animal. In the real world, the range in animal sizes has increased over the years. The cattle stunning box is designed to cater for the largest animal that is likely to be slaughtered. Therefore, the smaller animals will be able to back away from the slaughterman, lower their heads and present such a difficult target to reach that accurate placement of the gun can be compromised together with the safety of the slaughterman.

Variations in stunning pens



Within the red meat industry the presentation of cattle to the stunning point within a restraining pen without imposing undue stress or suffering is an essential part of animal handling and humane slaughter. Difficulties arising from incorrect animal handling, both human and animal stress levels associated with vagaries of both lairage and stunning box design can compound to render the stunning process at best awkward and at worst inhumane. A survey of cattle stunning pens in UK abattoirs was carried out to list the variations in stunning pen design to determine whether the retrograde fit of improvements to the design, would be possible.

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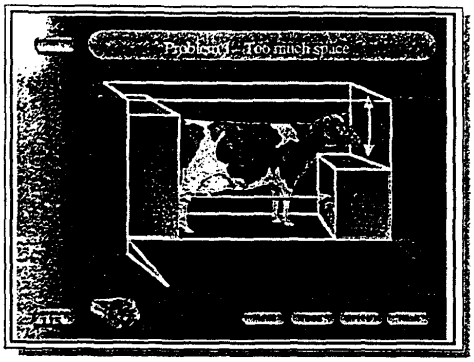
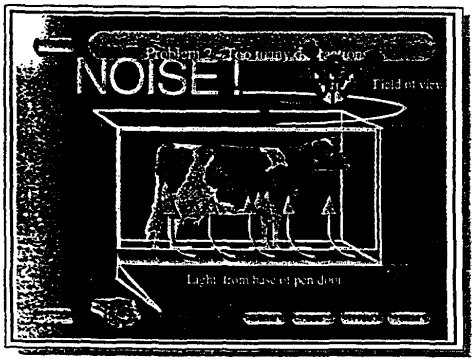
Problem 1 - Too much space



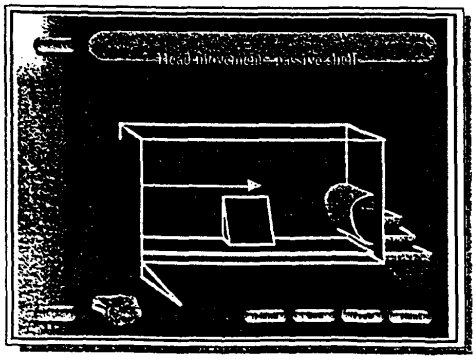
Effective mechanical stunning depends on the accurate positioning of a captive bolt gun on the forehead of cattle. Legislation (W.A.S.K. regulations 1995) requires that the instrument is positioned and applied so as to ensure that the projectile enters the cerebral cortex. In order to facilitate accurate and effective mechanical stunning the space around the animal within the stunning pen should be controlled. This is necessary with either small cattle that back up against the guillotine door or animals that place their heads down (normal grazing position). Therefore, the additional space in front of, and/or behind the animal, needs to be filled.

Problem 2 - Too many distractions



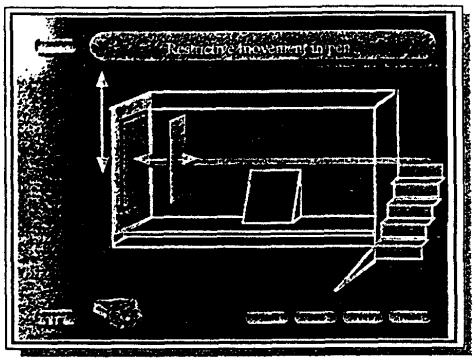
There are two sorts of noise: general background noise and impulse sounds, caused, for example, by the clanging of a gate or the hiss of air vented from a pneumatic system. The latter sounds are likely to be particularly frightening to animals but both background and impulse sounds may cause stress to cattle and therefore should be controlled. If cattle baulk because of the presence of the slaughterman within their field of view, in front of 'the point of balance', they will be more difficult to move into position within the pen. It is good practice for the slaughterman to remain out of the animal's view until he is ready to stun it. The majority of swing doors permit shafts of light from the usually well-lit slaughterhall to enter the cattle stunning pen at the base of the swing door. This unwanted light will attract animals to lower their heads to investigate the base of the pen.

Head movement: passive shelf



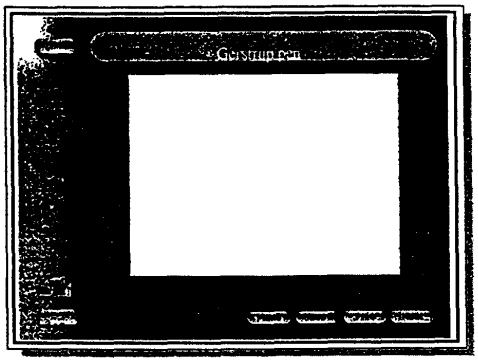
The Humane Slaughter Association recommend that fixed-shelf head positioning systems should be used wherever possible to improve shooting accuracy. This can be achieved by fabricating a static front shelf as shown in Figure 1. The curved metal shelf takes up the space at the front of the pen, thus preventing animals from lowering their heads. The dimensions shown in the diagram were developed for an existing cattle stunning pen (University of Bristol). Modifications to these dimensions may be required to fit existing commercial cattle stunning pens and a hold down bar was found necessary in open topped pens to prevent animals from climbing upon the static shelf.

Restrictive movement in a pen



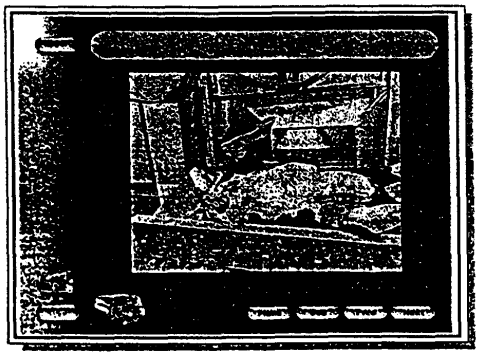
Analysis of data from the survey of existing cattle stunning pens supported the concept of a rump pusher mounted on, or designed to replace, the guillotine entry door (see diagram). A rump pusher powered by hydraulic ram can deliver sufficient force (1000 Kg) to encourage stubborn animals forward. The rump pusher is designed to be used only on short cattle that back away from the front of the pen and 'out of reach' of the slaughterman. The device is designed to move animals quietly in such a way as to prevent entrapment of rump, legs, hooves, etc. Modification to the swing door to permit animal exit before the rump pusher is fully withdrawn may be required.

Gerstrup pen

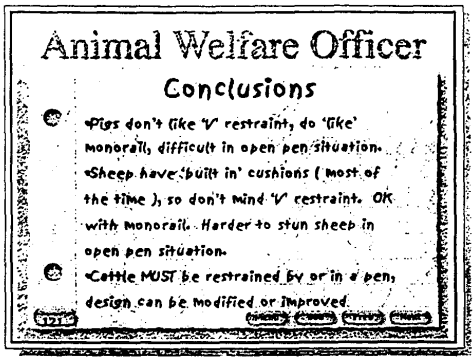


The gerstrup pen is a stand alone pen that does not incorporate part of the fabric of the slaughterhouse into its construction. Animals are enticed forward by the illusion that they can walk through the front of the pen. The animal places it's head through a wide opening at the front of the pen and a neck yoke is applied. The yoke restricts the lateral movement of the head but not the vertical movement. The head of the animal is presented to the slaughterman who approaches from the side.

Belgium pen



The photograph shows an animal being ejected from a stunning box in a slaughterhouse in Belgium. The cattle box has a well defined fillet to aid animal ejection and close examination will reveal a form of 'head restraint' built into the front of the pen. The rear door has an integral rump pusher that will aid forward movement of animals into the correct shooting position. Animals are ejected onto a cradle.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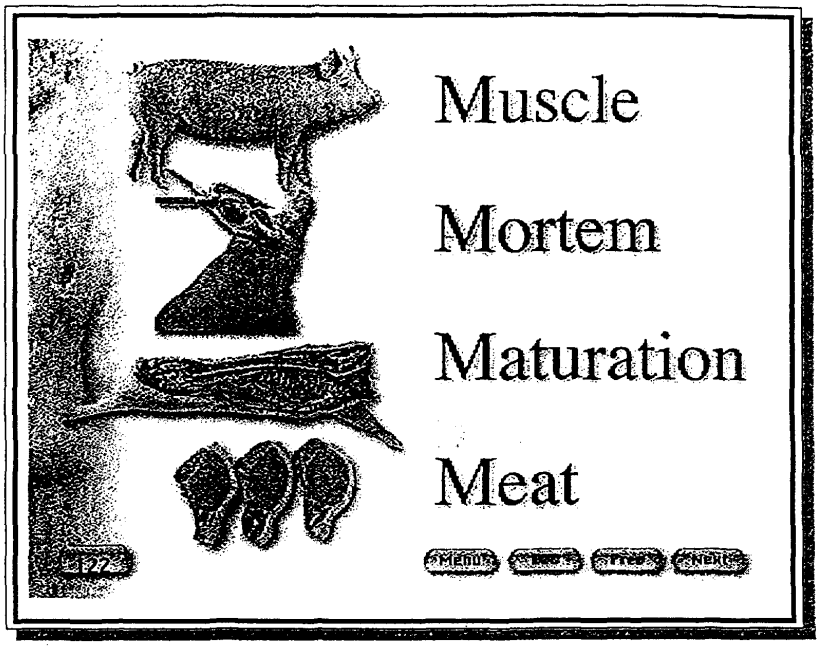
Conclusions
•Pigs don't like 'V' restraint, do 'like' monorail, difficult in open pen situation.
•Sheep have 'built in' cushions (most of the time), so don't mind 'V' restraint. OK with monorail. Harder to stun sheep in open pen situation.
•Cattle MUST be restrained by or in a pen, design can be modified or improved.



Notes

We have already described the possibility of a link between good welfare practices and the productior of good product quality. To enable us to explore this link in some detail it is necessary to have an understanding of the process by which living muscle is transformed into the saleable carcass. In particular we need to consider the biochemical basis of control of this process and then explore the 'real life' management strategies which can exert influence over these processes.

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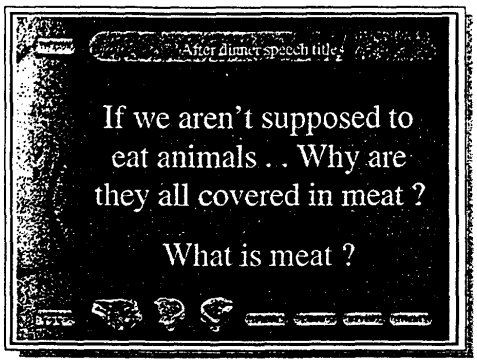
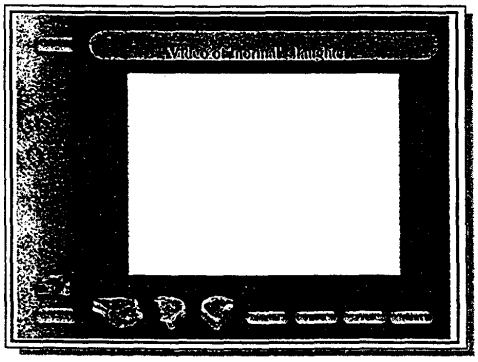
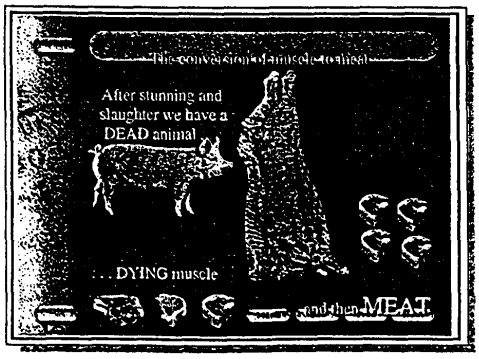
After dinner speech title



Video of normal slaughter

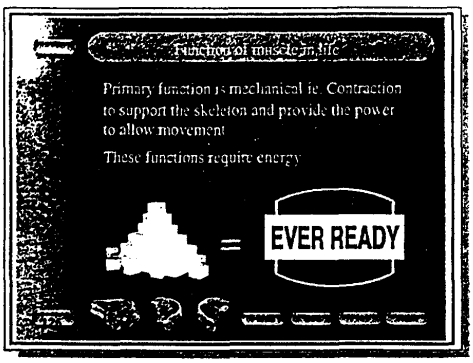


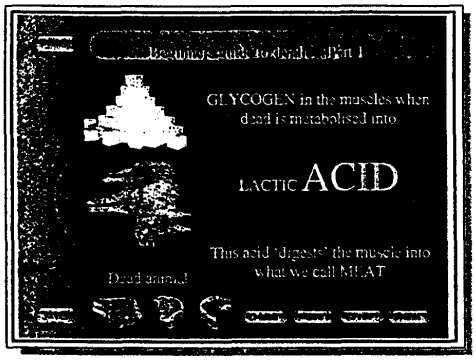
The conversion of muscle to meat

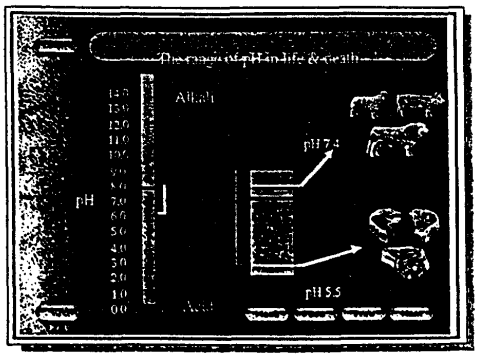


It is important to consider the conversion of muscle to meat as a process rather than an immediate event. In physiological terms the act of stunning and slaughter initiates the start of the death process and this is characterised by a fairly rapid decline in brain activity as the central nervous system is deprived of oxygen. The time to brain death is measured in seconds. However, muscle tissue is not dependent on oxygen for continuing functionality and the conversion of muscle to meat is measured in hours, and for full maturation , days. The manner in which this process occurs has a major influence on resulting meat quality.

Function of muscle in life







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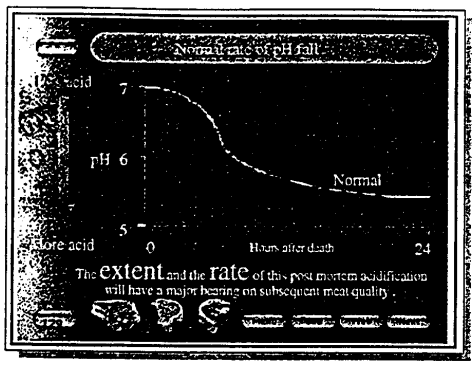
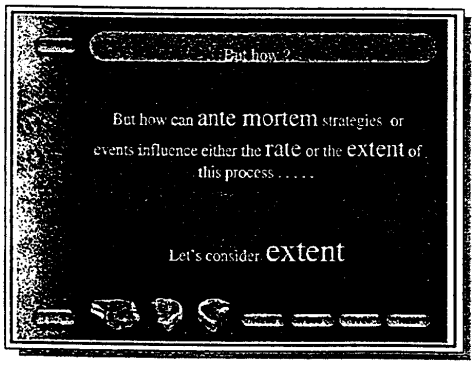
Normal rate of pH fall



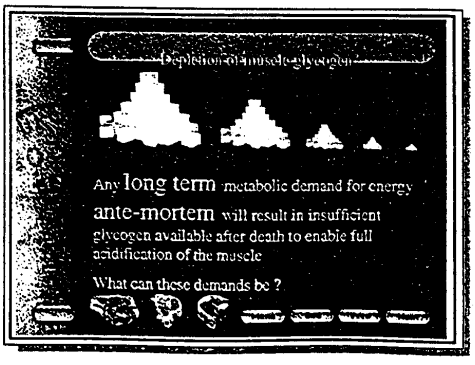
This LCD shows the normal pattern of pH fall which characterises the conversion of muscle to meat. The actual pattern of fall can have a major bearing on subsequent meat quality and both the extent and the rate of post mortem acidification are important. Post mortem metabolism continues until either all the glycogen present has been used up or when the low pH achieved disables the enzyme systems present which facilitate glycogen metabolism.

But how ?



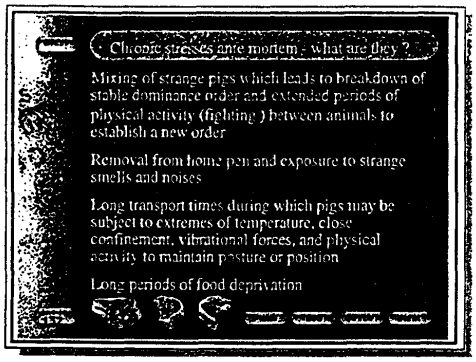
Since we have said that the pattern of post mortem acidification can have a significant impact on subsequent meat quality we will now consider how ante mortem practices can affect either the extent or the rate of this process.
We will firstly consider the extent i.e. what factors might control how acidic the muscle becomes.

Depletion of muscle glycogen



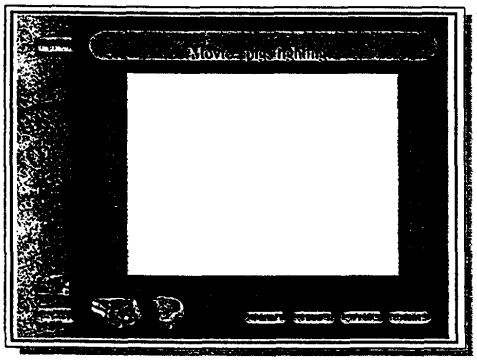
In the living animal energy production from glycogen is largely kept in balance by dietary intake and the circulation of energy substrates around the body. In the rested animal maintenance of this balance is easily achieved and at the point of slaughter the muscles contain sufficient energy reserves to allow full post mortem acidification to take place. However if there has been a long term metabolic demand for energy and the animal has been unable to meet that demand from dietary sources, then at the time of death glycogen levels in the muscles will be low and insufficient, to enable full acidification to take place. In the practical situation what might these demands be ?

Chronic stresses ante mortem - what are they ?

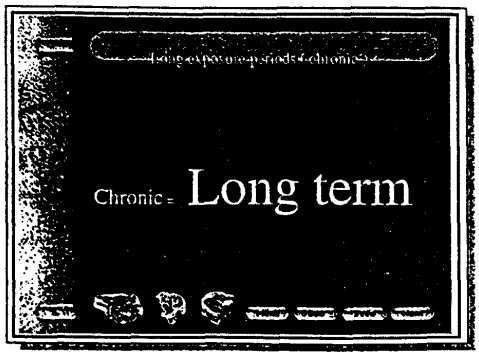


Any chronic (long term) stress will result in depletion of muscle glycogen in the ante mortem period. These stresses may be physical, physiological or even psychological and are often a combination of all three. The way in which we market animals for slaughter subjects them to a range of stresses. The procedures responsible are summarised in this LCD. It addresses the particular problems encountered with the way in which pigs are marketed and certainly pigs do present serious problems. However, similar problems exist with the marketing of cattle, particularly young bulls.

Movie - pigs fighting

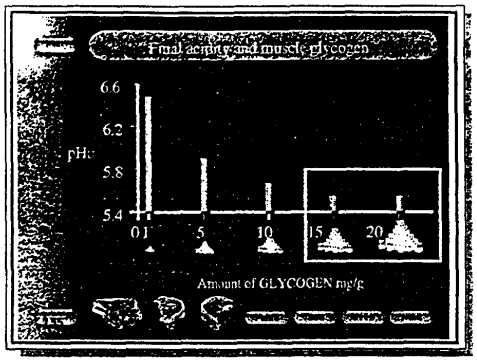


Long exposure periods (chronic)



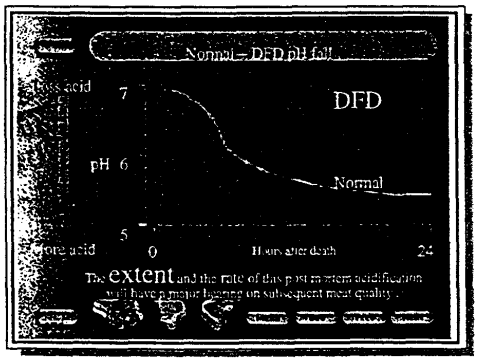
This LCD emphasises that it is exposure to long term, chronic stresses that results in muscle glycogen depletion in the live animal. The nature of the stressor can be less important than the duration of the exposure.

Final acidity and muscle glycogen



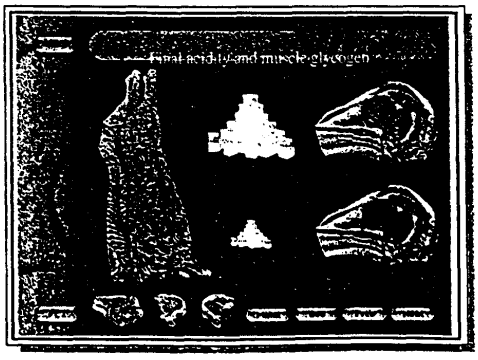
We have described how long term stress can deplete muscle glycogen to the extent that insufficient is present at the point of death to enable full acidification to take place. This relationship is shown graphically in this LCD. Where only minimal glycogen is present at slaughter the final pH of the meat remains high and it has been estimated that approximately 15 mg of glycogen per gram of muscle is required to enable full acidification to take place.

Normal + DFD pH fall



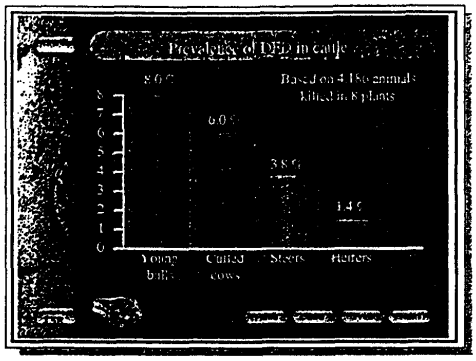
Where energy reserves have been depleted ante mortem the normal pattern of pH fall cannot occur and the final pH remains high. The high final pH has a major influence on the quality and characteristics of the meat and is commonly described as DFD (dark, firm and dry). This condition can occur in all three red meat species and constitutes a major quality defect

Final acidity and muscle glycogen



The occurrence of DFD beef has been linked to beef production from young bulls particularly where animals have been mixed immediately prior to slaughter. The stresses inflicted on these animals at this time result in severe depletion of muscle glycogen and restoration of normal levels requires several days. The result is the production of DCB (dark cutting beef) and at worst the meat appears almost black.

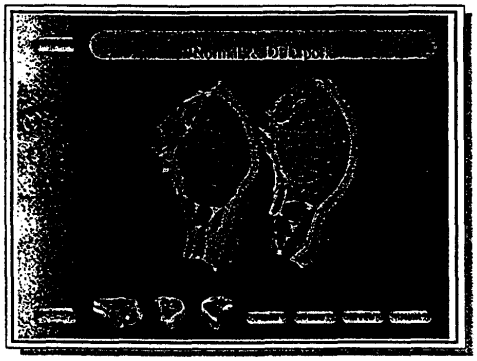
Average incidence of DFD found in the UK



Poor handling or mixing of groups of cattle will result in DFD beef. The incidence of DFD varies with the type of animal in relation to the inherent aggressive nature and how stressful different types of animal find a situation.

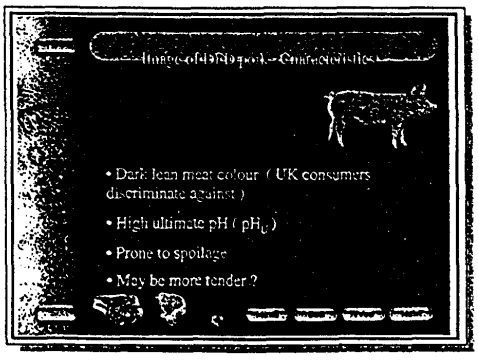
The chart indicates that the incidence of DFD found in British slaughterhouses could be improved.

'Normal' & DFD pork



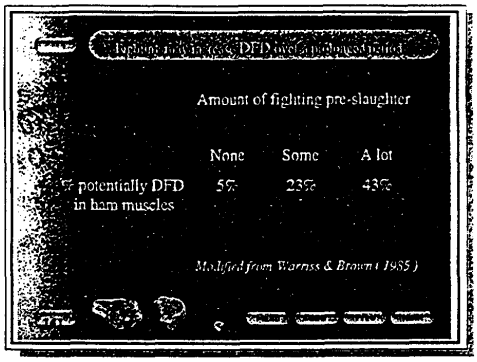
Where the DFD condition occurs in pigs it is readily identified as shown in this LCD. As with the production of dark cutting beef it constitutes a major quality defect.

DFD pork



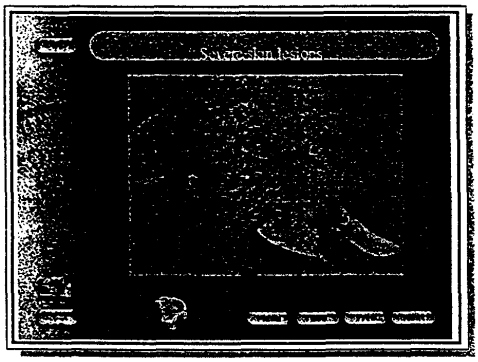
The quality problems associated with DFD meat are all a consequence of the high ultimate pH which affects the physical structure of the meat causing it to appear darker and to chemically bind water to the muscle proteins so making it appear dry. The consumer discriminates against the dark colour possibly because they associate the darker colour with meat from older animals. The major defect however is that the meat is more prone to spoilage because not only do bacteria grow faster at higher pH but also that the higher pH favours the growth of types of bacteria which utilize protein as an energy substrate.

Fighting may also increase DFD



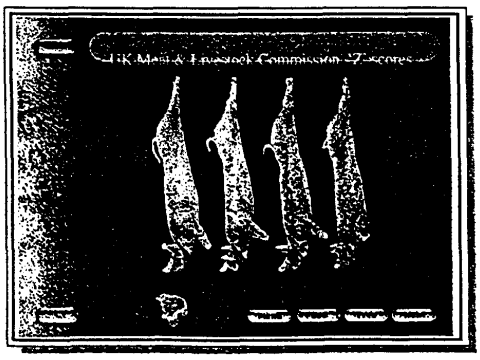
DFD in pigs is not often recognised as a problem by the industry because the effects of short term stresses are so obvious and of primary concern. However, approximately 10% of UK carcasses suffer from some DFD and the meat from them will have a reduced shelf life. A common cause of glycogen depletion leading to the production of DFD is the practice of mixing pigs from different rearing groups prior to slaughter. This results in prolonged fighting which requires high energy usage as pigs attempt to establish dominance orders.

Severe skin lesions



The consequences of pigs fighting prior to slaughter are often obvious in the finished carcass. Where the severity and/or duration is severe skin lesions are evident and can lead to downgrading of the carcass because they spoil the appearance of both pork and bacon products. They are most commonly seen around the forequarter of the animal but when severe can extend along the flank.

UK Meat & Livestock Commission - 'Z' scores



The condition is considered to be sufficiently important that the severity of the condition is assessed using a photographic scale. This assessment is described as the ' Z score ' and an example is shown in the LCD

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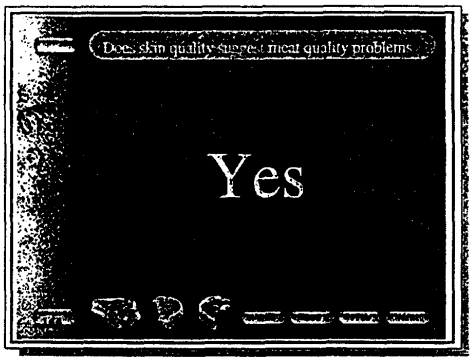
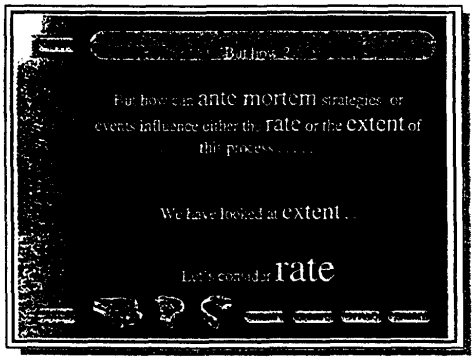
Does skin quality suggest meat quality problems



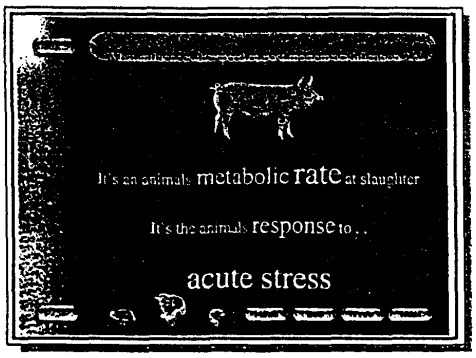
Carcasses showing severe skin damage will almost certainly produce poor lean meat quality because they are derived from pigs which have been involved in extended bouts of fighting.

But how ?



We have examined how chronic (long term) stresses can influence meat quality by preventing full acidification of the muscle post mortem. But we also know that the rate at which the acidification occurs can also affect resultant meat quality. How do ante mortem management practices exert an effect on the rate of pH fall ?

What influences the speed of post-mortem acidification ?



In simple terms energy production and energy usage in the live animal increase and decrease in response to the bodies' demands. In the resting, quiet animal the requirement for energy is low and the basal metabolic rate correspondingly is low. If the animal is exposed to physical, physiological or psychological stresses the requirement for energy increases and the metabolic rate increases to allow the animal to cope with those stresses. The response of animals (including humans) to acute stress is commonly referred to as the ' fight or flight ' response because it prepares the body to deal with the applied stress. Essentially the metabolic pathways concerned with energy production and usage are speeded up.

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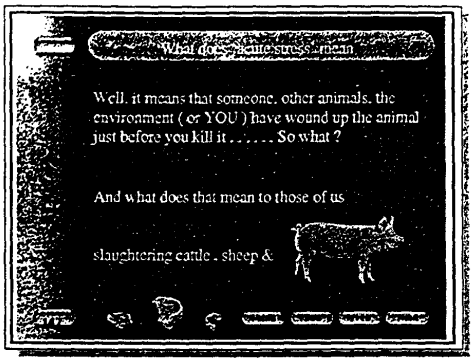
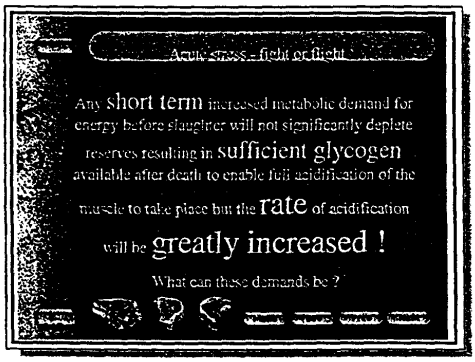
What does 'acute stress' mean ?



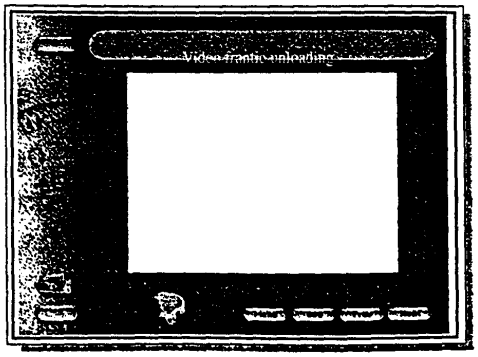
In layman's terms anything that we do to inflict severe stress on animals in the immediate pre slaughter period is likely to have consequences for resultant meat quality. These effects are particularly important in pig meat production since the development of leaner strains of pigs over the last twenty years has been associated with an inheritance of increased stress susceptibility. The increasing use of higher throughput, higher operating stress, slaughter plants increases the likelihood of stress related quality problems occurring.

Acute stress - fight or flight



As we have already described, acute stress in the immediate pre slaughter period will elicit the classic "fight or flight" response which readies the body to deal with the stressful situation. In this acute stress situation energy reserves in the form of glycogen are not markedly reduced and sufficient glycogen is present at the time of death to allow full acidification to take place. However the animals metabolic rate has been increased to facilitate response to the incurred stress and that increased rate will be operating at a cellular level even after slaughter.

Frantic unloading



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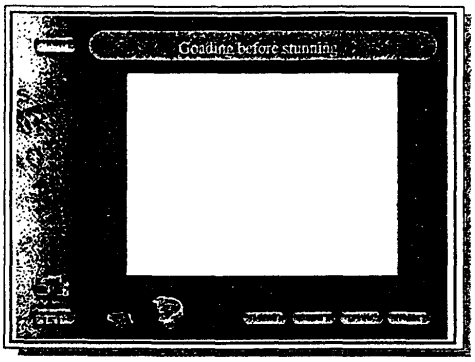
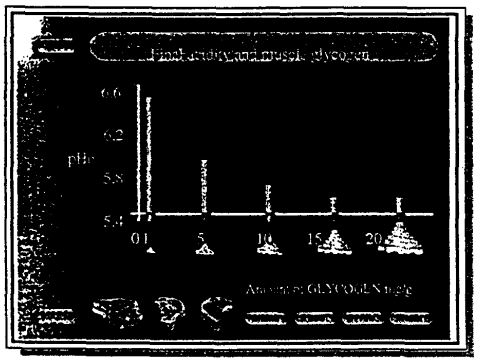
Goading before stunning



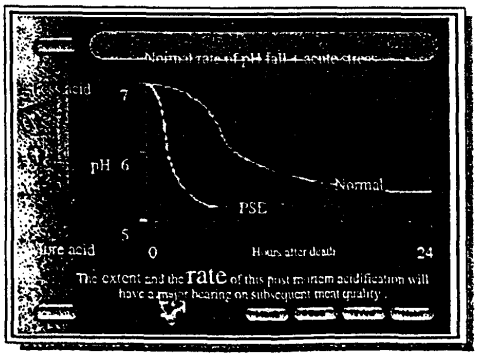
Final acidity and muscle glycogen



After slaughter live muscle changes to meat. As part of this change the meat becomes more acid. How fast this change occurs and the degree of the final acidity of the meat both help determine the quality of the meat.

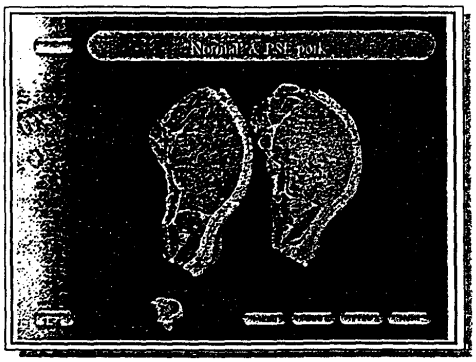
The degree of acidity is determined by the amount of glycogen present in the muscle at death. Glycogen is the fuel which powers muscle. The less glycogen that is present the less acidic the muscle will become. Muscle glycogen is reduced if animals are subjected to long term stress. This is the case in DFD beef. As the meat does not become acid enough it is not 'broken down' and remains dark, firm and dry.

Normal rate of pH fall + acute stress



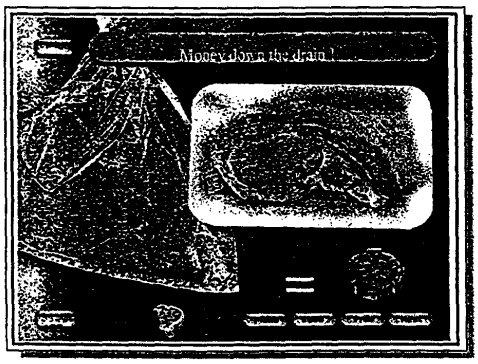
Where pigs have been exposed to acute stress immediately before slaughter the greatly increased metabolic rate is sustained after death and in the anaerobic conditions pertaining at this time the rate of post mortem metabolism is greatly increased leading to a rapid fall in muscle pH. A combination of low pH while the muscle temperature is still high affects the structural proteins of the muscle fibres and results in the production of pork meat which is pale in colour, soft in structure and an inability to chemically bind water so that large amounts of exudate are lost, particularly from cut surfaces. Such pork is described as PSE pork (pale,soft and exudative). The prevalence of this condition is a particular problem where stress susceptible breeds of pig make up a large proportion of the gene pool.

'Normal' & PSE pork



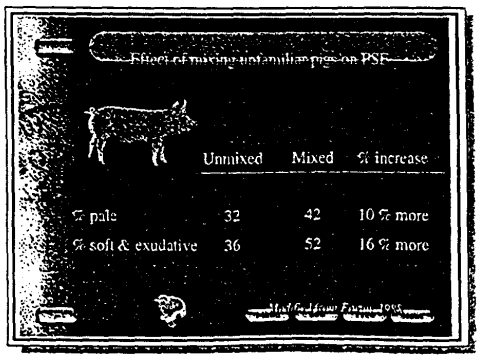
The characteristics of PSE meat make its appearance unattractive to the consumer particularly where cuts of meat are presented for purchase in multiple packs which emphasize differences in colour. Its occurrence can be identified instrumentally by measurement of lean muscle colour at 24 hours or by measuring pH at approximately 45 minutes post mortem. There is evidence that the texture of cooked PSE meat may be impaired despite the soft,open nature of the raw meat.

Money down the drain !



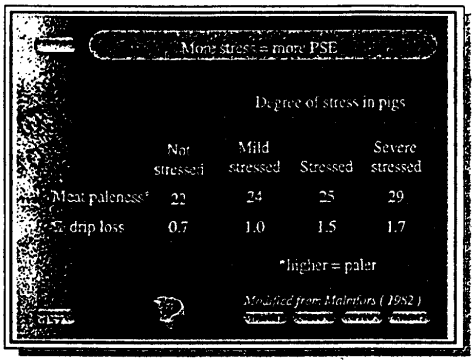
The second important characteristic of PSE meat is the amount of drip lost from the muscle tissues. This can occur in the whole carcass which necessarily results in loss of carcass weight and thus profit. The drip is particularly evident when cuts of meat are presented for sale in retail packs. The amount of drip from cut surfaces is particularly pronounced and makes the product unattractive since a pool of exudate can quickly form in the polystyrene tray. In an experimental situation drip loss can be measured by suspending slices of lean tissue in nylon netting for fixed periods and estimating the amount of loss by weight difference.

Effects on mixing unfamiliar pigs



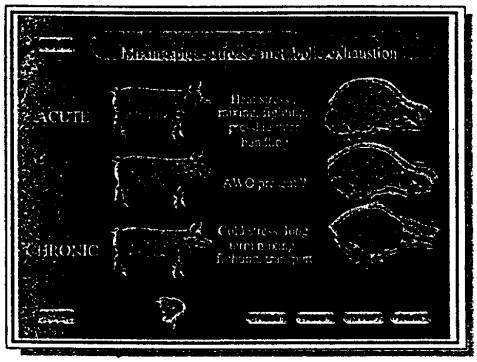
Mixing pigs at any time during the marketing process, from farm to time of slaughter, will reduce meat quality. If pigs which have not been reared together in the same pen are mixed at the farm before loading, on the lorry, or in the slaughterhouse lairage there will be an increase in stress and fighting. This will be reflected in an increase in the incidence and severity of PSE meat.

More stressed pigs show more PSE



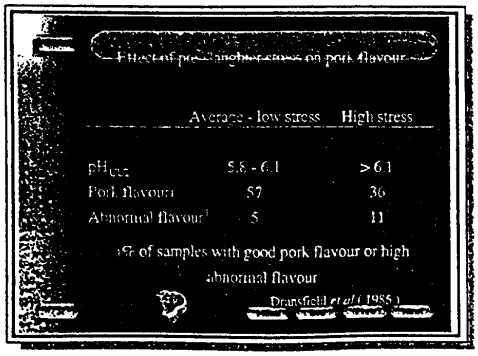
The more that pigs are stressed before slaughter, the more PSE pork will be produced. The more that they are stressed the greater will be the severity of the loss in meat quality and the greater will be the economic loss, indirectly through customer rejection and directly as carcass weight is lost through drip.

Mixing pigs - stress - metabolic exhaustion



We have described the underlying biochemical mechanisms by which ante mortem stress can influence ultimate meat quality in pigs by affecting either the extent or the rate at which post mortem glycolysis proceeds. This LCD summarises the the effects of the two types of stress which are differentiated primarily by their duration. Both situations demonstrate the close link between welfare and quality which was suggested at the outset of the course.

Effect of pre-slaughter stress on pork flavour



This data suggests that there is a further consequence of exposing pigs to extremes of pre slaughter stress over and above the effects on post mortem metabolism It suggests that pork derived from pigs exposed to a high stress situation and which produced meat with a higher ultimate pH, was judged to have less good pork flavour and a higher incidence of abnormal flavour.

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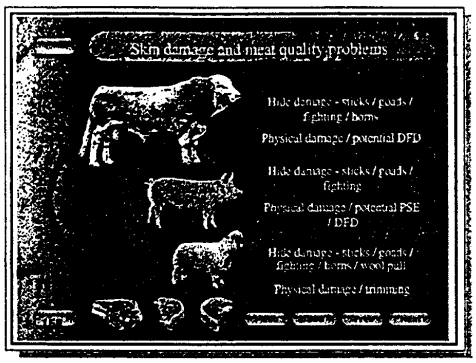
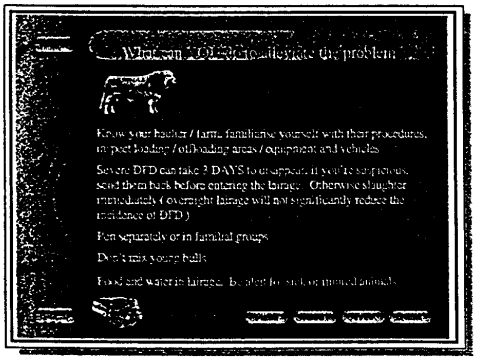
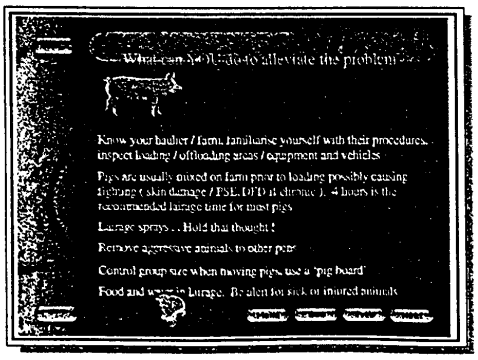
Skin damage and meat quality problems



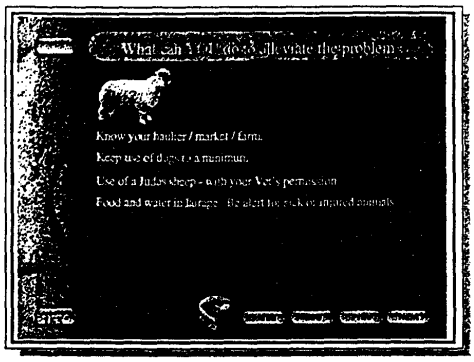
What can YOU do to alleviate the problem



What can YOU do to alleviate the problem



What can YOU do to alleviate the problem



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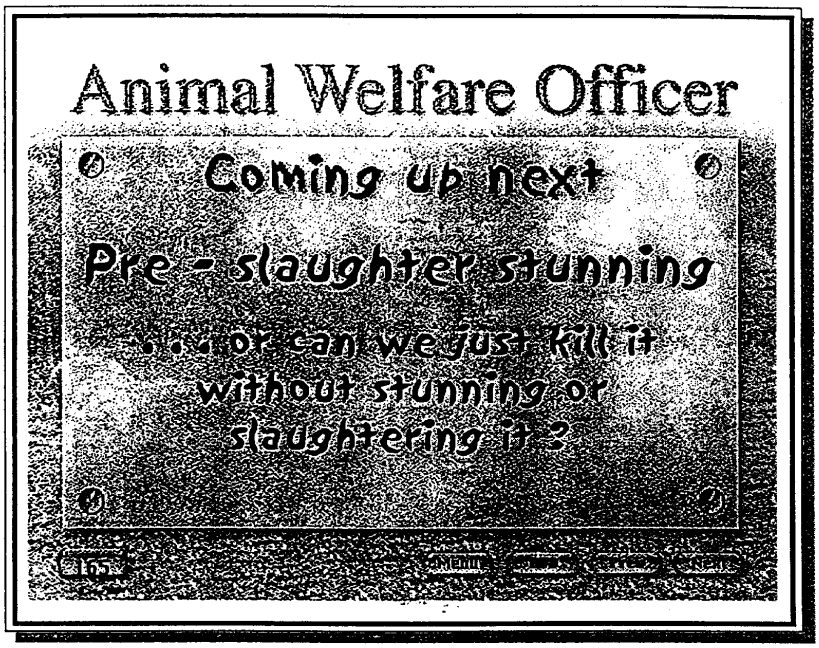

Notes

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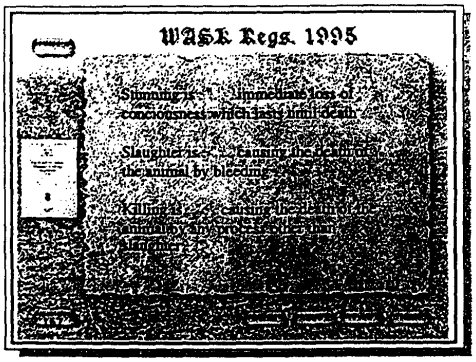
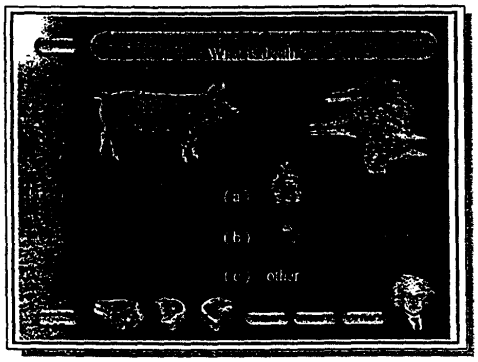


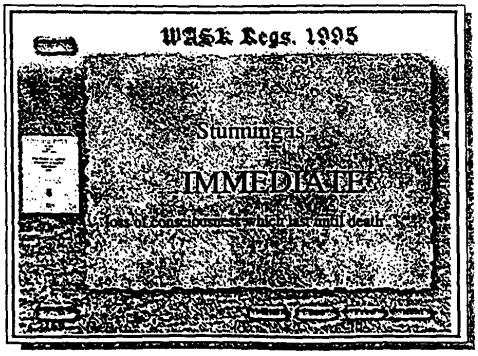
It is important to understand the differences between stunning, slaughter and killing as defined by the legislation (WASK, 1995). A 'stunning' method is one which causes the immediate loss of consciousness which lasts until death. 'Slaughter' is causing the death of the stunned animal by bleeding. 'Killing' is causing the death of the animal by any other process other than slaughter, for example, modified atmosphere killing of pigs.

What is death ?



Is death said to occur when the heart stops beating? Is an animal dead when its brain is dead? Or is death something else, for example, the death of all the cells in the body? Over half a million people die in the UK each year as a result of their heart stopping. However, brain death accounts for only 1% of all deaths each year. These people suffered brain damage from which they could not possibly recover - Yet prompt action by the doctors ensured that ventilation was taken over by a machine and the heart continued to beat. So the question is, were these people dead or alive? If death is described as 'the death of all the cells in the body' then it should be pointed out that many tissues continue to function a long time after the classical signs of death, for example the nails and hair of corpses continue to grow for a period of time after the person has been declared dead.

WASK Regs. 1995



Legislation describes stunning is the IMMEDIATE loss of consciousness which lasts until death. One of the important aspects of this piece of legislation is the word 'immediate'.

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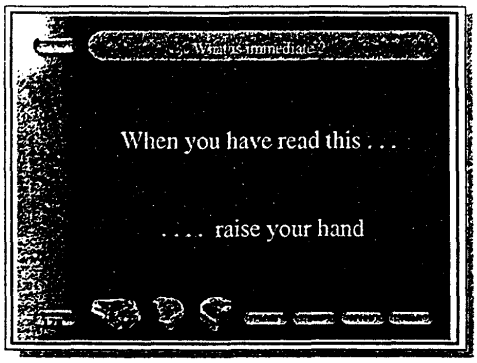
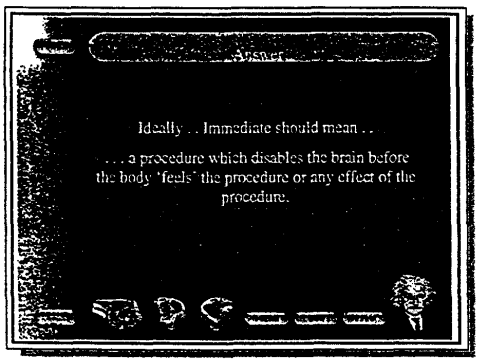
What is immediate ?

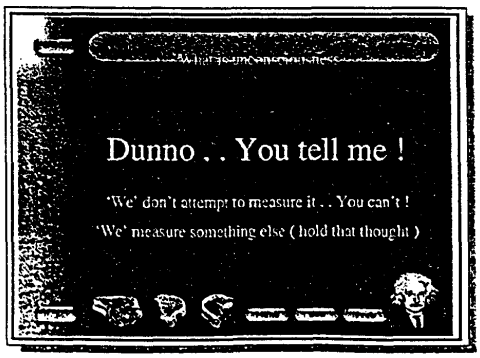


Answer



In terms of animal welfare 'immediate' should mean the application of a procedure which disables the brain before the animal feels the procedure or any effect of the procedure. In real terms this means that the stunning method should not cause the animal any pain and it should prevent it feeling the pain of any further procedures, such as bleeding.

What is unconsciousness ?



Unconsciousness with respect to the stunning and slaughter of animals is a state of unresponsiveness to an external stimuli. Basically speaking, this means the animal must not be able to feel any pain associated with the stunning method or sticking. The assessment of consciousness and unconsciousness in animals is difficult as there are no universal methods that can be applied. Therefore to assess the effectiveness of a stunning method it is necessary to consider a number of other tests.

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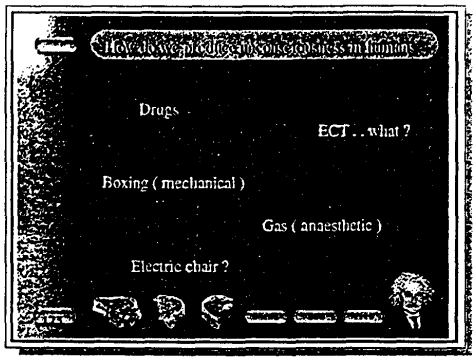
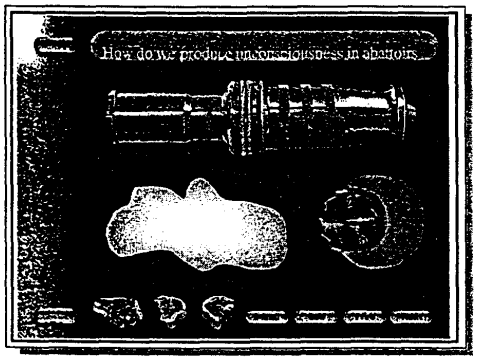
How do we produce unconsciousness in humans ?



The most common example of unconsciousness in humans, which many people are familiar with, is the administration of a general anaesthetic for the purpose of surgery. This is produced by the introduction of certain chemicals into the bloodstream of the patient.

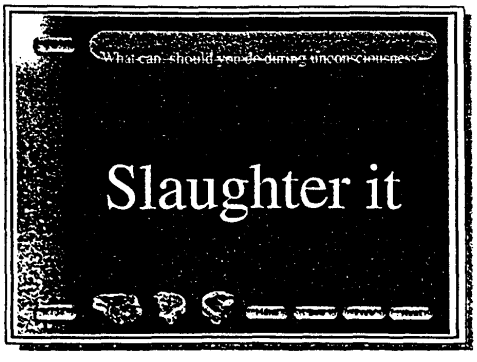
Other examples of unconsciousness in humans include: the state produced when a person suffers a blow to the head, whether it is during a boxing match or 'knocking yourself out' on a low door frame. Electroconvulsive therapy (ECT) is the administration of an electrical current to the head of the person undergoing treatment for various mental health conditions. I' is thought to cause unconsciousness followed by a state o1 amnesia (the inability to recall certain facts and events).

How do we produce unconsciousness in abattoirs ?



Unconsciousness is produced in abattoirs using the various stunning and killing methods permitted under legislation. They include the use of mechanical stunning equipment (for example a captive bolt pistol), the use of gas mixtures and the use of electricity. The way in which these methods produce unconsciousness is covered in more detail later.

What can, should you do during unconsciousness ?



During the period of unconsciousness produced by the stunning method the animal should be slaughtered. This causes the death of the animal before it recovers from

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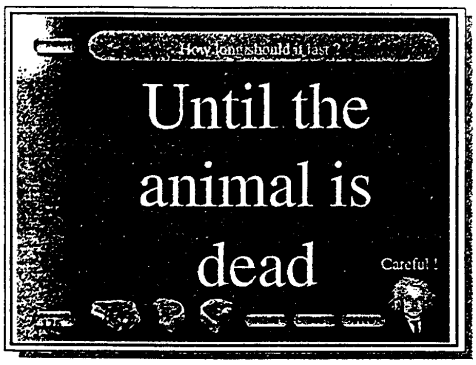
How long should it last ?



Notes

Whilst electrical stunning now exists for nearly all of the red meat species that are farmed and slaughtered commercially, as well as the innovation of new technologies such as gaseous stunning. Still for many species, simple, cheap and effective stunning is achieved using mechanical methods.

Whilst it may appear that mechanical stunning is a simple one stage process, inevitably innefective stunning compromises animal welfare by inflicting severe trauma when mechanical failure and or human error combine.

An understanding of the basic principles will allow you as the AWO to train, maintain and advise both slaughtermen and management as to the best use of mechanical stunning.

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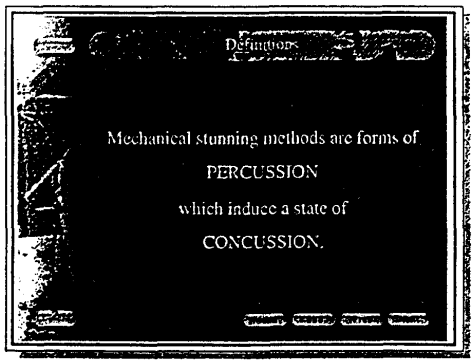
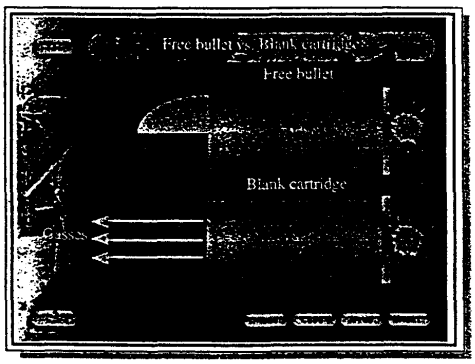
Definitions



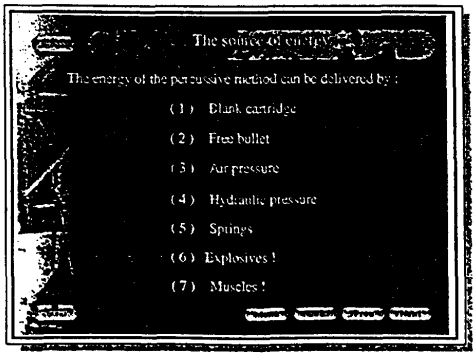
Whilst seeming a bit obvious, it's important to emphasise the simple principle of mechanical stunning. Conventionally, penetration of the head is not thought to be part of 'knocking someone out'. A severe blow to the head (percussion) is sufficient to knock them out (concussion or STUN !)

Free bullet vs. blank cartridge



In 'the field' with a hand gun, shotgun or rifle, or in the abattoir with a captive bolt, the power source that is use is a resevoir of gun powder ignited by cordite situated in the casing of the shell. In the case of 'free bullet' or shotgun, a projectile or projectiles (shot) is accelerated out of the firearm to the target. In the case of captive bolt, the bolt whether penetrating or not is accelerated out of (but not away from) the pistol towards (and into in the case of penetrative captive bolt) the target.

The source of energy



Many energy sources are / have been used to stun animals mechanically. All rely on acceleration of either an object which impacts with the animals head or a shockwave which has the same effect on neural tissue.

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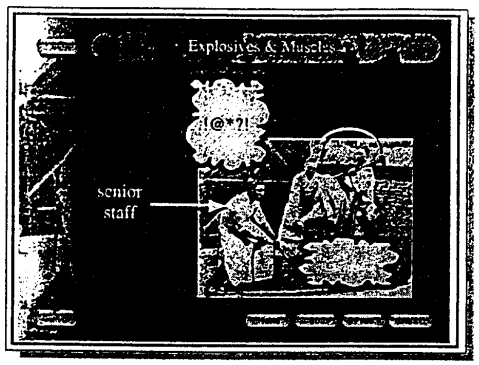
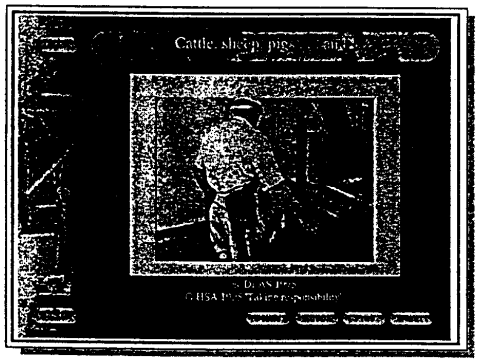
Explosives & Muscles



The 'Poleaxe' was (UK) and is (some parts of the world) an extremely effective method of mechanical stunning of nearly all species of animal. The energies involved (if you'd like to calculate them) compare favourably with any modern captive bolt system (free bullet is in a different league).

It surely was the logistics of the procedure that caused most concern. However, it is true that this method of pre-slaughter stunning is dreadfully abused in some countries which for the price of a captive bolt gun and cartridges could be avoided.

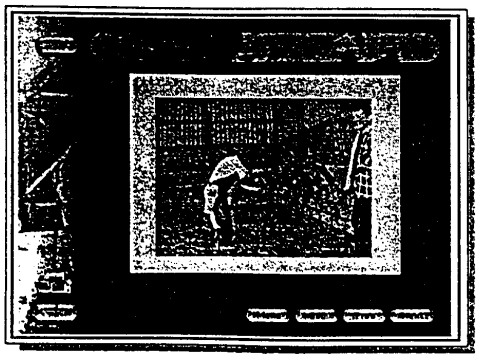
Cattle, sheep & pigs



Captive bolt stunning is generally reroducibly effective on cattle and sheep. Whilst it can be no less effective on pigs, the high degree of physical activity associated with captive bolt shooting of pigs gives some cause for concern.

The same indicies of effective stunning should be observed, although pigs tend to exhibit increased clonic (kicking) activity with increasing cartridge size and can miss out the tonic (ridgid) phase of stunning completely. In the abscence of rhythmic breathing however, the animal is stunned / dying or dead.

Cattle, sheep & pigs . . . . and



More exotic species of animals have been humanely stunned pre-slaughter. Ostriches like pigs show a high degree of clonic activity after shooting with captive bolt (invasive or non-invasive). Assessing a mechanical stun in an ostrich is difficult because of the levels of post shooting activity and the difficulty in determining other indices of effective stunning (rhythmic breathing).

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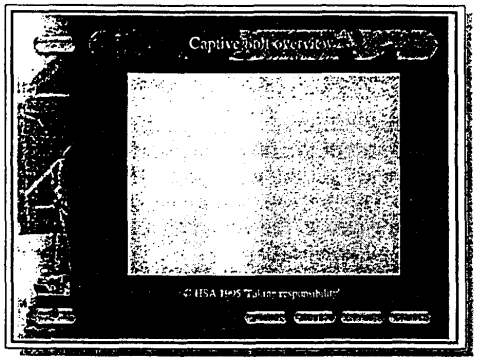
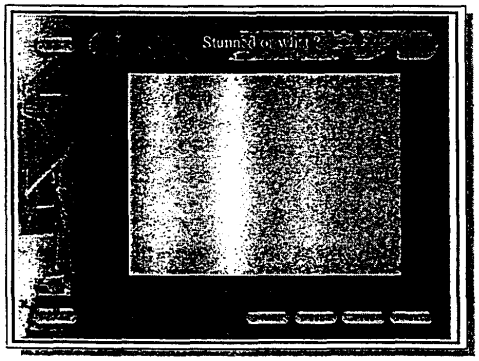
Captive bolt overview



Stunned or what ?

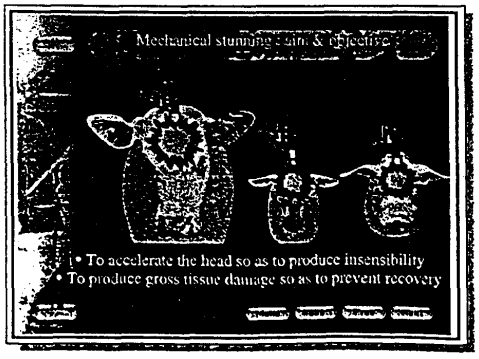


Is a high neck shot in deer a pre-slaughter stunning method ?

No . . . . a 'high neck shot' is used when a high probability of a kill is required. (See WASK definitions on Stunning, Slaughtering & Killing). The energies involved and the tissue damage incurred after a HNS are capable of 'killing' the animal rather than stunning the animal. In both cases the animal immeduately looses consciousness, but in the case of 'stunning' this definition accommodates the probability of the return of consciousness which is why 'stunning' MUST be followed by 'slaughter' whereas 'killing' needn't.

Caution : Human or mechanical error will always affect the outcome of any procedure . . . be vigilant and be prepared to act quickly to protect the welfare of the animal.

Mechanical stunning : Aim & Objective



With captive bolt the blow to the correct position on the animals head (varies subtley with species) is sufficient to produce a stunned animal. It is accepted that the animal in most cases will recover from the blow, in extreme cases using the highest power cartridge (0.25 calibre 6 grain (Red)) animals can cardiac arrest AFTER humane stunning. This condition is VERY rare and is not likely to be seen routinely in any abattoirs. The animal having been stunned by the superficial blow will recover where the captive bolt is not penetrative (mushroom headed knockers). Where the captive bolt penetrates, the tissue damage to deep brain structures AFTER a humane stun (during unconsciousness) is such that the animal is unlikely to recover and even die. Legislation (WASK 1995) requires 'stunning' to be followed by 'slaughter' (or pithing where allowed) to kill the animal.

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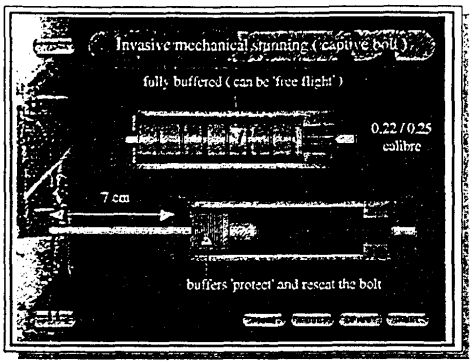
Invasive mechanical stunning (captive bolt)

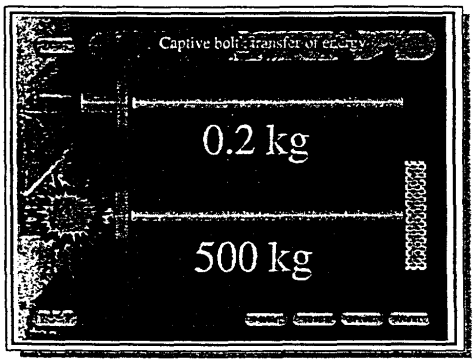


The design of a captive bolt gun is simple and robust. Modern mettalurgy allows for the construction of gun with high performance and durability.

All new guns are 'fully buffered'. The buffers protect the barrel end from the impact of the bolt and return the bolt back to the firing position ready for the next shot (IF PROPERLY MAINTAINED !). The buffers wear out and should be replaced with the spare one in the new box of cartridges so that over time they are all renewed.

The average bolt extension is 7cm, bad maintenance can decrease this with consequences for welfare. Other designs simply have longer bolts (eg. Cox Universal).

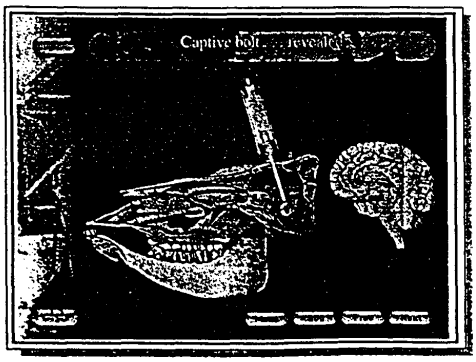
Captive bolt : Transfer of energy



It is very difficult to give an impression of the 'size' of the blow . . . it's all horrible physics of impulse forces and the stuff we hated at school. Having said that . . . an indication of the forces involved is show in the thumbnail opposite. A captive bolt weighing 200g (0.2Kg) travelling at the average speed normally produced by a pistol, will hit an object with a force equivalent to 500Kg (2,500 x the weight of the bolt).

Interestingly (scientific bit) very little of that energy is transmitted to the animal , most of it stays in the gun . . . . conservation of energy and all that !

Captive bolt revealed



Diagramatically the ideal is a blow of sufficent velocity (force) and penetration to the deep brain structures so as to render the animal stunned and unlikely to recover. Captive bolt is a 'pre-slaughter stunning method' NOT a killing method under the law (WASK 1995).

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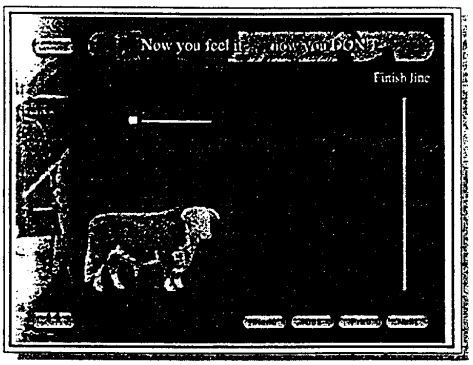
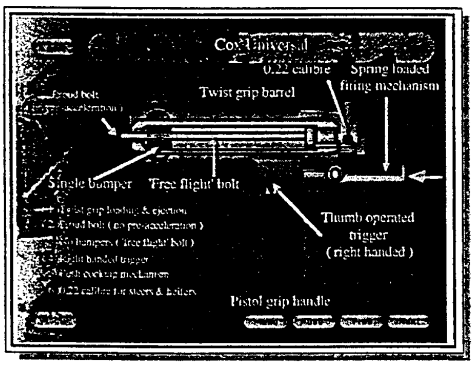
Now you feel it . . now you don't



You have to go on the Animal Welfare Officer Training Course to experience the full impact of this demonstration . . . many people have commented that . . well anyway . . . !

You, he, she . . IT can't feel the shot because nerves work slower that captive bolt . . . . . OK !!!

Cox Universal



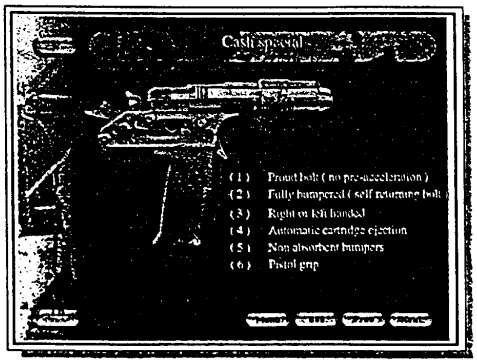
The Cox Universal is a 0.22 calibre captive bolt that is 'handed', a left handed person would find this awkward since the thumb trigger is on the LHS !

It is also one of the few guns that is NOT fully buffered. This does not increase the performance, however the Cox Universal (now made by Accles & Shelvoke) is one of the faster captive bolt pistols with the deepest penetration.

For more info, see their Website !!

http://www.acclesandshelvoke.co.uk/

Cash Special



The Cash is a very popular gun made by Accles & Shelvoke.

For more info, see their Website !!

http://www.acclesandshelvoke.co.uk/

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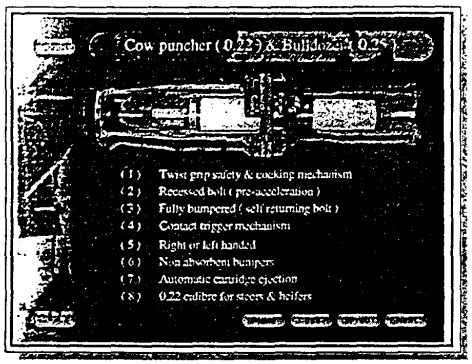
Cowpuncher (0.22) & Bulldozer (0.25)

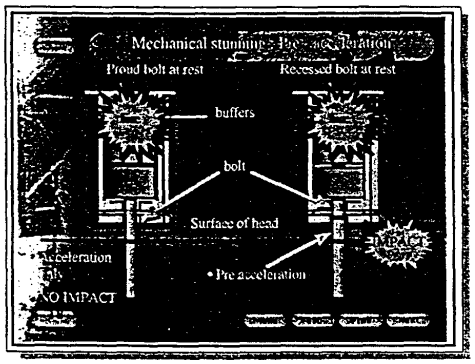


The Cow Puncher (0.22 calibre) and it's big brother the Bulldozer (0.25 calibre) are examples of captive bolt pistols that do not resemble a conventional gun as well as having a trigger which fires on contact with the animals head. Used in high throughput cattle plants in the UK and abroad.

For more info, see their Website !!

http://www.acclesandshelvoke.co.uk/

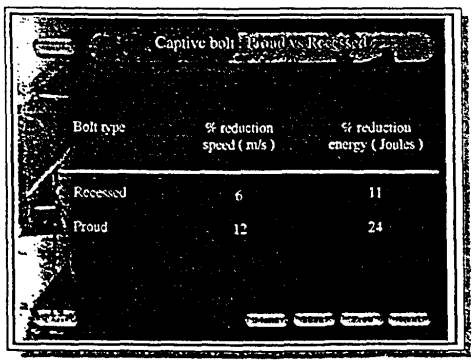
Mechanical stunning : Pre - acceleration



It is . . . . when a bolt is moving at nearly maximun speed (and therefore energy) before it it strikes the animals head.

Some guns have 'proud' bolts which are in contact with the skin before shooting. This requires the explosive charge to accelerate the bolt whilst already in contact with a hard surface of the head. This can in conjunction with poor positioning, incorrect cartridge, badly maintained gun and the hardness of the skull, be the cause for innefective stunning in cattle.

Captive bolt : Proud vs Recessed



The table opposite shows that a recessed bolt with pre-acceleration looses less speed and less energy than a proud design when shooting an animal. This would appear to to suggest that the recess would cause a less effective stun. In reality it is generally more effective since the amount of energy that is transmitted to the head from the bolt occurs in a much shorter period of time. Since the bolt is moving prior to contact, there is an impact which is not present in 'proud designs'. In these cases, whilst the stun (applied correctly) will still be effective, some of the energy is lost since it only accelerates and does not impact. Concussion stunners rely solely on impact, and all have pre-acceleration so would transfer more energy over the same short period of time . . hence their effectiveness.

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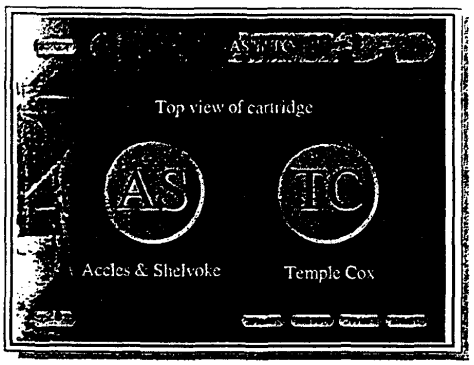
AS 'n' TC



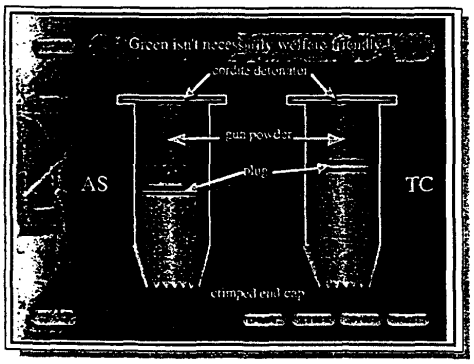
This scenario should NOT exist now, but I've put it in just in case !

Some plants were using Temple Cox guns (TC) and some plants were using Cash guns made by Accles & Shelvoke (AS) . . some were using both !

There WAS a discrepancy between the manufacturers cartridge colour coding and the amount of gunpowder in them (grains - a grain is 65mg of gunpowder . . . not very much !). Since Accles bought Temple Cox, this discrepancy has been abolished since there is only one supply and one colour coded scale of grain size for both 0.22 and 0.25 calibre guns.

Just go and check your stock though . . to be sure !

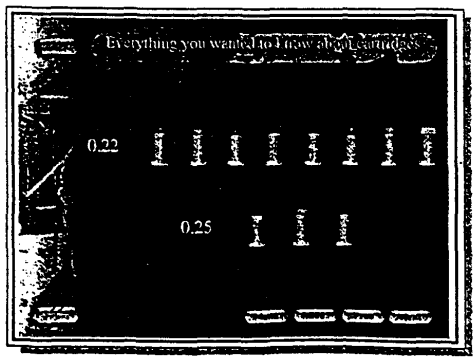
Green isn't necessarily welfare friendly !



As stated previously the discrepancy between Cash (AS) and Temple Cox (TC) has been resolved.

A BLANK cartridge is a simple piece of kit ! A plug holds the gunpowder in the casing at the base of the cartridge next to the cordite. Cordite is smeared CAREFULLY arount the base and rim of the casing and is detonated by the eccentrically placed firing pin of the gun on shooting. The cordite burns at phenomenal rate ingniting the gunpowder at the same time (gunpowder doesn't actually burn that well !) thus producing enormous volumes of hot exhaust gasses in the confined space of the breach so expelling the bolt down the barrel of the pistol . . . OK !

Everything you wanted to know about cartridges



Cartridges are colour coded. The colour relates to the amount of gunpowder at a given calibre. Changing cartridge power can be useful in ensuring humane reproducible stunning whilst not placing excessive strain on both the gun and slaughterman.

For more info, see their Website !!

http://www.acciesandshelvoke.co.uk/

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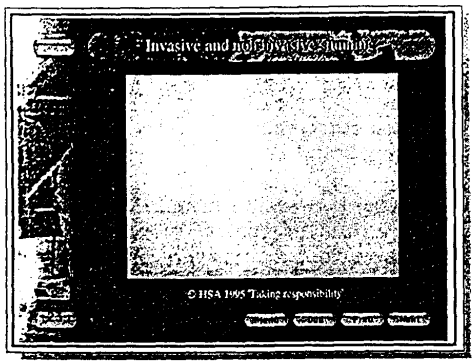
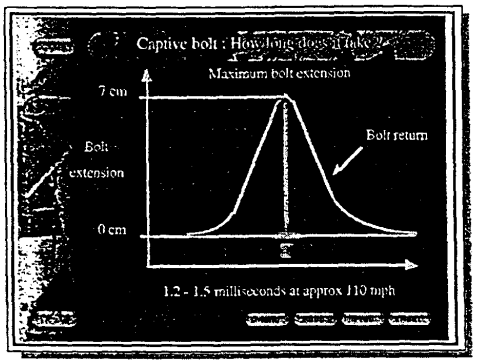
Invasive and non invasive stunning.



There is a qualitative difference between the two types of captive bolt application, however, quantitatively they BOTH produce a humane stun for slaughter to take place during the period of insensibility.

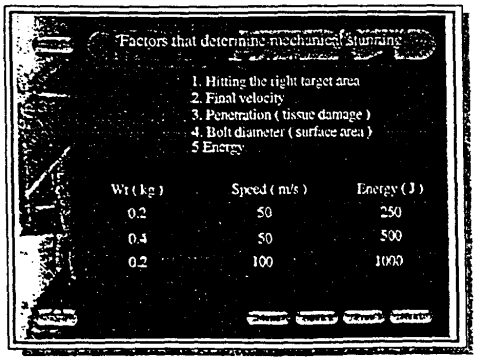
Invasive stunning is commonly understood to mean invasive captive bolt whilst examples of non-invasive systems are the mushroom headed knockers. We / I keep comimg back to the debate of an irreversible stun which intuitively means you've killed it ! The invasive captive bolt may achieve this in practice however, in law (WASK 1995) it is a stunning method NOT a killing method and as a consequence should be followed up by vigilance, slaughter and / or pithing.

Captive bolt : How long does it take ?



Well, it's fast . . . ! On average (purple cap) a captive bolt will travel to full extension (average 7cm) in 1.2 - 1.5 thousandth's of a second. This is roughly a hundred times faster than nerve conduction velocity and so conforms to the WASK requirements for 'immediacy' . . . taking that to mean in this case that the animal is rendered insensible to pain (unconscious) before the animal could ever have felt the shot application.

Factore that determine mechanical stunning.



Of all the criteria we could look at . . Target area . . Penetration . . Bolt diameter . . the energy from the final velocity of the bolt on impact is the single most important factor that ensures reproducible effective mechanical stunning.

The amount of energy is more affected by speed that . . say, the weight (mass really !) of the bolt. So, compromising the performance of the gun by whatever means has a profound effect on the efficay of the stun. There is however no 'amount of energy' that can be said to produce a stun below which you won't, above which you will, since you may have messed up the application ! Having said that, we all appreciate that very low energies are likely to be inneffective, so we are really talking about maintaining the performance of any gun to NOT LESS THAN the manufacturers specs.

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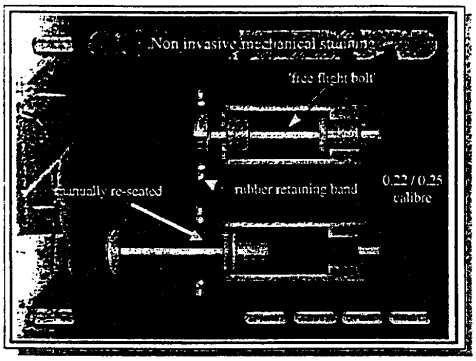
Non invasive mechanical stunning.

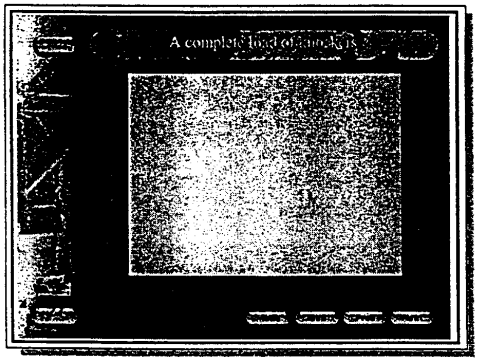


The mushroom headed knocker tends to be 'free flight' with a single buffer to protect the end of the barrel from excesive impact damage. It is the modern equivalent of the poleaxe ! It produces a stun from which the animal may recover since there is no gross tissue damage to prevent this occurring. It came back into popularity with the BSE crisis in an attempt to avoid cross contamination with invasive captive bolt. In practice it is harder and more tiring to use in a commercial plant and the OTMS scheme takes care of the BSE problem.

For more info, see their Website !!

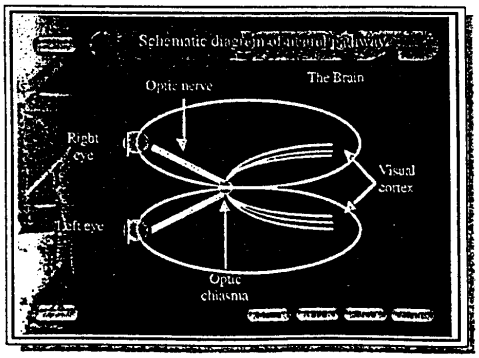
http://www.acclesandshelvoke.co.uk/

A complete load of knockers



Although (obviously) you can't see it, the video clip that is this thubnail shows clearly that non invasive systems are as equally effective as invasive systems. However, as an AWO, be vigilant when observing the stunning process and check for effective stunning, short stun-to-stick intervals and good sticking . . whilst the animal is insensible . . . if in doubt . . reshoot !

Schematic diagram of neural pathway.



Well, here's the science bit. 'We' measure 'residual consciousness'. You can't prove, and nobody can measure whether you're conscious whilst you are reading this . . if you started at the front of the manual, then by now you probably aren't ! What scientist do (amongst other things) is to measure a simple response to a simple stimulus. It is argued (and no one disputes it) that when this simple response has gone, then the more sophisticated process in the brain that is 'conscoiusness' MUST have dissapeared at the same time but more likely before this measurable response is lost.

The response is 'evoked' by the stimulus applied . . say a flash of light in the eye . . this Visually Evoked Response or VER is then observed as the animal responds to a stunning or slaughter teatment thus giving us / you . . . TIMES !!!!!!

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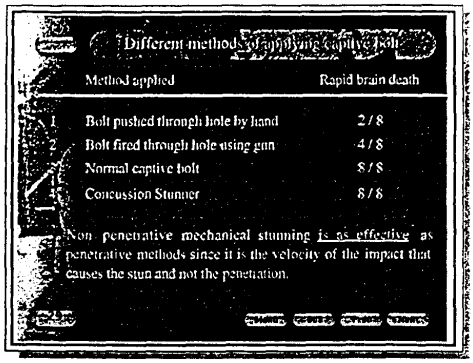
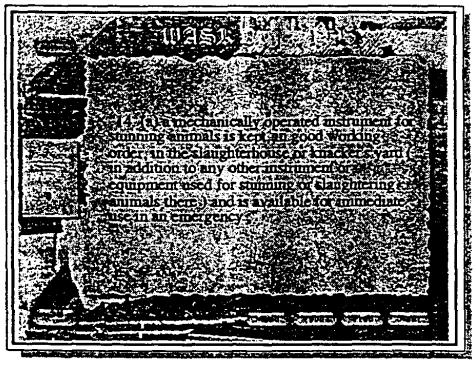
Different methods of applying captive bolt.



This series of experiments show conclusively that the skull and it's integrity plays a crucial role in determining the efficacy of mechanical stunning. The captive bolt pushed through a hole by hand or fired has between 25 and 50 % chance of producing a stun. Whereas a penetrative or non penetrative shot onto an intact skull has a 100% chance of producing a stun.

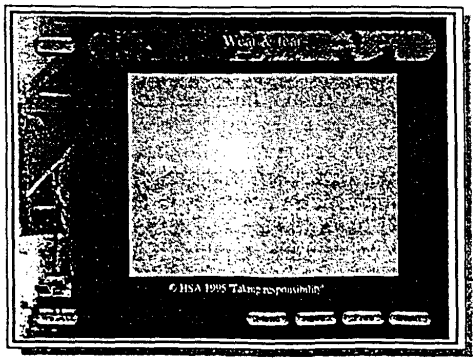
WASK Regs.



Unfortunately these are the old regs., but I've put them in here to emphasise good common sense and practice.

ALWAYS have a mechanically operated backup stunner at the stunning point IRRESPECTIVE of the pre slaughter stunning or killing method (Carbon Dioxide).

Wear & Tear



Gun maintenance is essential on a regular basis. ALL guns should be included in the daily / weekly round of maintenance ensuring optimum performance and reliablity during use.

The performance of some Cash guns can be checked using the 'Cash Stuncheck'.

For more info, see their Website !!

http://www.acclesandshelvoke.co.uk/

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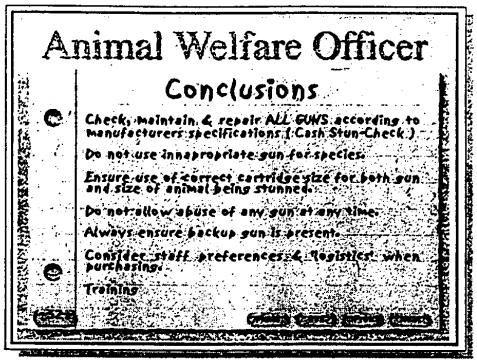
Conclusions



Check, maintain & repair ALL GUNS according to the manufacturers specifications (Cash Stun Check).

Do not use innapropriate gun for species.

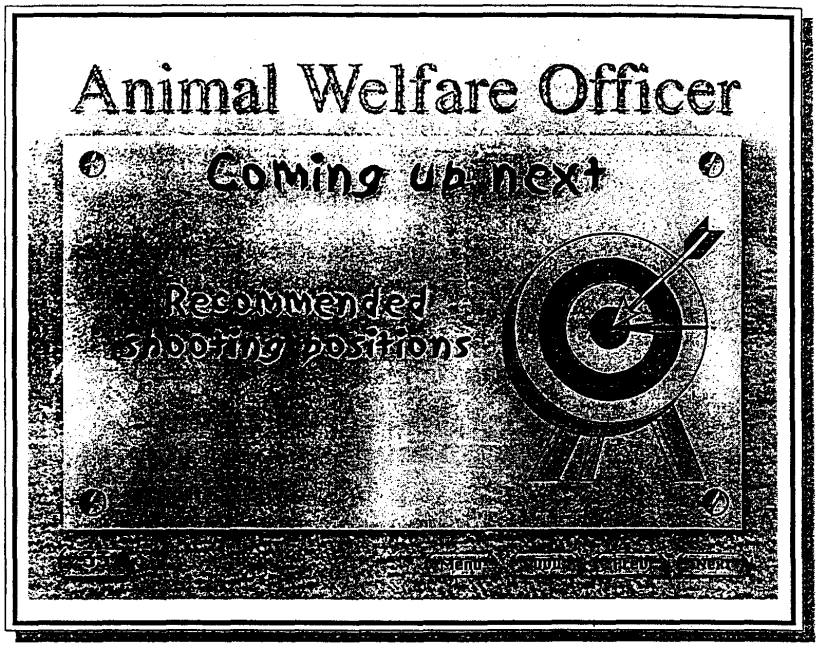
Ensure use of correct cartridge size for both gun and size of animal being stunned.

Do not allow abuse of ANY gun at ANY time.

Always ensure backup gun is present.

Consider staff training and logistics when purchasing.

Cascade training from the AWO Training Course.



Notes

The shooting positions of all species vary. This is because of the reletave position of the brain tc identifyable surface features. It isn't the case that we can target the nose and produce a stun !! Quite logically we target a centre point over the brain as described by some simple rules. Equally important, the trajectory of the bolt (if penetrative) is a component of the shot which MUST be taken into consideration. The surface position (with sufficient energy) can stand 'some' variation, but, the combination of the surface target and the requirement to pass penetrative captive bolt through specific parts of the underlying brain structure to ensure loss of recovery defines optimum position AND angle for each species.

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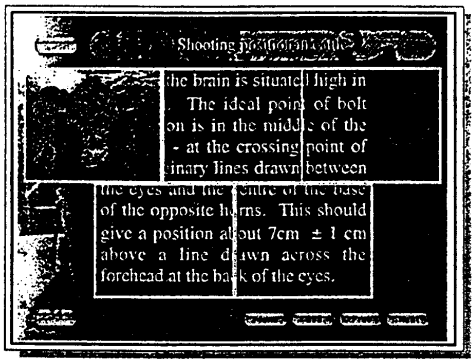
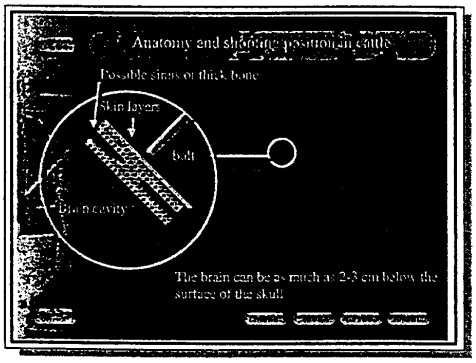
Shooting position in cattle.



A crossing point of two imaginary lines drawn between the eyes and the base of the opposite horns. This gives the optimum position of a target area about 7cm ± 1 cm above a line drawn across the forehead at the back of the eyes.

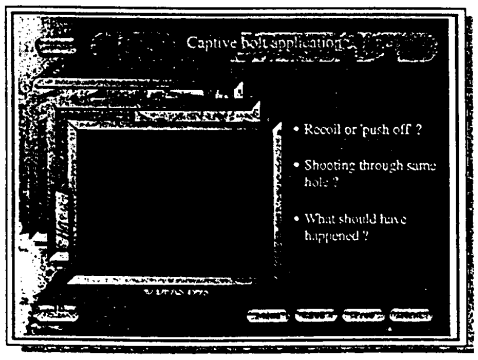
REMEMBER : Surface position AND angle of trajectory are the two main components - in this case you would need to be at right angles to the forehead.

Anatomy and shooting position in cattle.



We have discussed . . . or rather I have . . the merits of surface position AND angle in captive bolt shooting of animals. Anatomicly there are other considerations. In large cattle there can be as much as 2/3 cm of highly resistive tissue to penetrate before reaching the crainial cavity in which the brain 'floats'. The impact on the surface should be sufficient enough to produce a stun, but in some cases that's not waht happens . . . . nothing happens. The composition of the bone and tissue can act as a 'buffer' to the intended effects of the shot. Rather than transmit an impluse shock to the head (producing a stun) the 'compliance' of the tissue absorbs sufficient energy to

Captive bolt application.



If you've been on the AWO course you will know the issues behind these three important videos.

Badly maintained guns / duff cartridges / bad application / animal movement can compromise the application of the shot. In the first clip the gun performance is so poor that the bolt can be seen pushing the gun off the animals head . . given that this video is at 25 frames per second and we can see it, the gun must be very slow (poor maintenance) . it was a purple cap !

Do NOT shoot through the same hole . . move slightly back (1cm) and to one side (1cm).

He should have changed the gun . . increased cartridge size and changed position !!!!

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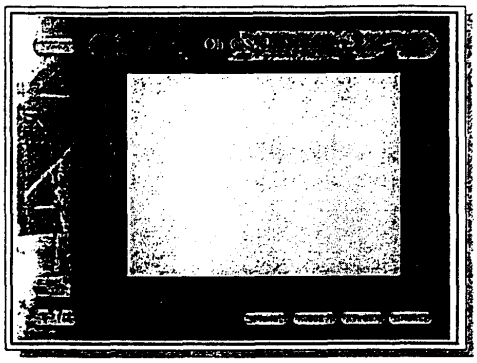
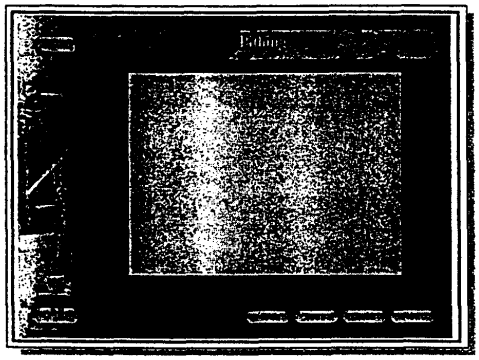
Oh @$%! . . . .



Well . . . sometimes with the best will in the world . . . it doesn't work. Many factors contribute to this scenario. DO EVERYTHING IN YOUR POWER to minimise / remove all the potential problems BEFORE you shoot. In some case (duff cartridge / mechanical failure) ther is little you can do . . . . but, if you (the slaughterman) are tired, bored, insensitive, hung over, badly trained, over confident, badly supervised, poor working conditions leading to errors, bad / broken equipment . . then do something about it . . if it was you being shot by the person described here . . . you'd want something done !

This is rarely the case . . . but be vigilant . . you may be on the Evening News . . some people already have thanks to micro video technology !!!!!!

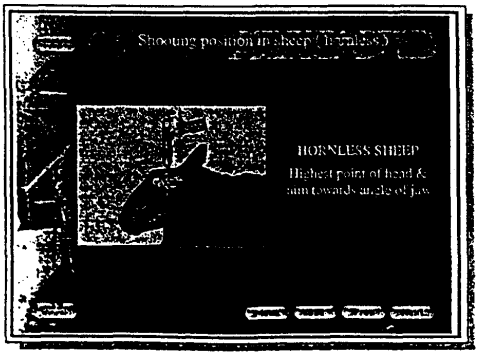
Pithing



It's a great shame that pithing is being banned in UK from December 31st 2000 for the slaughter of cattle, sheep or goats intended for human OR animal consumption.

A shame because as a welfare tool it's a good way of ensuring the death of a stunned animal with or without bleeding. This is an example of hygiene / food safety conflicting with welfare.

Shooting position - hornless sheep



Quite simply (if you've read the previous pages !) you need to target the highest point of the head and aim towards the angle of the jaw. This because of the optimum impact point for maximum impulse force AND the resulting trajectory destroying critical brain structures that prevent recovery.

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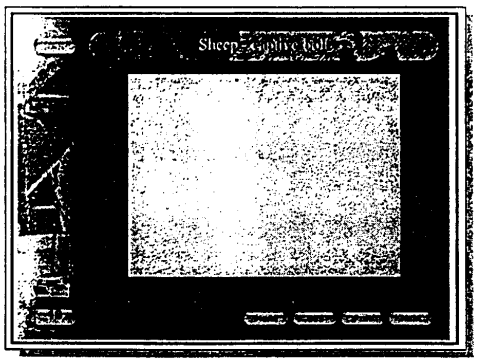
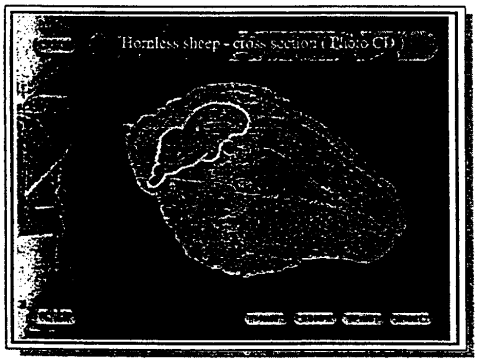
Sheep - captive bolt



This video clip (if you went on the AWO course), you will remeber shows a sheep being humanely stunned (how do you inhumanely stun . . . interesting thought. It would be a situation where the end result was unconsciousness, but the procedure was not 'immediate' . . in other words a conscious animal was repeatedly shot / hit until unconsciousness was achieved but maybe not as a consequence of the attempted stunning procedure)

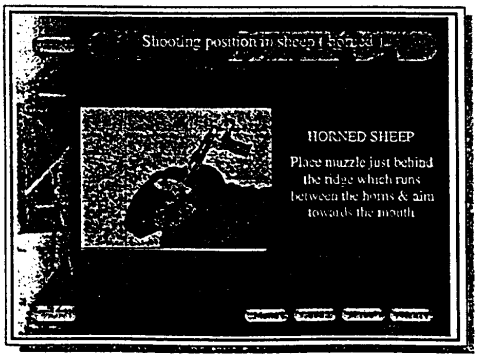
Anyway . . . this sheep demonstrates the shot . . the tonic or rigid phase, leading to the clonic (kicking phase) followed by slaughter whilts unconscious.

Hornless sheep



Quite simply . . again (if you've read the previous pages !) you need to target the highest point of the head and aim towards the angle of the jaw. This because of the optimum impact point for maximum impulse force AND the resulting trajectory destroying critical brain structures that prevent recovery.

Shooting position (horned)



Quite simply (if you've read the previous pages !) you need to place the muzzle of the gun just behind the ridge which runs between the horns and aim towards the mouth. This is a concession to the 'frontal' position because of the presence of horns and the resulting change in shape of the animals head which would make the criteria for hornless sheep incorrect. In these cases it is still (and always) because of the optimum impact point for maximum impulse force AND the resulting trajectory destroying critical brain structures that prevent recovery.

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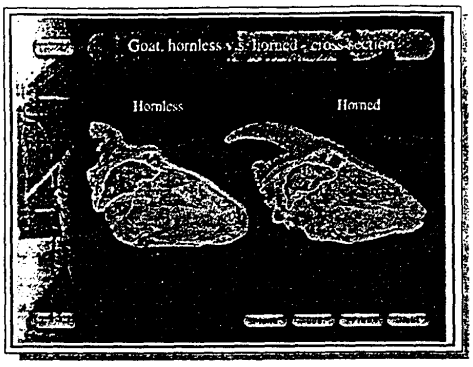
Goat, horned vs. hornless

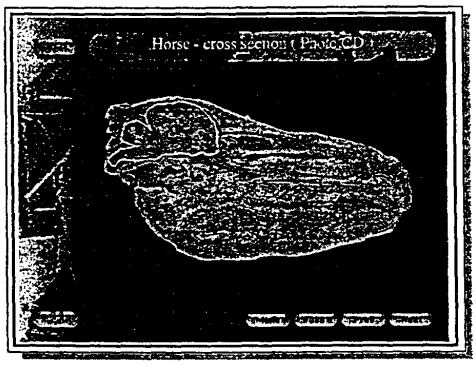


See the previous notes on this subject !

N.B. Even hornless goats would present a problem if you applied the criteria for hornless sheep . . it's true to say that all goats should be shot in the 'poll' position because of the morphology (shape) of the skull even when it does not have horns.

N.B. AGAIN - The WASK Regs. demand that any sheep or goat MUST be exanguinated (stuck) within 15 seconds of shooting . . this because there is always more risk of innefective stunning due to the problematic nature of th targeting and the absorptive nature of the tissue through whic.. you shoot.

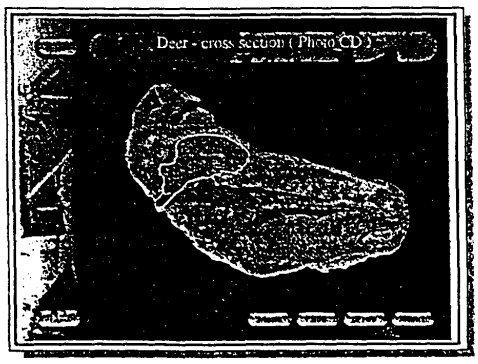
Horse



You can see the relative position and size of the brain. For shooting of horses it would be as well to look at the booklet from HSA on this contained within the AWO manual.

The physiology and mechanics and rquirements are no different to any other species other than when free bullet is used (as opposed to captive bolt) the head position and alignment of the rifle or hand gun is such that the path of the bullet is directly down the track of the spinal cord. Bullet fragments commonly end up in the neck, shoulders.

Deer

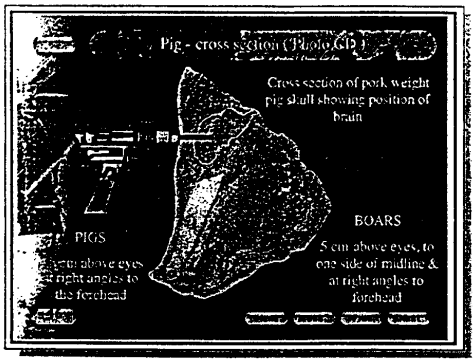


You can see the relative position and size of the brain. For shooting of deer it would be as well to look at the booklet from HSA on this contained within the AWO manual.

The physiology and mechanics and rquirements are no different to any other species other than when free bullet is used (as opposed to captive bolt) the head position and alignment of the rifle or hand gun is such that the path of the bullet is directly down the track of the spinal cord. Bullet fragments commonly end up in the neck, shoulders and some with high powered rifles can be found in the hind quaters !

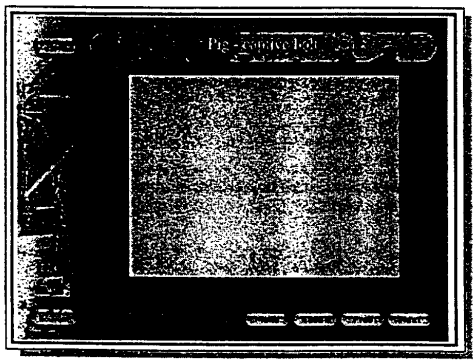
In deer a High Neck Shot is commonly applied, hitting the soft tissue at the base of the brain so reducing the chance of ricochet. Frontal shots are also applied as well as captive bolt.

Pig



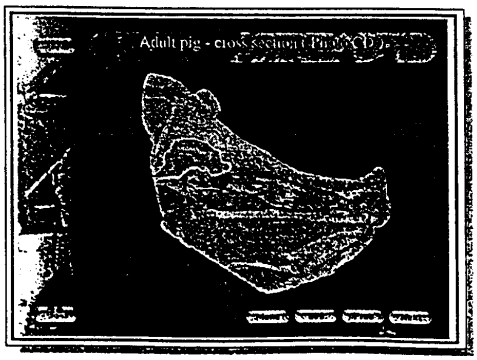
Shooting of pigs with captive bolt is not an exact science. Always use the highest grain size for the gun . . preferably use a 0.25 calibre gun (Cash Magnum 9000) with ared cap (6 grain). That is not to say that a Cash Special won't stun a prime pig, but use a black cap cartridge. Pigs are unusual in so far as they rarely display the tonic (rigid) pase after shooting. Rather, they exhibit high levels of clonic (kicking) activity which gets worse usually as you increase the size of the cartridge. Targeting, 2.5 cm above the eyes and at right angles to the foehead. The brain is quite small in proportion to the size of the head.

Pig - captive bolt

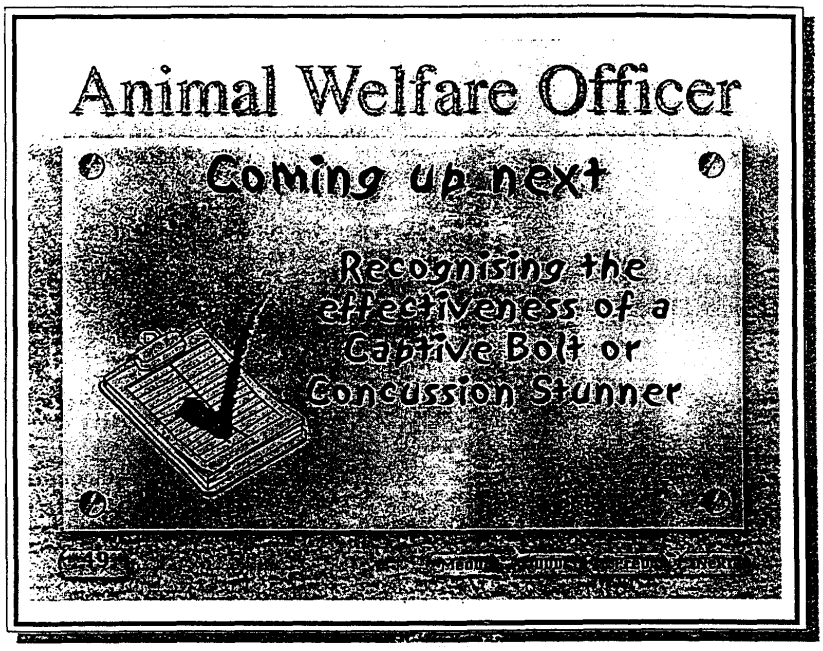


This clip shows the problem with clonic activity after a good humane stun. Shackling can be impossible until the activity ceases. Ensure that the animal is correctly stunned.

Adult pig



This shows the problem with captive bolt on sows and boars. The skull growth and composition can make even the most powerful guns innefective. Use a shotgun (see HSA booklet on firearms), electricity (head to back stunning, or Carbon Dioxide.



Notes

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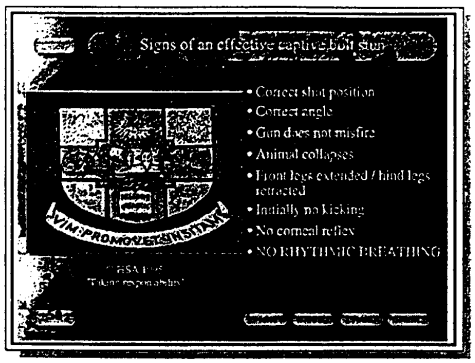
Signs of an effective captive bolt stun

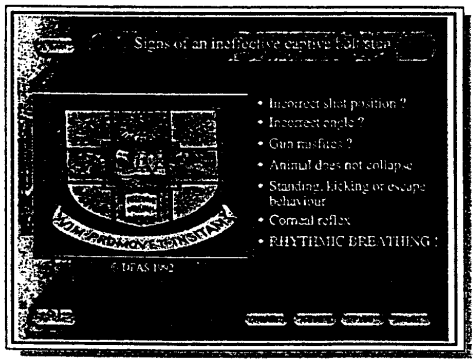


Well . . this applies to all species when mechanically stunning.

Correct position
Correct angle
Gun doesn't misfire
Animal collapses
Front legs extended / hind legs retracted
Initially no kicking
No corneal reflex

NO RHYTHMIC BREATHING !!!!!!

Signs of an ineffective captive bolt stun

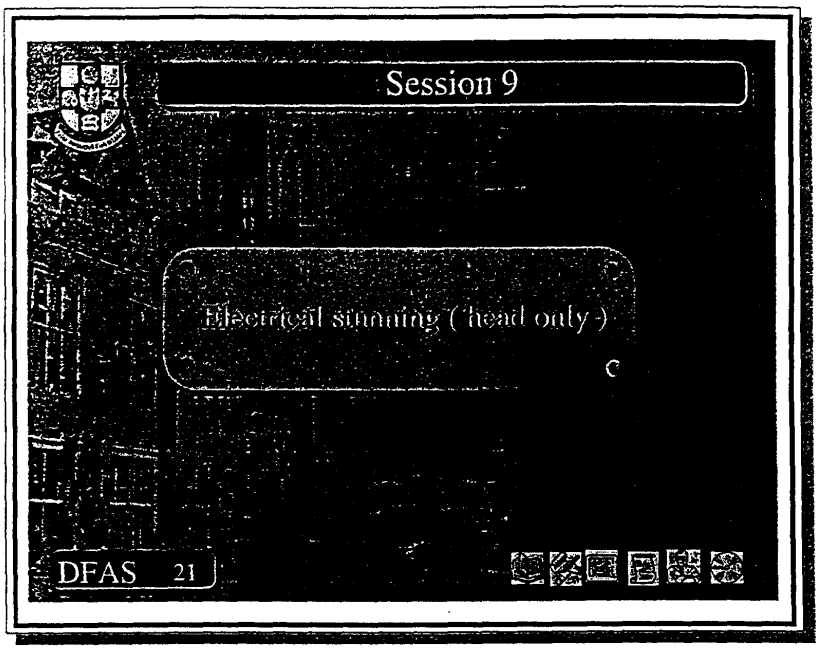


Well . . again, this applies to all species when mechanically stunning.

Incorrect position
Incorrect angle
Gun misfires
Animal cdoes not collapse
Standing, kicking or escape behaviour
No corneal reflex

RHYTHMIC BREATHING !!!!!!

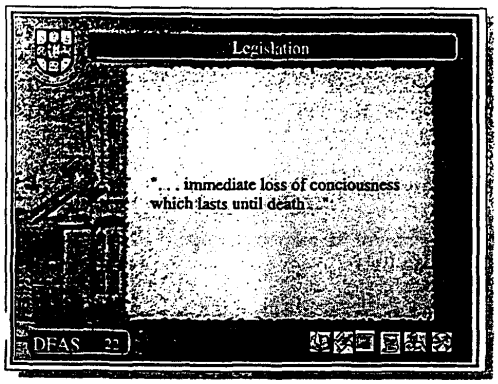
Animal Welfare



Notes

Mechanical bolt stunning when correctly applied is instantaneous (1.5 ms). With electrical stunning a certain amount of time is necessary for the "electricity" to flow. Typical stun times are 3 seconds or more. Therefore is electrical stunning instantaneous? How can we test for this legal requirement? Dutch workers in suggesting minimum stunning currents for pigs required that the current should stun if applied for less than 1 sec with the electrodes applied behind the ears in what is a poor position that doesn't span the brain.
How can we determine whether an electrically stunned animal is stunned or, remains stunned until it is dead?

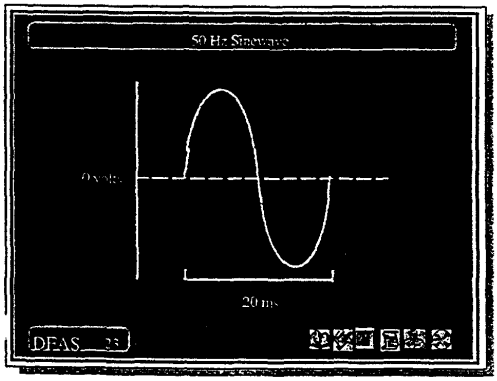
Legislation (WASK, 1995)



The WASK (1995) regulations define stunning as the immediate loss of consciousness which lasts until death. Immediate is a 'concept' rather than a well defined period of time and can be defined as "before the animal would 'feel' any pain associated with the application of the stunning treatment." Consciousness is "a state of mind" and can be referred to scientifically but not measured directly. We can however, measure the death of an animal. By 'death', we mean the death of the brain.

Death occurs in stages with the higher centres in the brain dying first (they have a greater demand for oxygenated blood) followed by the brain-stem, spinal cord, peripheral nerves and lastly the muscle.

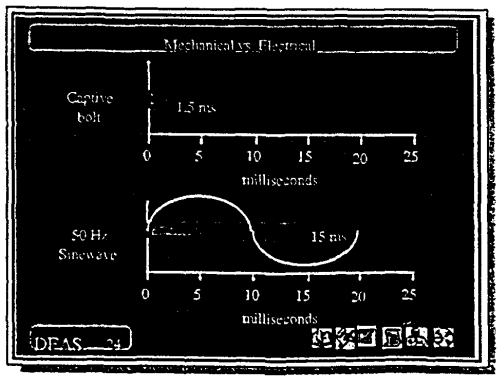
50 Hz sinewave



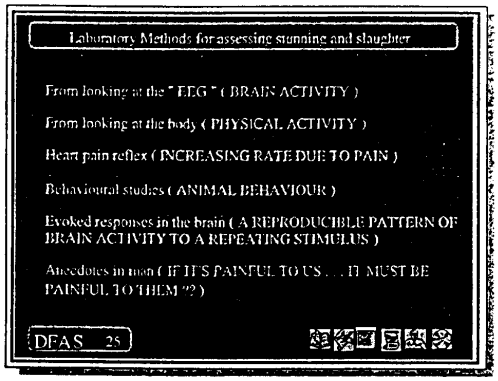
The waveform alternates positively and negatively with respect to 0 volts therefore, it is known as Alternating Current (a.c.). Sinusoidal denotes the shape of the waveform and because one waveform takes place in 20 ms, 50 waveforms will be seen in one second, the frequency is 50 Hz.

The majority of electrical stunners deliver a sinusoidal waveform at a frequency of 50 Hz (50 cycles per second). This frequency and waveform is simple to generate as transformed mains supply. This frequency and waveform will produce an effective stun by stimulating the brain and will maximise the stimulatory response of both skeletal muscle and cardiac muscle producing muscle contraction and with sufficient current, cardiac arrest.

Mechanical *vs.* Electrical



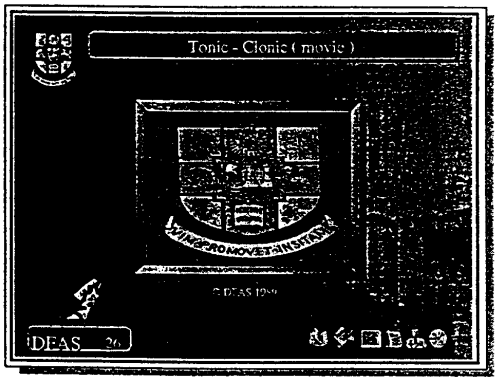
Comparison of mechanical methods vs electrical shows that the former is by far the quickest, however electrical stunning, in theory, will require 15 ms (at 50 Hz) to effect a stun. A point to bear in mind is the speed of conduction of impulses (information) within nerve fibres and nerve tissue, since in many cases the speed of application of the stun is faster than the body could recognise it anyway. The brain requires about 150 ms to respond (feel) a peripheral stimuli therefore, electrical stunning should produce unconsciousness 10 times faster than the animal's perception.



Laboratory methods for assessing stunning and slaughter

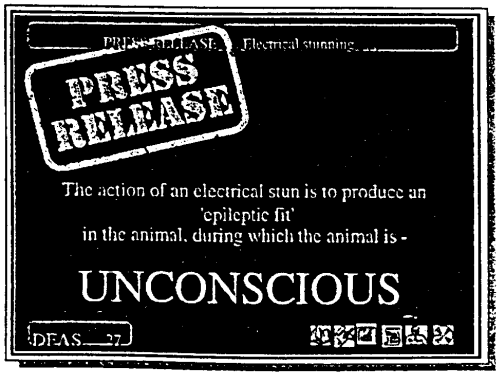
The list shown can be used to determine experimentally whether a particular stunning or slaughter method is effective. Combinations of methods are usually employed by scientists. In the abattoir situation, the OVS has to rely on the physical activity of the animal.

Action of Electrical Stunning.
An effective stun is achieved by passing an electric current through the brain. The relationship between current, voltage and resistance is given by:-
Ohm's Law $V = I \times R$
but it is the flow of current through the brain that determin whether a stun is effective or not, not the voltage.



Tonic - Clonic (movie)

Has anyone here witnessed an epileptic attack? Did you notice any similarity between the person's physical response to that fit and electrical stunning? Epilepsy in humans is directly comparable to the stunned state produced by the passage of electrical current. During a Grand Mal or Tonic / Clonic epileptic fit the patient is always unconscious and the pattern of brain waves is very different from normal. Electrical stunning triggers an identical response in the brain therefore the animal is unconscious during the fit that follows.



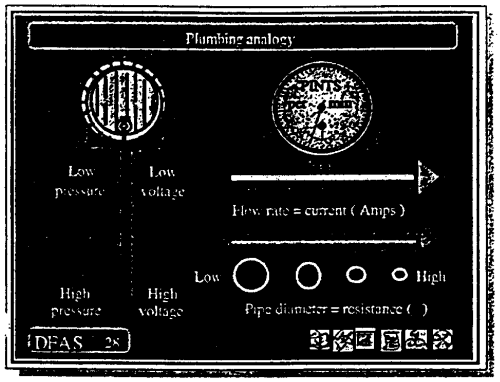
Press release

When sufficient current 'stimulates' the brain into an epileptic fit a sequence of events is triggered. The animal is initially tonic (stiff) particularly during the current application but, afterwards as well for up to about 15 s. After the tonic phase the animal enters a clonic phase which is seen as uncontrolled kicking or movements. In order to induce epilepsy sufficient electrical current must penetrate the brain of the animal.

It is important to be able to visualise the relationship between Current, Voltage and Resistance.

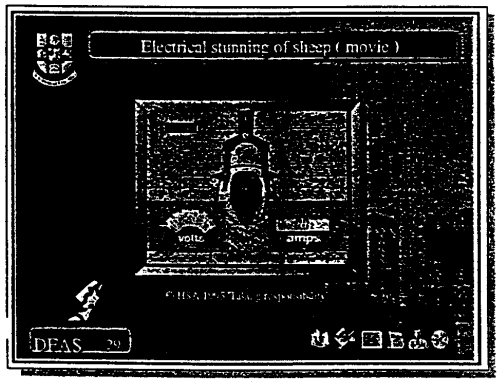
Comparison of the relationship between electrical parameters with plumbing may help to clarify the situation.

Plumbing analogy



The voltage can be compared to the pressure of water e.g. in the header tank; the current can be compared to the flow rate and the resistance the constriction of the pipe. Thus electrical voltage is the pressure available to push the electrons around the circuit; the current is the flow of those electrons and the resistance the resistance to flow offered by the load in the circuit.
The current that will be delivered to the animal will vary directly with resistance, assuming the voltage remains unchanged. The majority of electrical stunners on the market deliver a constant voltage current, therefore the "pressure" is pre-set. The amount of current (flow rate) required to stun each species has been determined experimentally therefore, the resistance of the animal (i.e. the pipe diameter) will determine 'your' ability to stun it.

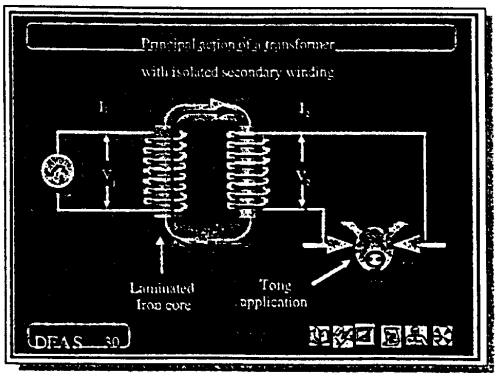
Electrical stunning of sheep



The resistance of the animal is made up of two parts: (a) the resistance of the tissues and, (b) the resistance of the interface between the electrodes and the skin of the animal. Therefore, the condition of the animal will affect your ability to stun it. The voltage is fixed e.g. 200 volts, we require 1.0 amp to successfully stun all sheep therefore, if the resistance is greater than 200 (Ohms) we cannot deliver sufficient current to stun.

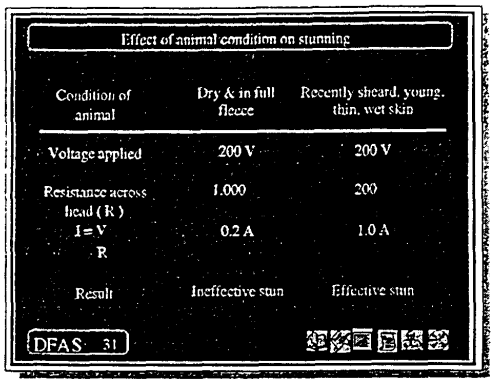
The plumbing analogy is that if we need to deliver 1 pint per min, with a pressure of 200 p.s.i., we require a pipe diameter that is sufficiently large to allow this flow rate to occur.

Principal action of a transformer



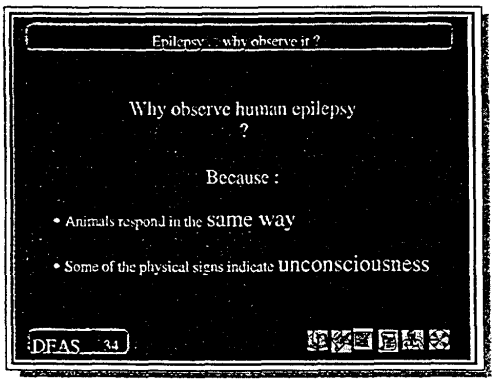
Using the same principal as a current transformer, a transformer with an isolated secondary winding has an output that has no physical connection with the primary winding or, mains supply. The output is isolated from ground and in order for current to flow, both electrodes need to be contacted. This form of transformer greatly reduces the risk of accidental electrocution either for the operator or for the adjacent animals when used in a pen situation. The one major disadvantage is that the output is floating with respect to earth potential, therefore the control of the output voltage is technically more difficult.

Effect of animal condition on stunning



The effect of the condition of the animal on stunning is very important as is the condition and application site of the electrodes. The higher stunning voltages employed today result in an increased build-up of a layer of carbon and / or tarnish on the electrodes. This quickly increases the resistance sensed to a level where the sensing circuitry will not turn the current on. The sensing circuitry is acting as a switch to ensure the tongs do not remain 'live' when not in use. Thus each stunning operative should be provided with a means of cleaning the stunning tong electrodes e.g. a powered (air or electric) stainless-steel wire brush, permanently situated in the stunning area for consistent, regular use.

Epilepsy

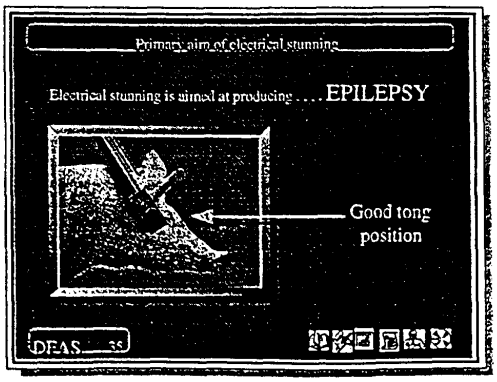


The reason why the observation of epilepsy in a human subject is relevant to electrical stunning in animals is that electrically stunned animals respond in the same way by undergoing an epileptic fit. Some of the physical signs in human epilepsy indicate that the human subject is unconscious and insensible to pain which is the main objective when stunning an animal.

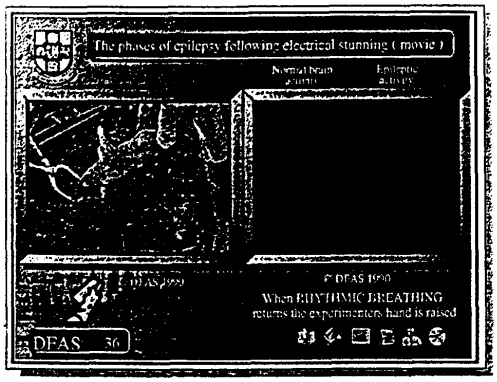
Epilepsy in animals

Electrically induced epilepsy in slaughter animals has similar signs to those in humans such as inhibition of breathing, excessive salivation, an initial TONIC (no kicking) phase followed by uncontrollable convulsions in the CLONIC (kicking) phase.

Primary aim of electrical stunning

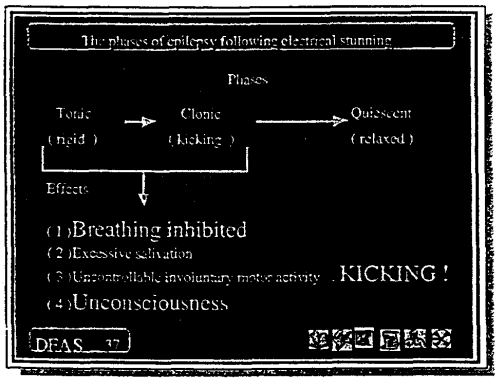


The target organ for electrical stunning is the brain. If you were using a captive-bolt gun to stun a sheep, you would apply it to the head of the animal so that the bolt penetrated the brain and produced tissue damage in the mid-brain region. The tong position employed to stun animals is in practice very variable. Ideally we require a position that affords good electrical contact between the electrodes and the skin and, in a position that spans the brain. The optimum position has been described as between the eyes and the ears on either side of the head. In this position there are wet routes i.e. the optic (eye) and the auditory (ear) nerves, that could channel the current through the bone of the skull which, acts as a good insulator, to the brain.



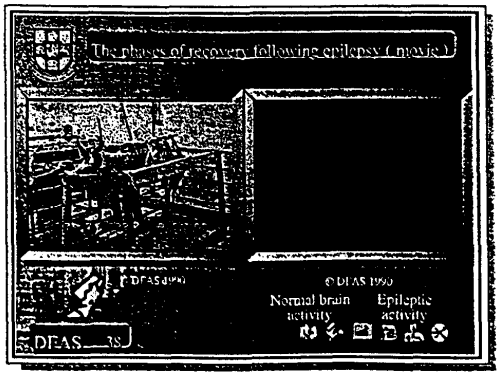
The phases of epilepsy following electrical stunning.

Red meat animals, whether cattle, sheep or pigs undergo an epileptic fit when stunned effectively. This fit is characterised by symptoms that we can recognise and use in an abattoir situation to determine whether an animal has been stunned effectively. It has been shown that electrical current stimulates the nerve endings in the brain to 'overproduce' chemical transmitters which, result in the spread of epilepsy throughout the whole brain area. We can identify epileptiform activity in the brain by the presence of high amplitude, low frequency activity in the electroencephalogram (EEG). We can also categorise the physical symptoms that a well stunned animal displays.



The phases of epilepsy

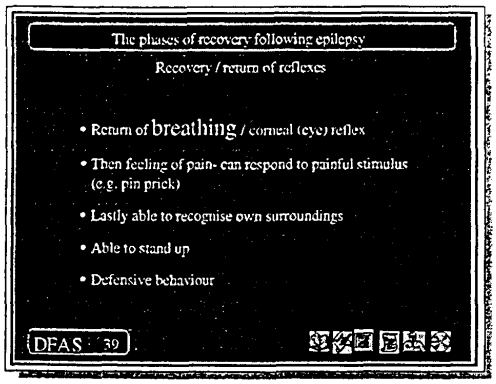
The table categorises the various physical responses or, phases that are usually seen following electrically induced epilepsy or, produced by successful electrical stunning. Following a successful stunning application the physical signs of epileptiform activity should be evident (Anil, 1991). Cessation of rhythmic breathing, salivation and limb rigidity are the first signs to be recognised in a recumbent animal. After 10 to 20 seconds the tonic phase ceases and kicking movements (clonic phase) follow. Immediate shackling and hoisting should take place without delay, ideally during the rigid phase. This is crucial in order to facilitate prompt and accurate sticking. MAFF recommend that the stunning-to-sticking interval should be less than 15 seconds. However there is considerable variation in the expression of the *Tonic / Clonic* phases and the times given above should only be used as guides.



The phases of recovery following epilepsy.

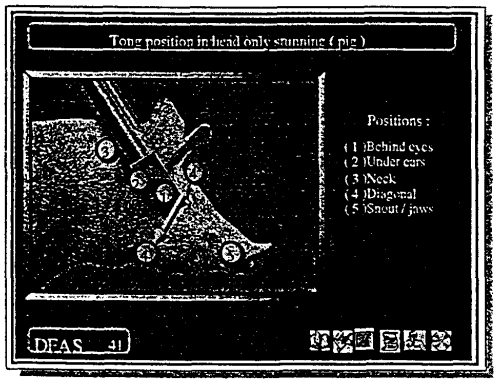
Provided that sufficient current to stun is applied to an animal, it should be rigid (tonic) during current application and remain tonic for a short period after the tongs are removed. Tong positions should also be observed as they contribute significantly to the current threshold required for effective stunning. An observer should assess whether the tongs span the brain as required by the legislation. If an application failed to stun and led to a second current application, the stun/kill line operation should be discontinued until remedial action has been taken. This could take the form of making adjustments to the control equipment, cleaning tong electrodes or optimising tong positioning.

50 Hz Low voltage stunning



Recovery from an electrical stun begins with the resumption of rhythmic breathing usually within 30-40 seconds. This is the first indication of recovery. Then the other reflexes, lost during epilepsy, begin to return: the eye (corneal) reflex returns at the same time as rhythmic breathing (both are brain-stem reflexes) followed by ability to feel pain and the animal becoming visually aware of its surroundings. All these events usually take place within a minute. Next the animal will attempt to rise and then display defence behaviour. The presence of rhythmic breathing denotes that the medulla in the brain-stem has returned to normal function. Consciousness requires the functional operation of higher brain centres in th mid-brain and cortex that will recover after the brain-stem ha returned to normal function. Therefore, the presence of rhythmic breathing indicates a point in the recovery process.

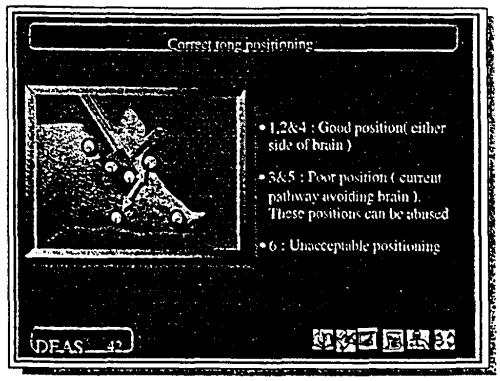
Tong position in head only stunning (pig)



Tong positions in manual electrical stunning of pigs can be classified into 5 basic positions with a position (6) elsewhere on the animal. Positions (1), (2), (3) and (5) are usually seen with 'on-floor' stunning of pigs which are free-standing in a stunning pen.

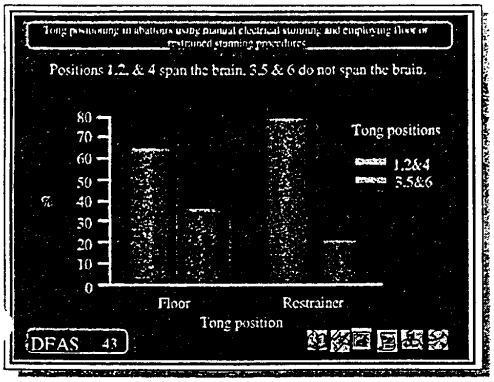
Position (5) is the normal application site for pigs that are stunned as they reach the front of a restraining conveyor (V-restrainer). With this type of restraint, the tongs are difficult to apply to the sides of the head as the conveyor sides prevent placement therefore, a diagonal application is used with one electrode applied to the top of the head and the secon applied beneath.

Categorisation of tong positions



A survey of nineteen abattoirs used the tong position classification, to record the variation found in practice. The tong positions were classified as follows:
(1), (2) and (4) were classifies as good tong positions because the electrode sites spanned the brain.
(3) and (5) were classifies as poor positions as the electrode sites did not span the brain but relied on the spread of current field to induce epilepsy in the brain.

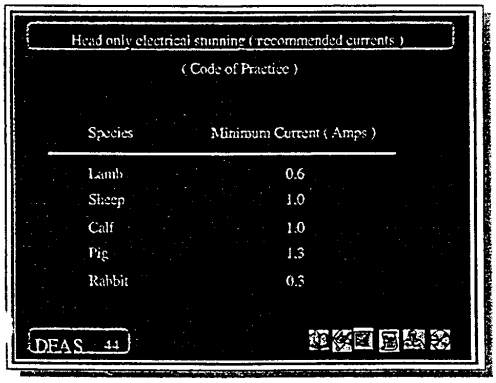
Tong position is crucial, ESPECIALLY WHEN USING LOWER VOLTAGES. Every attempt must be made by stunning operatives to apply the electrodes in a good position. If position (1) is difficult because of the profile of the animals head, select position (2) beneath the ears.



Tong position in abattoirs using manual methods on floor and in restrainers

The results from the survey of abattoirs are shown in the histogram. 65% of pigs stunned on-floor (unrestrained), had the electrodes applied in a "good position" whilst 35% had electrodes applied in a "poor position." When pigs were restrained prior to stunning, the situation was improved to 80% with "good positions" but 20% still had the electrodes applied "away" from the brain.

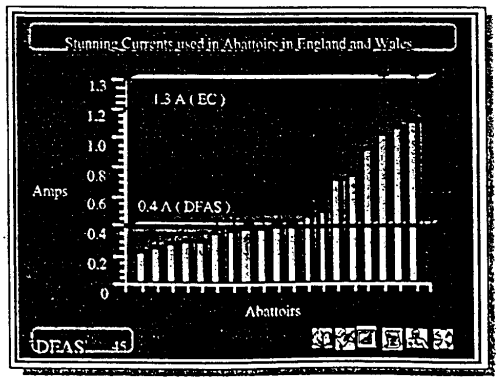
These results emphasised the difficulties encountered with manual application of electrodes to animals. The MAFF issued a guidance note to the industry following these results explaining the importance of tong positioning.



Head only electrical stunning

The Code of Practice contains recommendations for current levels in different species. Although the U.K. Legislation does not specify figures, the Code of Practice can be used as a guideline. A draft EU directive has been issued for consultation which specifies minimum current levels for all species.

The value of 1.3 Amps for pigs was determined by a researcher from the Netherlands using a neck application (position (3)). Research at Langford has shown that 0.410 Amp is sufficient to induce an effective stun when applied in position (1). The required increase in current between a "good position" and a "poor position" is nearly 1 Amp. Tong positioning together with the required level of current is essential for effective stunning.



Stunning currents (Amps ± s.d.) used in abattoirs in England and Wales

The survey of pig abattoirs also measured the stunning currents applied. This produced the histogram shown which, is arranged in ascending order of currents and represents the stunning currents that were being used commercially at the time of the survey. The top line represents the EC recommendation of 1.3 Amps. The bottom line represents the current required to produce an effective stun when the tongs are placed in the ideal position (Position 1). Nine abattoirs were not delivering sufficient current, on average, to meet the lowest recommended level of 0.410 Amp. Within this population, 35% of pigs had the tongs applied in a "poor position". The implications for animal welfare were very concerning and, in addition to the guidance notes, MAFF developed what has become known as "the Fail-safe" legislation.

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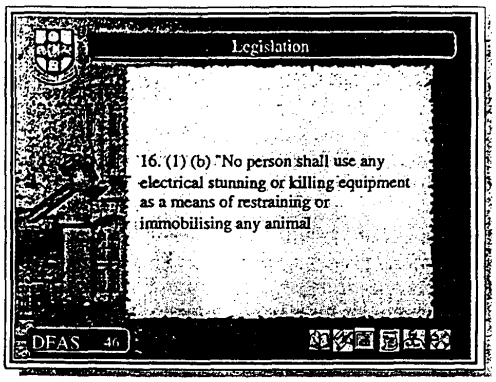
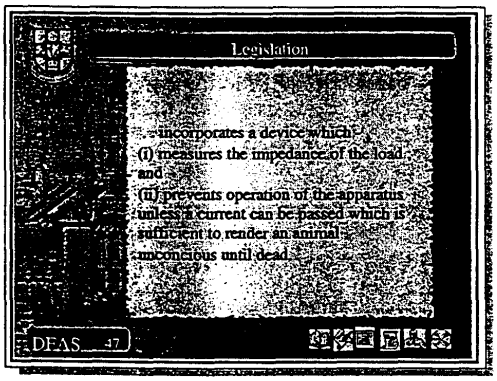
Legislation



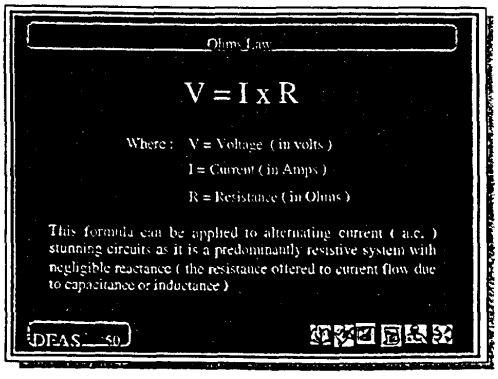
Electrical stunning equipment must only be used for stunning an animal. It must not be used as a goad or to immobilise the animal to allow them to be hoisted and stuck without proper and effective stunning. Regulation 16(1)(b). Daily checks of the equipment and regular maintenance by qualified electricians. Operator training and supervision by AWO, OVS & Management is an essential requirement and details of methodology should be included in the Company Welfare Policy. If an animal is delayed between stunning and sticking e.g. through falling from the shackle, it should be restunned immediately and stuck as soon as possible. Recent research has shown that electrical stunning can be effectively reappli- to extent the period of unconsciousness.

Fail-safe legislation



Has your electrical stunning equipment been fitted with a fail-safe device? The response of previous AWO delegates has shown that about 40% believe that they have a fail-safe fitted to their equipment. To date the concept of fail-safe is recognised as having animal welfare at heart however, practically it has proved impossible to achieve. A fail-safe should work by setting the maximum resistance that can be sensed by the tongs with a given voltage setting for a particular species and still result in an effective stun. e.g. A 200 volt stunner used on pigs where the minimum current necessary to stun is 1.3 Amps. Using Ohm's Law, the maximum resistance below which the equipment will deliver sufficient current is 200 / 1.3 = 1[illegible] Ohms. Therefore the fail-safe would be set at 489 Ohn... However in practice there is insufficient correlation between sensed resistance at low voltage and resistance to a high voltage

Ohms Law



Before further investigation into the action of Electrical Stunning an understanding of How Electricity Works is essential. An electrical current is the movement of electrons through a conductor. The direction of this movement of electrons alternates first one way then the other with respect to zero (at 50 times a second for mains supply) with alternating current. The relationship between current, resistance and voltage is given by Ohm's Law. Ohm's Law can be applied to a.c. circuits e.g. electrical stunning of animals, because it has been shown that reactance plays an insignificant part in the overall resistance to current flow.

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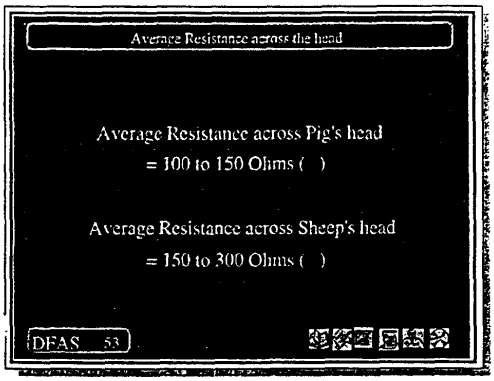
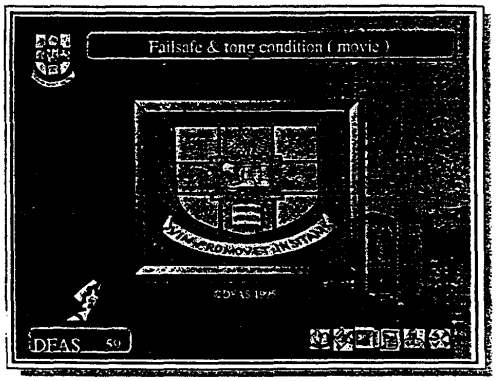
Average resistance across the head of animals



The data given was produced from the insertion of currer sensing circuitry in electrical stunners in commercial abattoir The ranges were calculated (Ohm's law) from measurement taken during stunning current flow in a normal day throughput, thus these results will be lower than those mad with low current sensing circuits.

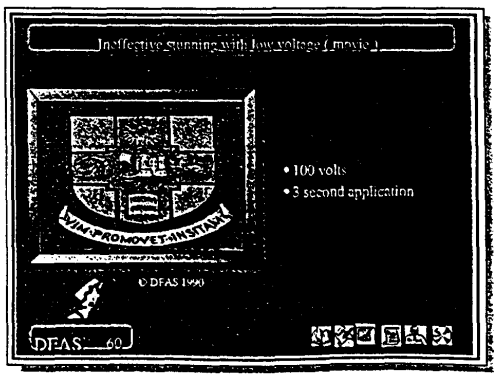
The calculated mean impedance of the nose-to-neck applicatio for the electrical stunning of cattle was on average 98 and the average impedance to the nose to brisket application was 15

Fail-safe & tong condition.



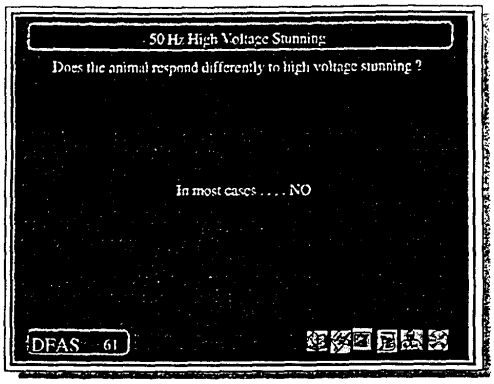
The example shown was of a pig stunned normally followe by an animal which did not go immediately tonic when th tongs were applied. The "Stork" stunner employed, operate at high voltage but for safety reasons, used an electronic switc to turn 'on' the stunning current. A low voltage sensin current was used to detect the resistance between th electrodes. When the resistance fell below the pre-set valu the current was turned 'on' and the first pig was stunned. Th second pig offered a higher resistance (higher than the pre-s value) and the operative had to apply more pressure to opera the electronic switch and stun the pig. The operation was n immediate. The stunning tong electrodes were found to b extremely tarnished and worn and required replacement. Whe the electrodes were replaced the stunning system met th legislative requirements.

50 Hz Low voltage stunning



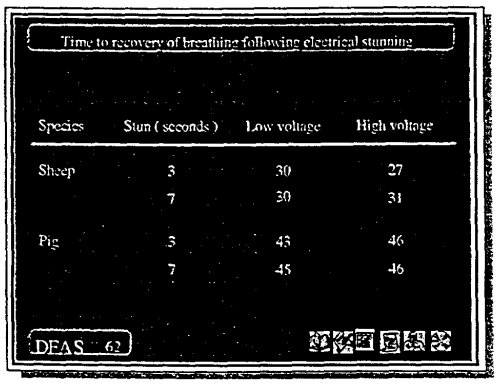
Recovery from an electrical stun can be reliably identified b the resumption of rhythmic breathing usually within 40-50 seconds for pigs. This is the first indication of recovery ar should be used by the operatives and staff of an abattoir indicate that something is wrong. Procedures should b written in the Company Welfare Policy for a course of actic that should be taken. In the case of the pig that received tc little current, it was breathing rhythmically immediately t tongs were removed. When an animal displays rhythm breathing during bleeding, it should be restunned (mechanic back-up) immediately. The animal should be restuck - recovery occurred due to poor bleeding, resticking will reve this cause. A long stun-to-stick interval, a misapplication the stunning tongs or an equipment failure could all result signs of recovery during bleeding.

50 Hz high voltage stunning



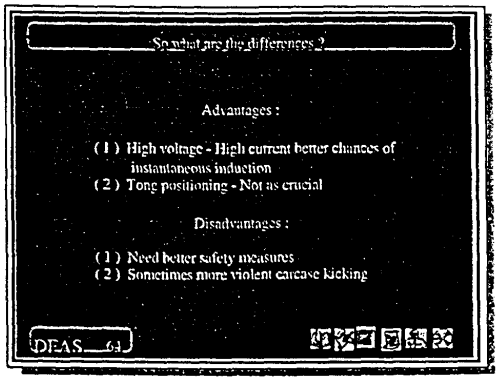
High voltage stunning (200 volts) produces the same responses in animals as low voltage stunning, in the majority of cases. The aim of electrical stunning is to induce epilepsy, whether through the application of high or low voltages. Epilepsy is triggered by a supra-threshold application of current. It has been shown that with higher voltages the amplitude of current produced rises more quickly. The duration of the stun application tends to be shorter for higher voltages but the duration of insensibility produced is very similar. The production of epilepsy can be considered as a switch. Once the switch is turned 'on', applying higher currents or, applying the current for a longer time should ha little effect on the 'effectiveness' of the stun.

Time to recovery of breathing following electrical stunning in sheep and pigs.



The table reinforces the concept that the production of epilepsy can be considered as a switch. The data shows that when current is applied for 3 or 7 s and when the current is applied from a low or high voltage source (provided there is sufficient current available to stun) the time to return of rhythmic breathing movements is not significantly different for either sheep or, pigs. The average times to return of rhythmic breathing are significantly different between the two species with sheep recovering more quickly than pigs. Experimental work with electrical stunning of cattle suggests a significantly longer average time of 50 s.

So what are the differences ?



The main advantages of high voltage stunning are:
Better chances of instantaneous induction - one second or less should be sufficient to induce epilepsy and tong positioning is not as crucial. The disadvantages include the need for better safety measures due to the potentially lethal effects of high voltages. Excessive kicking post-stun is also a practical problem created by short applications at high voltage.

The welfare advantages of high voltage stunning are significant. Provided that some of the safety and carcass quality problems can be avoided it can be a very effective method.

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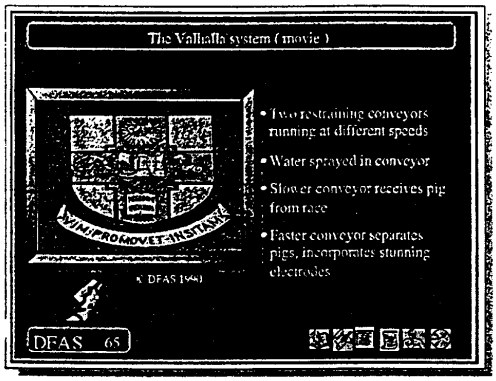
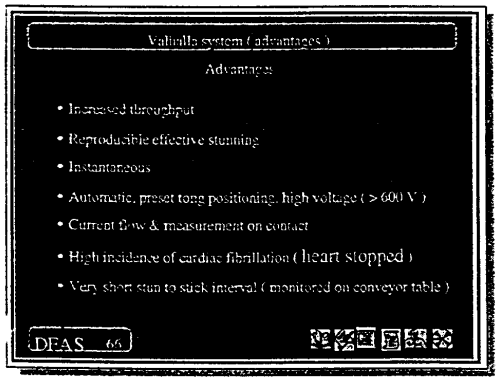
The Valhalla system



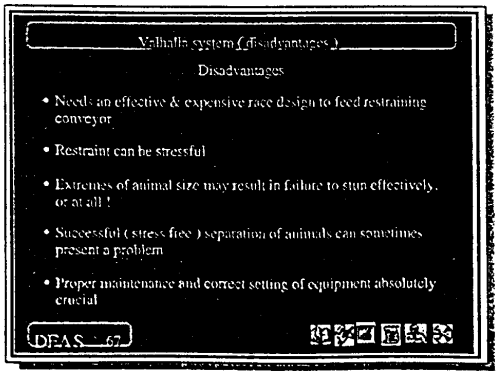
Fully automatic high voltage stunning systems incorporated into restraining conveyors are used for high throughput pig operations. The restraining conveyors (usually V-type) receive the pigs from a race. The slower moving first conveyor transfers the pig to the faster one in front which separates the front pig from the one behind. An automatic stunner makes contact with the pig's head and moves forward with the pig for the duration of the stun - usually about 0.75 s. Voltages of more than 600 volts are used and the current duration is very short. Currents and voltages used to stun pigs are displayed at the front of the conveyor carrying the electrode carriage.

Valhalla system (advantages)



Automatic systems were developed to stun pigs electrically to meet the demand for high throughput. The initial capital expense can be offset against labour savings. The systems can apply very high voltages (600-1000 volts) which ensures very high currents. A Valhalla operating at 700 volts induced cardiac arrest in 40 % of pigs processed. When the pigs were wetted prior to the Valhalla, over 90% of pigs received a cardiac arrest at stunning. The promotion of the start of death to the point of stun, has major welfare benefits in that the stun-to-stick interval or the sticking operation have no effect on animal welfare. The Valhalla is usually used in conjunction with a horizontal bleeding table which reduces the stun-to-stick interval to a minimum and pigs can be stuck whilst tonic which can effect the rate of blood loss.

Valhalla system (disadvantages)



The major problem with all systems that require pigs in single file is the difficulty in designing stress-free race systems to separate them. Experimental work has shown that pigs prefer to be kept in familial groups up to and including the point of stun. V-restraint has been demonstrated to be more stressful than other types of restraint for pigs. Pigs tend to fight the hard, unyielding sides of the restrainers and try to escape. Variation in animal size can also result in misapplication and seriously compromise animal welfare. There are two V-restrainers employed by the Valhalla the first, picks-up the pigs from the single-animal race and the second, travelling at a higher speed than the first, separates pigs. Pig separation is essential to allow the electrode carriage time to return into position ready for the subsequent pig. Plant engineers must regularly maintain and service the equipment.

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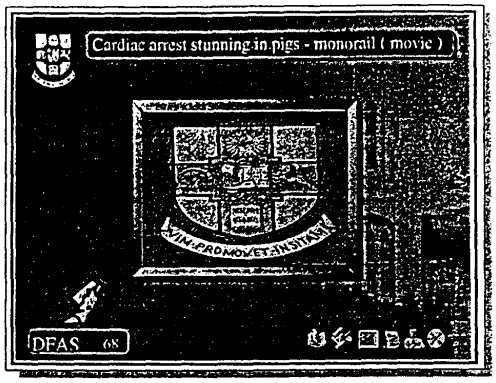
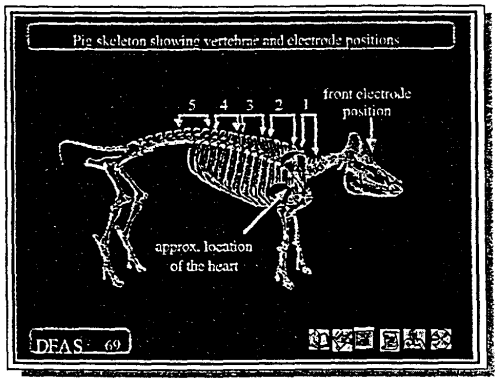
Monorail restraint - The Stork "Midas"



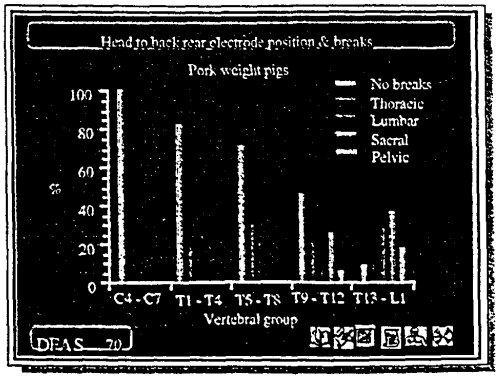
The monorail system of animal restraint was developed in Europe and the U.S. at about the same time. The 'belt' or single-rail rises up out the floor of a single animal race such that the animals walk onto the rail. The floor falls away and the animals are carried on their bellies on the rail. Stork developed the Midas compact from a single conveyor belt that transports the pig to the stunning section. An optical system is used to detect the presence and position of an animal and stunning electrodes are applied to the head. A further electrode is applied to the chest of the animal and a separate lower voltage current is applied between the contralateral head electrode and the chest electrode to induce cardiac arrest. The Midas syste has built-in time, voltage, current monitoring and storag facilities that enables the profiles from each pig to be stored and analysed statistically.

Head-to-back stunning of pigs



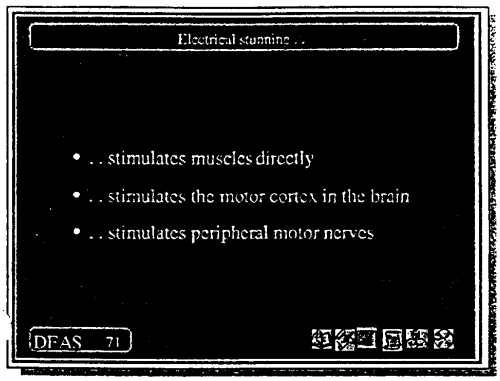
The induction of a cardiac arrest at stunning was investigated experimentally to determine the optimum position for the rear electrode when the recommended minimum current of 1.3 Amps was applied. The approximate positions of the 1st (T1) and the 14th (T14) thoracic vertebrae were identified and marked on the pigs back when it had entered a single animal restrainer. This enabled the rear electrode position to be placed close to a predetermined position to give a approximately normal distribution between the 4th cervical vertebra (C4) and the 1st lumbar vertebra (L1). The groups were as follows C4 - C7, T1 - T4, T5 - T8, T9 - T12 and T13 - L1 as illustrated in the Figure. The current was applied to both bacon and po weight pigs and the resultant carcass quality was determined.

Head-to-back stunning with pork weight pigs.



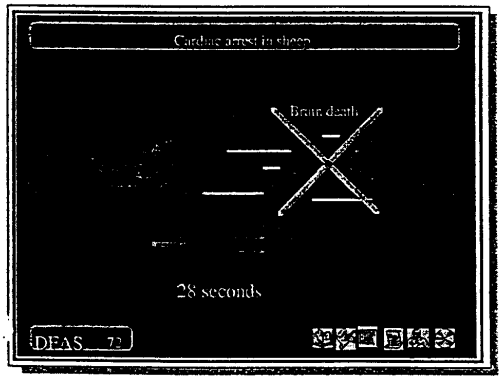
The histogram shows the results obtained with pork weight pigs. Similar results were obtained when bacon weight pigs were tested. There was only one position that produced acceptable carcass quality i.e. no broken bones and very little haemorrhaged muscle. This electrode position was between C4 and C7 on the neck of the pigs. Unfortunately this was the only position where a cardiac arrest could not be guaranteed. The Midas stunner utilises a split stun where two separate applications are used. The cardiac arrest cycle was applied at a lower voltage than the head stun which was sufficient to induce ventricular fibrillation but insufficient to induce epilepsy. It is probable that head-to-back stunning systems that use a single application to induce epilepsy in the brain and a cardiac arrest are not suitable for use with pigs due to the carcass quality problems produced.

The action of electrical stunning



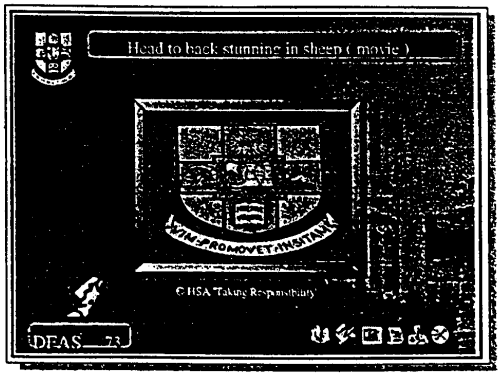
Electrical stunning can result in broken bones and haemorrhages within the muscles (meat). The aim of electrical stunning is to induce epilepsy in the brain that will render an animal unconscious until it dies through exsanguination. When a voltage is applied, a current field builds-up that spreads out with time into the body of the animal. It is the current field that produces the damage by direct muscle stimulation. Electrical current will induce muscle contraction as a direct consequence. The current will also stimulate motor neurones in the brain that will induce muscle contraction and the peripheral motor nerves will also be stimulated to induce contraction. However, it is generally believed that direct stimulation of muscles agonistically about joints is more damaging than the suggested alternative routes for stimulating muscles to contract.

Cardiac arrest in sheep

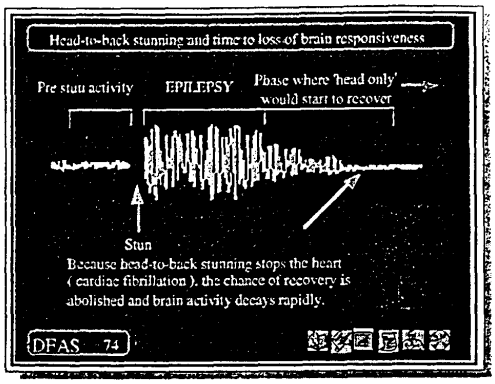


With sheep, laboratory studies have shown that cardiac arrest stunning resulted in brain death in an average of 28 seconds. Sheep with less emphasis placed by the industry on muscle development, do not suffer from the same quality defects as pigs in that they do not suffer from compression fractures of the vertebrae and the associated haemorrhages. The minimum recommended current for head to back stunning sheep and lamb is 1.0 Amp, which should be applied for a minimum of 3 seconds. The application of electrodes to sheep offer different problems to those with pigs. Wool and lanolin are good insulators, electrodes must either penetrate through the wool or use water or saline as a means of transferring current to the animal.

Head-to-back stunning - Sheep

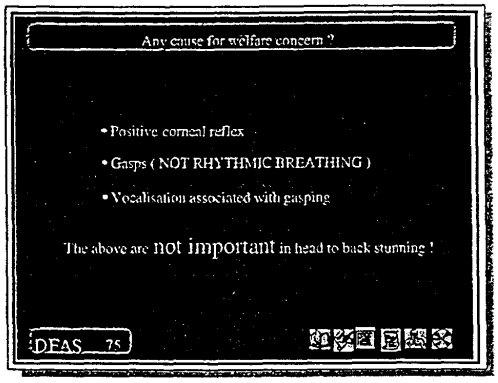


A handset is used to apply the electrodes to the animal. The electrodes, designed to contact the head, are usually two spikes with water/saline sprayed onto the contact area. The length of the spikes (not the tips) are generally applied in front of the animal's eyes in a 'wiping' motion. The rear electrode is sponge covered and is again supplied with copious amounts of water/saline. It important to 'spread out' the contact area for the rear electrode or, pelt-burn may result due to localised heating brought about by a small contact area. The rear electrode should be applied first with head electrodes being applied in front of or, level with the eyes. In the event of the front electrodes being applied too far back, epilepsy will not be induced and the animal will receive a painful cardiac arrest.



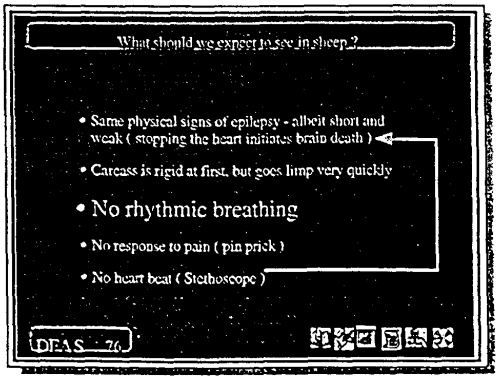
Effect of head to back stunning on time to loss of brain responsiveness

Head-to-back stunning initiates both epilepsy in the brain and a cardiac arrest. The HALF activity produced by the brain demands an increased oxygen consumption from the cerebral circulation which 'uses up' the available oxygen more quickly thus resulting in a rapid brain death. Although epilepsy is achieved with both head only and head-to-back stunning it is short lasting with head-to-back stunning and recovery cannot take place before the animal dies. Ventricular fibrillation ('a heart attack') is a painful experience therefore, it is important to ensure that the electrodes span both the brain and the heart before the current is applied.



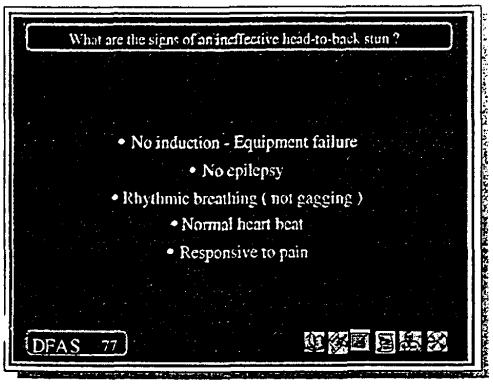
Any cause for Welfare concern ?

Following head-to-back stunning sheep there may be symptoms present that may cause concern for the animal's welfare. There may be a positive corneal reflex and respiratory gasps present. Research in Bristol has shown that this type of reflex activity is not associated with any sensibility. These brain-stem reflex signs may be present although the higher centres in the cortex and mid-brain may be irreversibly damaged due to the lack of oxygenated blood produced by a cardiac arrest. Therefore, positive eye reflex and respiratory gasps which are of spinal origin should not be associated with recovery in this case.



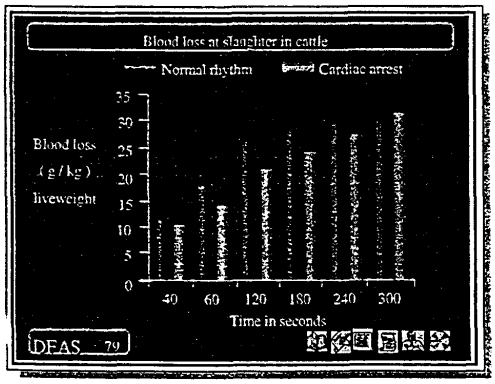
What physical symptoms should we expect to see in sheep ?

Following head-to-back stunning we would expect to see the same physical signs of epilepsy as with head only stunning, albeit relatively shorter due to the cardiac arrest which prevents oxygen from reaching the brain. The animal should be tonic initially but this tonic phase will not give rise to clonic activity and a flaccid carcass will result. There will be no rhythmic breathing, no response to a pin prick and no regular heart beat - test with a stethoscope. The application of electrical current between the head and the back of the animal will affect the spinal cord as well as the brain. Preventing the expression of spinal reflexes which are responsible for the convulsions seen post-stun where the dampening effect of the brain on spinal reflexes is removed by an effective stun.



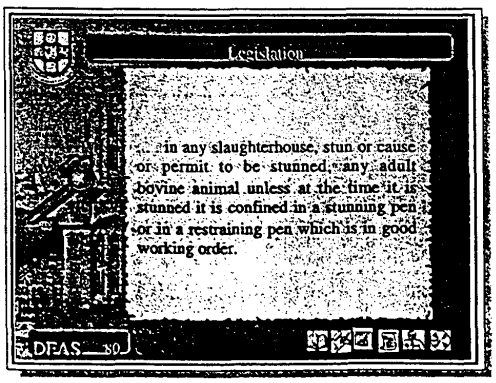
What are the signs of an ineffective head to back stun ?

Failure to induce a stun or, ineffective head-to-back stunning can be recognised if the following occur: Failure to induce a stun can be caused by poor electrode placement, inadequate electrode contact, equipment failure or breakdown. An ineffective stun can be characterised by a lack of epilepsy, the presence of rhythmic breathing, a normal heart beat or recognised if the animal responds to a painful stimulus post-stun. Recognising an effective cardiac arrest stun should be simpler than for a head-only stun. There are 'grey' areas between a well stunned animal and an animal that is not stunned. Care and experience is needed to make an accurate diagnosis.



Blood loss at slaughter in cattle.

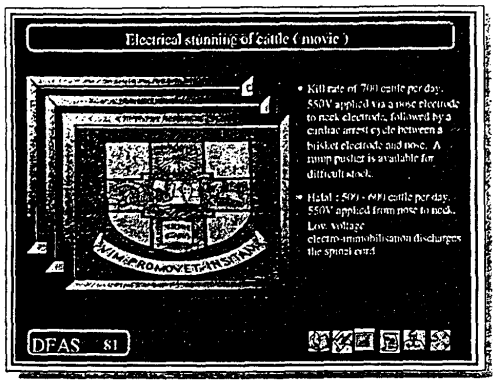
As reported earlier, the effect of stopping the heart at stunning on the amount of blood lost at bleeding is insignificant. The blood loss curves for cattle show a slight difference in the rate of blood loss with time. This increase is probably produced by movement in the 'live' animal during bleeding. By five minutes however, there is no difference between the weight of blood voided from the carcass between the two treatments. The important difference is that for animals with normal heart rhythm following stunning, it is the loss of blood that kills the animal, therefore any impedance to blood loss will extend the time to brain death. With animals with hearts which have stopped beating, the sole purpose of sticking is to void the carcass of blood. Inducing cardiac arrest in pigs with head to back stunning can produce carcass quality problems depending on current amplitude and application site.



Legislation

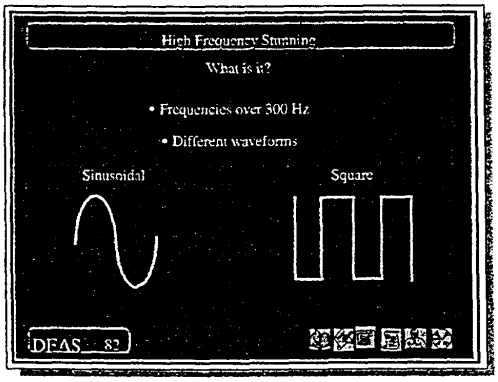
Electrical stunning of cattle is permitted in this country provided that they are restrained, Regulation 15(1). The induction of cardiac arrest is not a legislative requirement but there are no EU abattoirs that are electrically stunning cattle without the cardiac arrest cycle. Jarvis an engineering company from New Zealand has produced the "Beef stunner" which utilises a split stun system. Three cycles are employed as follows: (i) a 3 s head-only cycle, to stun the animal, (ii) a 15 s cardiac cycle, to induce ventricular fibrillation (cardiac arrest), and (iii) a 4 s spinal discharge cycle, employed to reduce post kill convulsions. The Jarvis Beef Stunner is available in the UK through SFK / Gjerstrup.

The Jarvis Beef Stunner



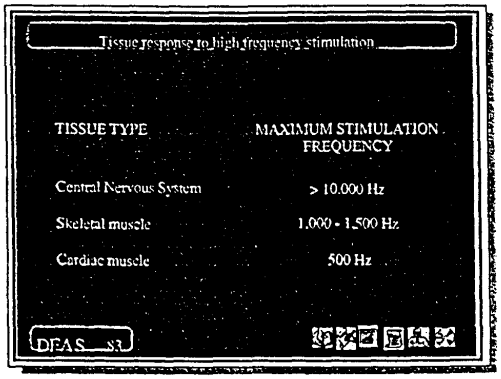
Research at Langford has shown that: an effective and immediate stun was produced when 1.15 amps sinusoidal AC at 50 Hz was applied between the nose and neck electrodes for <1 s. However, when applied for 3 s, head-only currents of >0.46 amp sinusoidal a.c. at 50 Hz were sufficient to induce epileptiform activity in the brain, identified as high amplitude low frequency activity in the electroencephalogram. The induction of effective head-only electrical stunning resulted in an average interval of 50 seconds before the return of intrinsic signs of recovery, seen as the return of rhythmic breathing movements, positive corneal and palpebral reflexes. The cardiac arrest cycle successfully induced ventricular fibrillatic when >1.51 amps sinusoidal AC at 50 Hz was applied for between the nose and brisket electrodes.

High frequency stunning

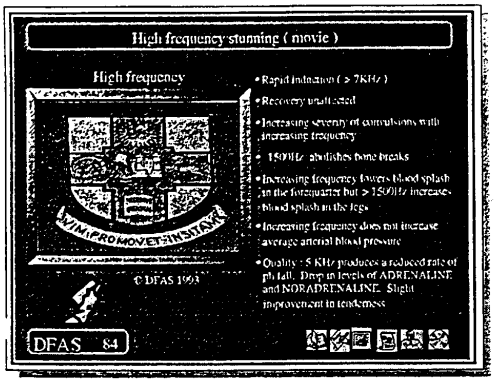


Stunning currents are supplied either as alternating currents (a.c.) or pulsed direct current (d.c.). The normal/usual frequency is classified as low frequency or 50 Hertz a.c. which is the mains frequency in the UK. The waveform could be sinusoidal or squarewave and the frequency of the current can be varied. Traditionally, high frequency denotes waveforms aver 300 Hz when used to stun animals and low frequency is at <300 Hz. High frequency waveforms can produce epilepsy but sometimes different physical behaviour can be expected. High frequencies (>300 Hz) do not stop the heart. Therefore, they can not be used with head-to-back stunning systems to initiate cardiac arrest. The main reason f using high frequencies is the possibility of reducing carc damage. Post-stun convulsions can be a problem with very high frequencies in excess of 3000 Hertz.

Tissue response to high frequency stimulation

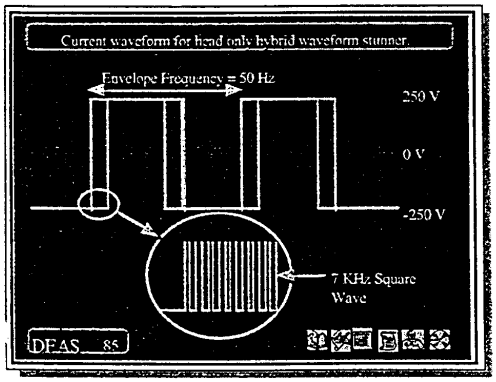


One of the major problems of stunning an animal with an alternating sinusoidal current at 50 Hz is the production of carcass and meat quality problems which may occur as a direct result of muscle stimulation. Therefore increasing the frequency to a level that will still produce a stunned animal but will not produce the same level of direct muscle stimulation has commercial advantages. The table gives the approximate maximum stimulation frequencies at which the central nervous system, skeletal muscle and cardiac muscle will respond. Thus a frequency above 1500 Hz will not produce the same degree of muscle stimulation as a similar current at 50 Hz.



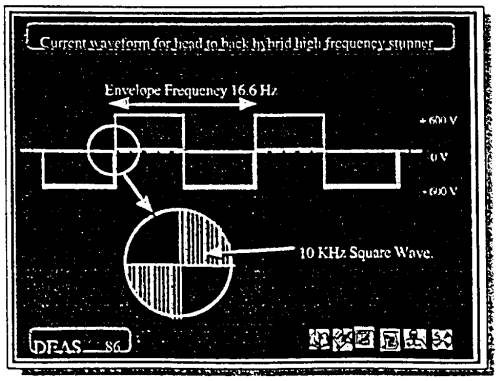
The advantages/disadvantages of high frequency stunning

>7 kHz produced epilepsy (EEG) with a rapid induction.
Recovery times were unaffected by the frequency of the waveform.
Convulsive activity more severe with increasing frequencies.
>1500 Hz abolished stun induced broken bones, by reducing the muscle contractions induced by the stun current.
Blood splash is reduced in the forequarter but >1500 produced an increased occurrence in the hindquarter.
mean arterial blood pressure was unaffected by frequency.
5000 Hz produced slow pH fall. Adrenaline/noradrenaline significantly fell with 5 kHz and drip also fell with slight improvement in tenderness.



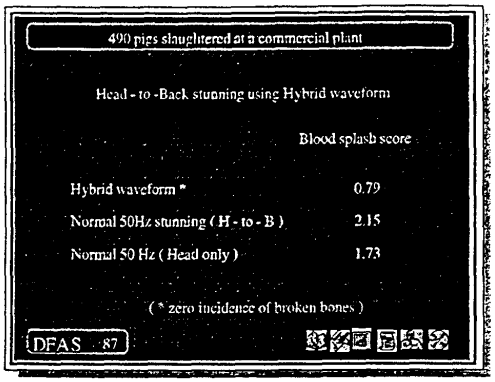
Current waveform for head only hybrid waveform stunner

Research carried out at Langford for the MLC has produced an alternative waveform to the conventional waveforms used to date. The hybrid waveform shown in the diagram was developed for head only applications at greater than 1.3 Amps as recommended in the MAFF codes of practice. It combines pulses of high frequency 7 kHz squarewave within an envelope frequency of 50 Hz. The frequency of the envelope plus the high frequency component can be adjusted within plant to control the extent of post stun kicking to manageable levels and the degree of direct muscle stimulation has bee significantly reduced so as to minimise quality defects. Further trials are required with different waveforms before the hybrid waveform stunner should be manufactured commercially.



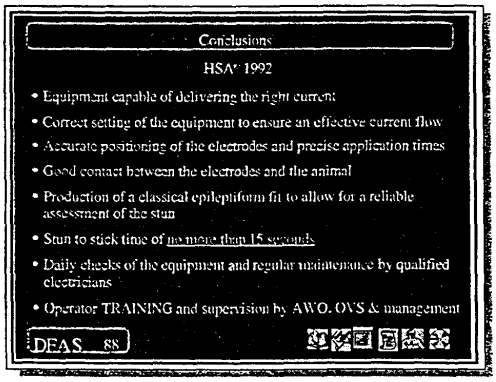
Current waveform for head to back hybrid high frequency stunner

The hybrid waveform developed for head to back application also combines a high frequency component at 10 kHz within a low frequency envelope at 16.6 Hz. The high frequency component will ensure that the animal is stunned whereas the envelope is sufficient to stimulate cardiac muscle to produce cardiac arrest. However this envelope is insufficient to cause the gross skeletal muscle stimulation seen with 50 Hz sinusoidal waveforms, which could result in carcass and meat quality defects. Both waveforms have been tested commercially and it is hoped that further research will result in the development of commercial versions of these devices which would be available to the meat industry.



Small commercial trial of Hybrid Head-to-Back waveform

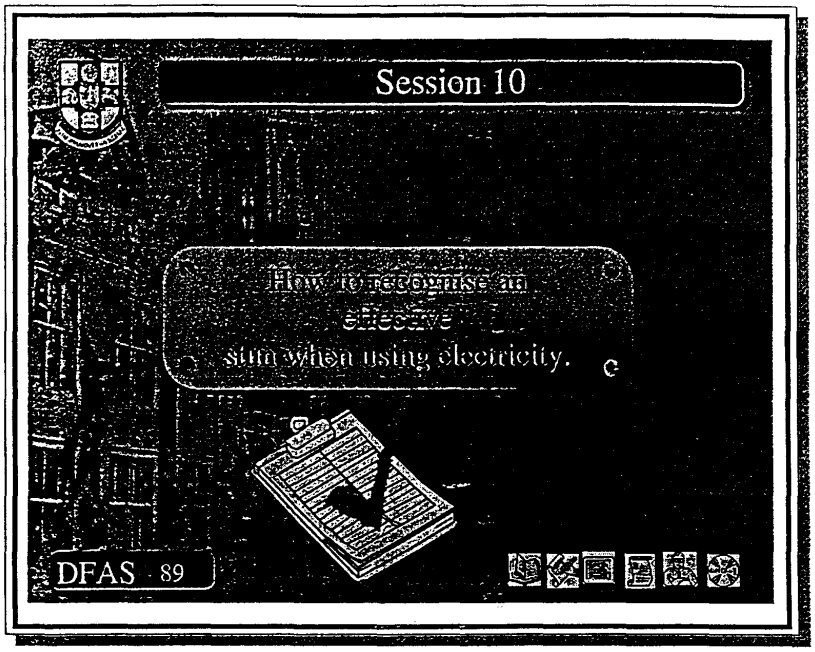
The head-to-back hybrid waveform was tested commercially in a limited trial. Blood splash (haemorrhages within the muscle) were scored as: 0 = none, 1 = mild, 2 = moderate and 3 = severe haemorrhaging. The application of the hybrid waveform reduced the incidence of broken bones to zero and reduced the incidence of blood splash to less than 'mild.' This score was less than half the score achieved with head-only stunning at 50 Hz and nearly a third of that achieved with head-to-back stunning at 50 Hz. These results were very encouraging and suggest that further development with hybrid waveforms would be worthwhile.



HSA Conclusions

Can your electrical stunner actually produce unconsciousness?
Is the correct setting always selected for the species being stunned?
Are your application sites correct and is the current applied for about 3 sec?
Is there good electrical contact between the electrodes and the animal?
Production of an epileptiform fit - do you know which physical signs to look for?
Short stun to stick time with head only stunning, why 15 s?
Daily equipment checks and regular, scheduled maintenance?
Operator training and supervision? Can you train your colleagues to have a better understanding of animal welfare and the equipment that they use on a daily basis?

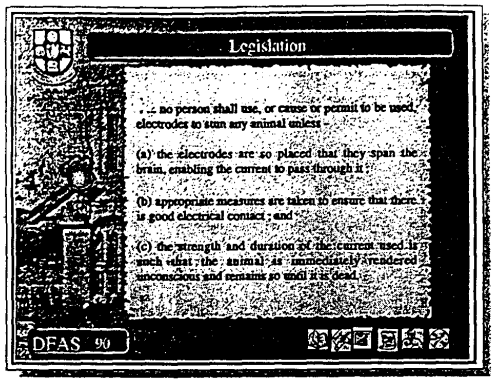
Animal Welfare



Notes

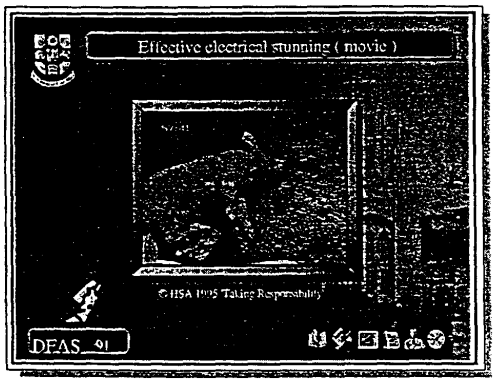
The presence of a tonic phase after the electrodes have been removed, followed by a clonic phase are good indicators. Rolled eyes and excessive salivation usually occur. Vocalisation and occasional gasps may also be present. However, the one symptom that must be absent with an effective electrical stun is rhythmic breathing. The one exception i.e. cattle. Some rhythmic breathing movements were reported in 93 per cent of animals that were 'cardiac arrest stunned' in experiments at Langford.

Legislation



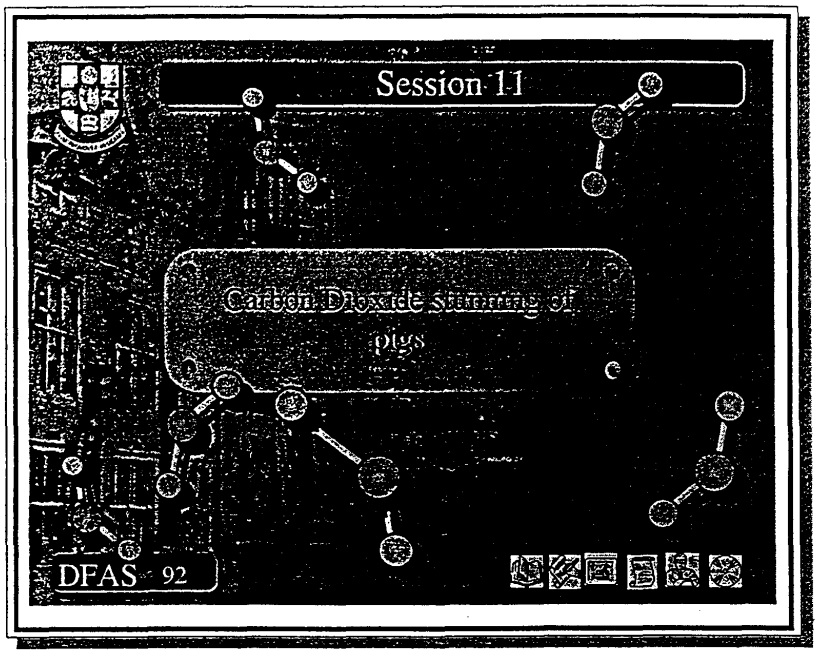
MAFF funded research projects have been used to underpin legislation. Schedule 5, part II section 8 specifies, in some detail, how electrodes should be used to achieve successful stunning. They must be applied to span the brain - the target organ. Appropriate measures must be taken to ensure good electrical contact i.e. the electrodes used should be specific to the species being stunned, should make contact over a sufficiently large area and be kept clean. Section 8 (c) doesn't legislate for a minimum current but emphasises the importance of current amplitude and places the responsibility on the Plant Management and the OVS to ensure that sufficient current is applied to result in an effective stun.

Effective electrical stunning



The aim of electrical stunning is to induce epileptiform activity in the brain. Well stunned animals will exhibit a tonic phase with front legs extended and hind legs flexed into the body, beyond the duration of current application. Epilepsy begins at the start of the stun therefore, with long application times, the tonic phase may be over before the tongs are removed. The animal will enter the clonic phase which is characterised by uncontrolled muscle activity. The epilepsy will continue producing the symptoms that have both phases and rhythmic

Animal Welfare

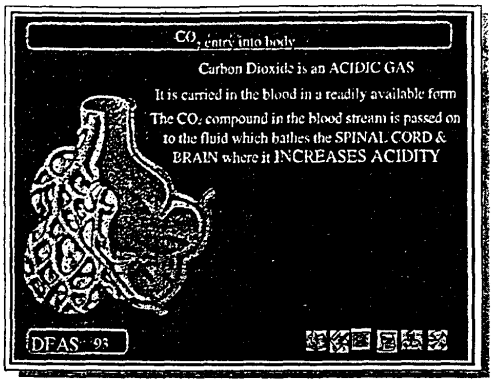


Notes

Carbon dioxide is a heavy gas that is colourless and forms an acid (carbonic acid) when it dissolves in water. It is used in fire extinguishes because it does not support combustion i.e. it removes oxygen from the atmosphere surrounding the fire. However, it is an anaesthetic gas that does not induce anaesthesia by removing oxygen from the atmosphere it has a more direct effect on neural function. Carbon dioxide is also used for carbonating beverages and in the solid form is called dry ice. Carbon dioxide occurs naturally in the air:

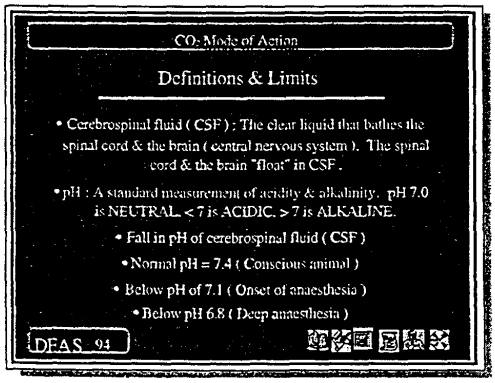
Composition of the air:
Nitrogen 78%
Oxygen 21%
Argon and other gases 0.97%
Carbon dioxide 0.03%

CO2 entry into the body



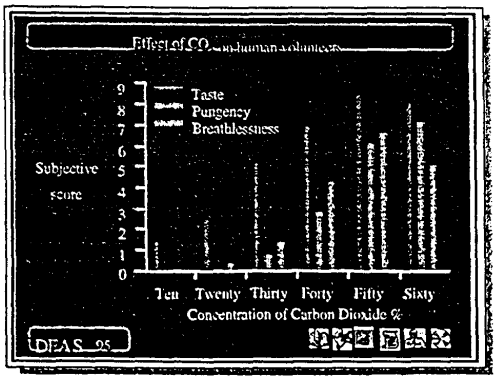
CO_2 dissolves in water to form a weak acid, it is also carried in the blood in a readily available form. The CO_2 compound once in the blood will cross into the fluid bathing the spinal cord and brain (cerebrospinal fluid - CSF) increasing the acidity of the CSF. Acidity of fluids is measured using a scale of pH, for a neutral solution the pH is 7. For an acid solution the pH is less than 7 and for an alkaline solution the pH is greater than 7.

CO2 mode of action



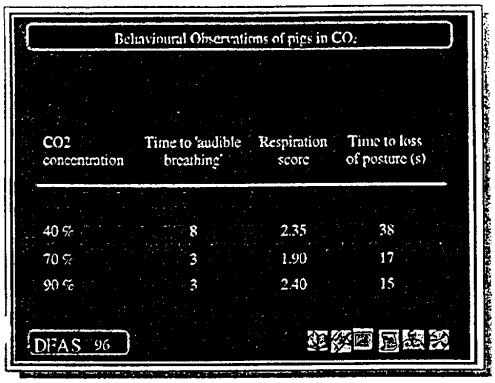
Once the pH of the CSF is lowered from its normal value of 7.4 (by 0.3 pH unit) to 7.1 the animal begins to lose consciousness. If the exposure to high concentrations of CO_2 continues the pH will drop further and when it falls below 6.8 the animal will enter a stage of deep anaesthesia. If the animal is allowed to breathe CO_2 beyond this stage it will die. However, there are two major concerns with the use of CO_2 for the preslaughter stunning of animals, (a) CO_2 being an acidic gas is pungent to inhale at high concentrations (> 40%), and (b) CO_2 being a potent respiratory stimulant also causes a sense of breathlessness.

Effect of CO2 on human volunteers



CO_2 enters the body through the lungs. It is carried in the blood and affects the normal action of nervous tissue. This results in loss of consciousness and eventually death.
Effect of CO_2 on human volunteers is shown in the histogram. The volunteers were asked to take a single breath through a face-mask of the concentrations of CO_2 shown on the x-axis. They were asked to score their reactions to the gas mixture on a scale of 0 - 9 for taste, pungency and breathlessness. Where 0 represents normal respiration and 9 - maximum aversion. The explanation for the limit on CO_2 concentration at 60% was that volunteers were unable to take a full breath of the gas at higher concentrations and thus register an accurate score.
The reaction of the volunteers to exposure to CO_2 was dramatic with gas concentrations above 30% the aversion to inhaling a single breath was conclusive.

Behavioural observations of pigs in CO2

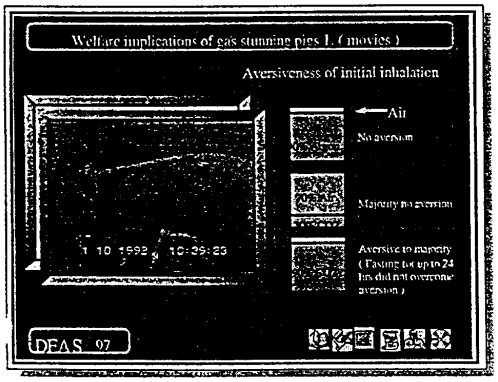


The use of CO_2 for preslaughter stunning/killing is not immediate in action and as such is the one exception to 'legal definition of stunning.' CO_2 is used to stun pigs and not humans therefore, we need to gauge the response of pigs to immersion in increased concentrations of CO_2.

The data shown in the table shows the analysis of the experimental video which recorded the pigs response to exposure to the following gas concentrations 40% CO_2, 70% CO_2 and 90% CO_2.

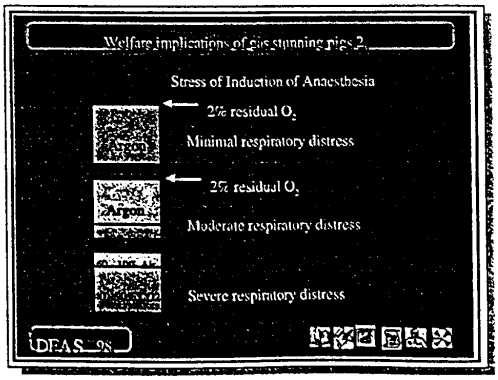
The WASK (1995) Regulations require at least 70% carbon dioxide by volume in atmospheric air but, the majority of equipment suppliers aim for at least 90% CO_2.

Welfare implications of gas stunning pigs 1.



The response to carbon dioxide inhalation was tested experimentally by offering pigs a food reward of chopped apples contained in a specially prepared trough for a 10 min. period daily. The trough was gas-tight until a flap at the front was raised by the pig. Following a two week training period the atmosphere within the trough was varied as shown in the diagram and monitored continuously. The behaviour of each pig was recorded on video tape and later analysed. Pigs continued to feed when 90% Argon was present in the trough, in most cases losing posture, recovering, and returning for more! When 30% CO_2 was present the majority of animals were not affected sufficiently to prevent feeding but when a concentration of 90% CO_2 was used the majority of pigs refused to feed even when fasted for 24 hours.

Welfare implications of gas stunning pigs 2.



When pigs were immersed into atmospheres containing different gas concentrations the stress of induction was assessed in terms of the degree of respiratory distress that was observed and scored on a scale where:-
0 = none, 1 = mild hyperventilation, 2 = moderate hyperventilation and 3 = severe hyperventilation.

Concentrations of carbon dioxide above 40% provoked severe respiratory distress while anoxia with Argon giving 2% residual oxygen produced minimal respiratory distress. A gas mixture of argon and carbon dioxide which can reduce the time to loss of consciousness and reduce the post stun convulsions gave moderate respiratory distress.

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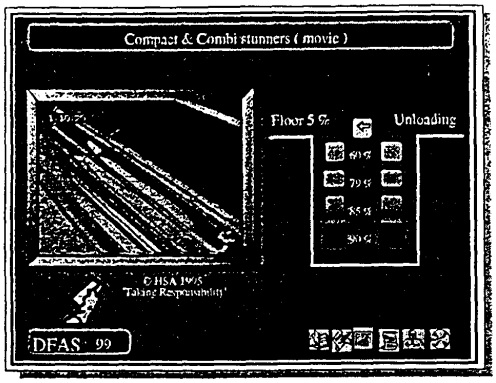
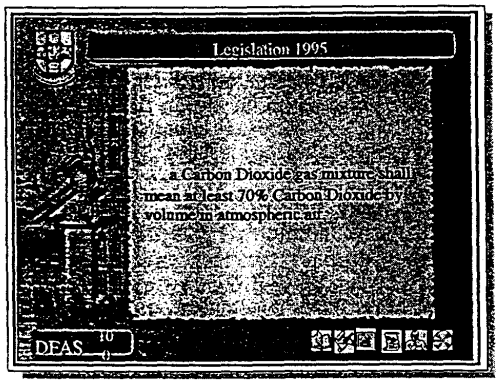
Training Course

Compact stunner



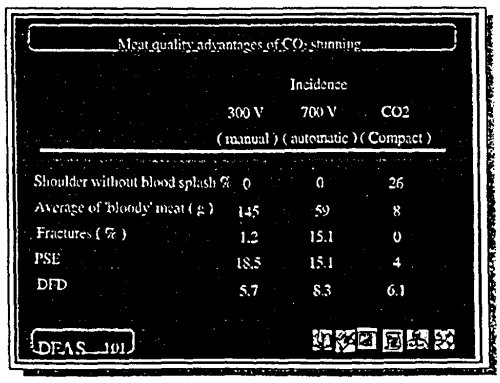
The original commercial equipment was known as a 'Dip-Lift' which was a similar design to the "gas tower" shown in the video, the major drawback of the dip-lift is it's slow throughput. The Oval Tunnel was developed to speed up the procedure but it was soon superceded by the Compact Stunner. The diagram shows the 'paternoster' arrangement of compartments in which a pig is held. A more recent development was the Combi-Stunner, which utilises the same 'paternoster' arrangement but each compartment will carry two pigs. Pressure on throughputs has led to Combi-Stunners that will contain 4 pigs in each compartment and the Danes have developed a side-loading stunner that is designed to stu groups of 4 - 6 pigs.

Legislation



Monitoring equipment is also required (WASK, 1995) such that the chamber is fitted with devices which-
(i) measure the concentration by volume of carbon dioxide in the gas mixture at the point of maximum exposure;
(ii) when the chamber is in operation, continuously display the concentration by volume of carbon dioxide as a percentage of the gas mixture at the point of maximum concentration in the chamber; and
(iii) give clearly visible and audible warning signals if the concentration by volume of carbon dioxide falls below 70%;
(f) there is a means of flushing the chamber with atmospheric air with the minimum of delay; and
(g) there is a means of access to any pig with the minimum delay.

Meat quality advantages of CO2 stunning



There are major advantages that CO_2 stunning offers over conventional preslaughter stunning. The main commercial advantage is seen by significant improvements in meat quality. In comparison with electrical stunning, gas stunning systems will significantly reduce the amount and extent of muscle haemorrhaging (blood splash). The number of bone fractures is reduced to zero, but the effect on PSE is masked by the different handling these pigs received because they were slaughtered at different plants.
A major welfare advantage of controlled atmosphere stun/killing is that the animals can exposed to an atmosphere by simply dropping or moving them into it. Other stunning methods require the application of a device directly onto the head of the animal which usually requires some form of restraint.

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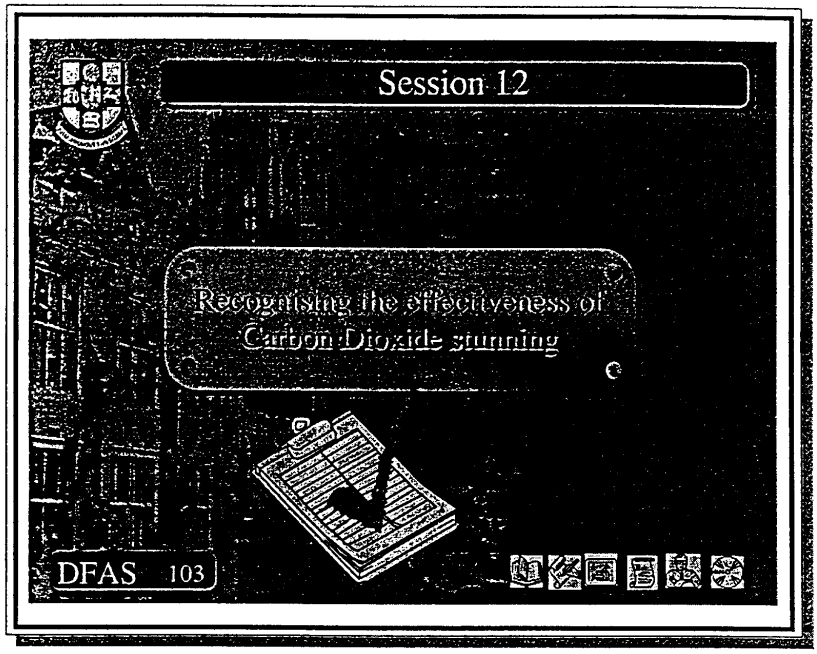
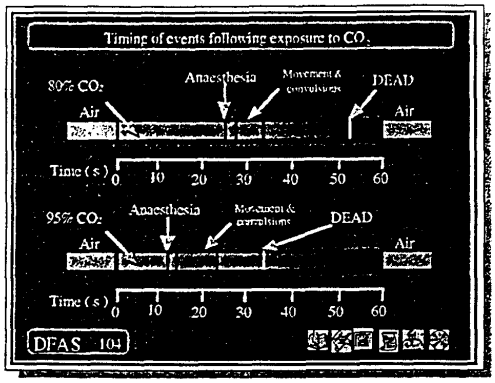


Notes

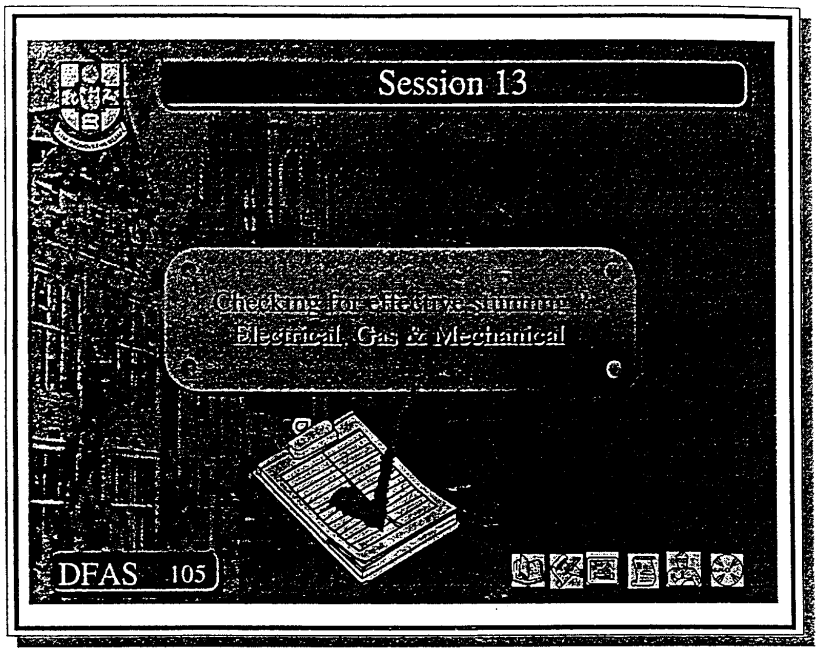
WASK (1995) Schedule 7 describes the "Killing of Pigs by exposure to CO_2". UK legislation requires the pigs to be killed in the gas and not simply stunned, as required under the EC (93/119/EC) Directive. The absence of rhythmic breathing movements in a pig that has been exposed to CO_2 indicates a loss of brain function down to the the level of the medulla in the brain-stem such that the animal cannot clear the high concentration of CO_2 from it's circulation and the acidification of the CSF that produced the anaesthesia becomes irreversible and the pig cannot recover. Therefore, the loss of rhythmic breathing is a useful indicator that the pig has been successfully stun/killed in the gas.

Timing of events following exposure to CO2



The data reported by Anders Forslid, shown in the diagram was generated following direct exposure to the concentrations shown. Commercial CO_2 stunners expose pigs to an increasing concentration gradient with time as the previous slide of the compact stunner shows. Therefore, exposure times given in the diagram are only reliable when the pig is exposed to the specific concentration shown. The concentration gradient seen in commercial stunners will lengthen the time to death using CO_2 immersion. This time will depend on the concentration gradient in the stunner so absolute times cannot be specified. Operatives are encouraged to determine exposure times based on the manufacturers guidelines and by assessir the absence of rhythmic breathing movements in pigs followin exposure.

Animal Welfare

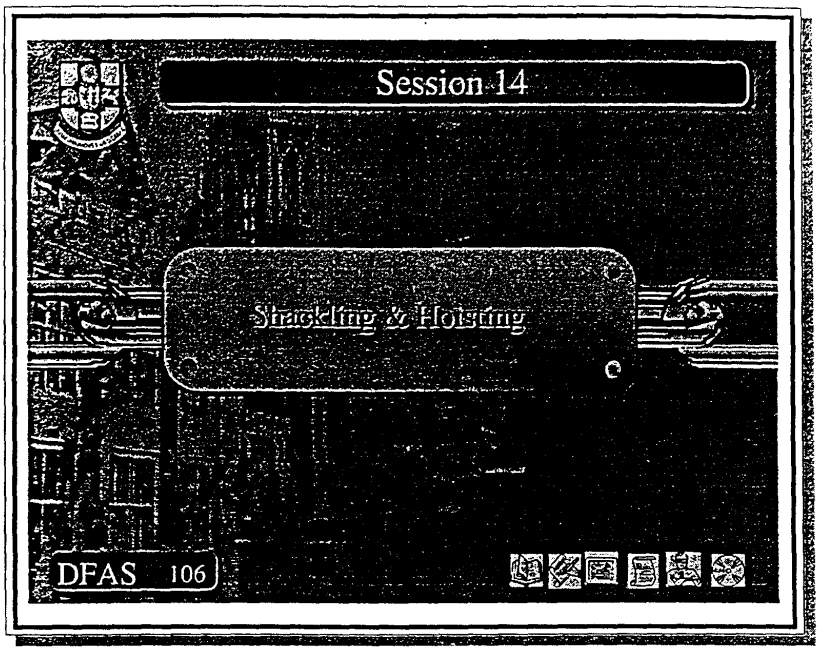


Notes

The abattoir is a difficult and dangerous environment to make a detailed assessment of the depth of anaesthesia using clinical symptoms. The absence of rhythmic breathing movements will indicate that the animal is unable to sustain consciousness following either electrical, gas or mechanical stunning methods. The only exception to this rule is when a cardiac arrest stun has been used with cattle (Jarvis Beef Stunner) where provided there is no continued heart function the presence of rhythmic breathing for a limited period can be accepted on welfare grounds.

Rhythmic breathing can be assessed remotely by careful observation. Assessment during clonic activity is more difficult but can be made by covering the animal's nostrils by hand to determine the absence/presence of rhythmic breathing movements.

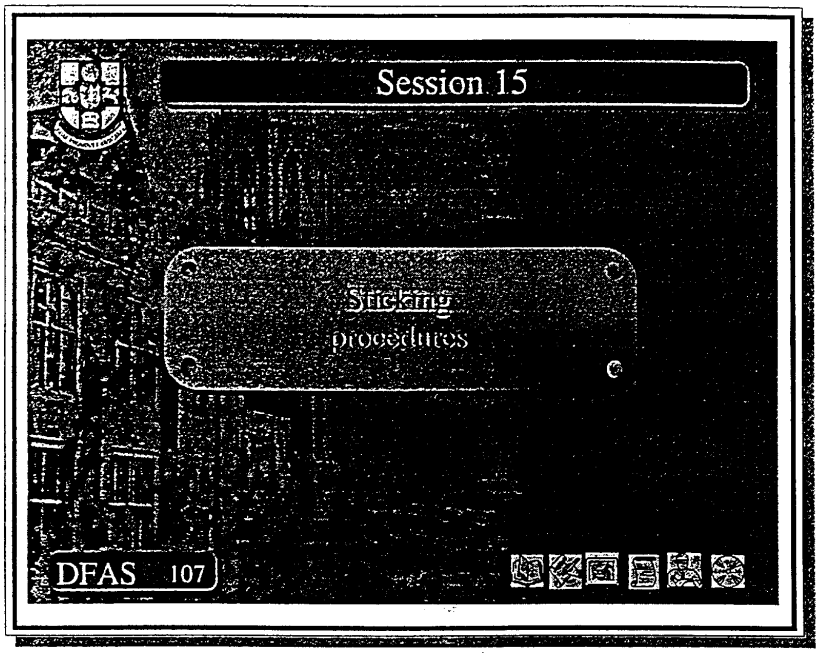
Animal Welfare



Notes

Preslaughter stunning is often assumed to produce immobility. This is seldom the case however, stunning methods can be adapted (e.g. increased stun duration) to try a limit the degree of post-stun convulsions. Many abattoirs shackle pigs during the electrical stunning process itself and although this action cannot be condoned from a health & safety viewpoint, provided the equipment is well maintained and the operative wears protective gloves it is beneficial in reducing the stun-to-stick time. WASK (1995) legislation requires that in England and Wales no person shall bleed any bull, cow, heifer, steer, calf, sheep, goat or pig in a slaughterhouse, knacker's yard or lairage within sight of any other such animal. This requirement will have a direct effect on the time between stunning and exsanguination

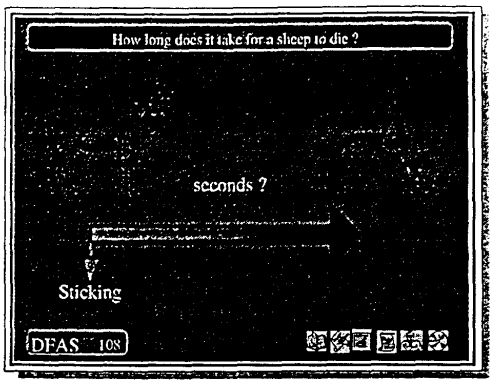
Animal Welfare



Notes

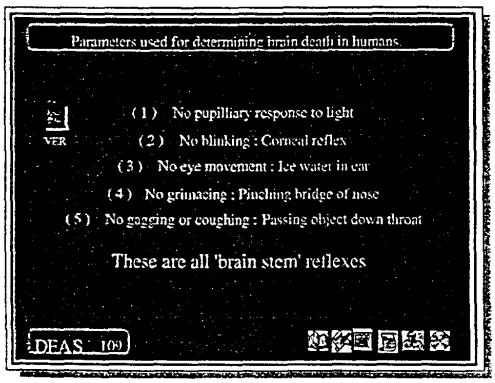
WASK (1995) schedule 6, 2. (2) States that "Any person engaged in the bleeding or pithing of any animal which has been stunned shall ensure that the animal is bled or pithed without delay after it has been stunned. Traditionally the slaughter of animals has been considered a two stage process of stunning followed by exsanguination (sticking). Sticking is a vital part of the process as most stunning methods should be considered as reversible, where the animal is unconscious for a limited period of time. Cardiac arrest stunning and CO_2 stunning of pigs however, result in the death of the animal therefore, sticking simply voids the carcass of blood and plays no part in animal welfare.

How long does it take for a sheep to die ?



A major component of the slaughtering process is the time between stunning and sticking. This should be expressed from the start of stun to the first appearance of blood from the sticking wound. Keeping this time to a minimum is crucial when using head only stunning systems. Ministry recommendations are for a maximum stunning to sticking time of 15 sec for sheep, goats and pigs and a maximum of 10 sec for calves. The length of unconsciousness produced by the head only stun is finite and the animal therefore, could recover before the sticking process has resulted in irreversible loss of brain responsiveness.

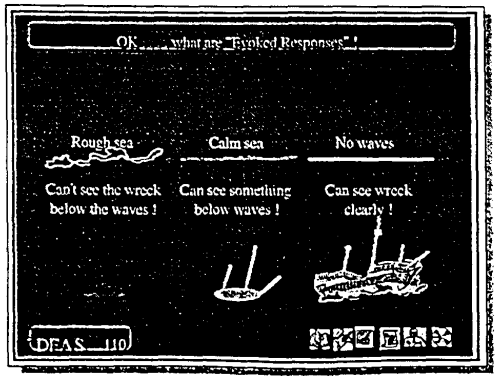
Parameters used for determining brain death in humans



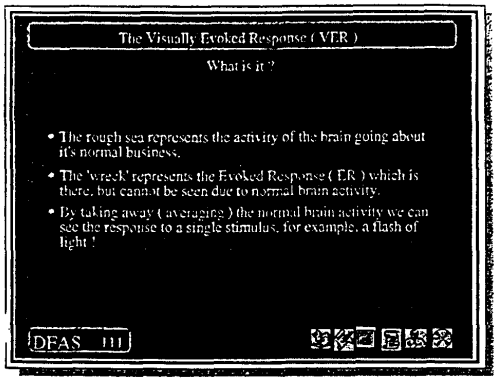
Examination of an animals response to the five brain-stem reflexes shown below are medical tests for residual consciousness. They are used by medics in intensive care facilities to determine death.

(1) No pupillary response to light.
(2) No corneal reflex.
(3) No vestibula - ocular reflexes. (iced water in the ear stimulating eye movement towards ear).
(4) No grimacing in response to pinching the face.
(5) No gagging or coughing in response to brachial stimulation by suction catheter passed down the trachea.

OK . . . what are Evoked Responses ? an analogy . .



The EEG can be compared to the surface of a rough sea. We can think of the information required as a wrecked ship lying on the seabed, unseen due to the rough surface. The methodology for calming the sea to reveal the wreck, is the technique of Averaged Evoked Responses (AER's).
The eye is unable to see the wreck when the sea is rough, but if the wind drops.....the waves become smaller and the outline of the wreck becomes visible. When the wind dies..... the wreck becomes completely visible (provided water is clear!). This clarification is a useful analogy for explaining the use and action of AER's.

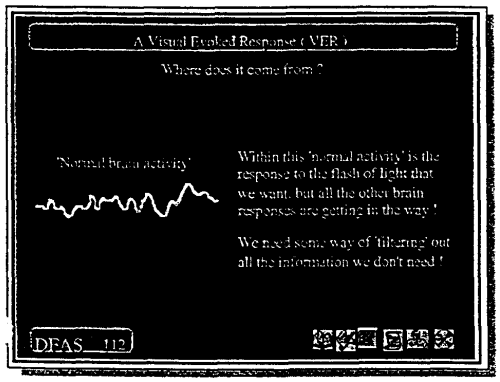


The visually evoked Response (VER) what is is . .

The VER is covered or obscured by a mass of other or, background activity not related to the light stimulus. The methodology that we use to reveal the VER is signal averaging.

Signal Averaging.

If epochs of EEG (short periods of brain activity) that are associated with a light stimuli are added together, any activity that is associated with the stimulus will be enhanced or exaggerated. This will occur because random activity will tend to cancel each other out. If the resulting signal is divided by the number of epochs that were added together then the resulting signal is the Averaged Visual Evoked Response (AVER). The 'A' is traditionally omitted and the abbreviation VER more commonly used.

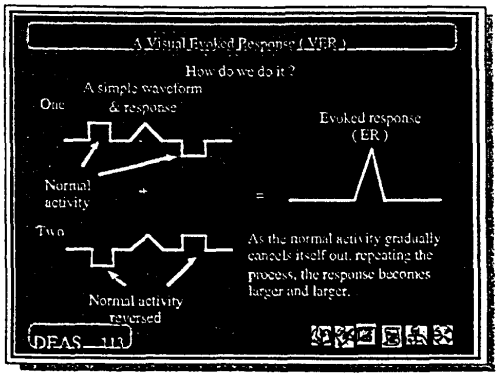


The visually evoked Response (VER) where does it come from . .

By recording the response in an animal to an external stimuli we will be able to measure the precise time when the animal no longer responds to that stimulus. If the measurement is of a neural pathway, we will be able to determine the time when that pathway in the brain fails or dies.

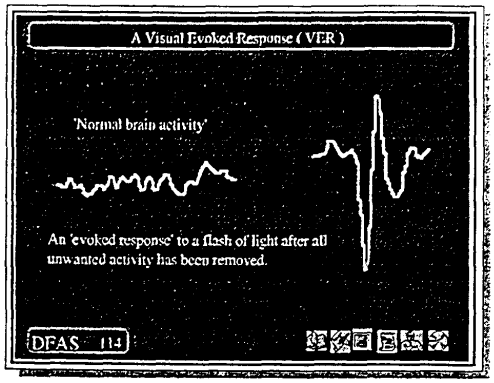
If the stimulus chosen is a flash of light produced by a strobe we will measure the Visual Evoked Responsiveness of that animal.

Much of our early work utilised VER's. In order to record the neural response to the visual stimuli, it was necessary to implant recording electrodes onto the surface of the visual cortex of the brain.



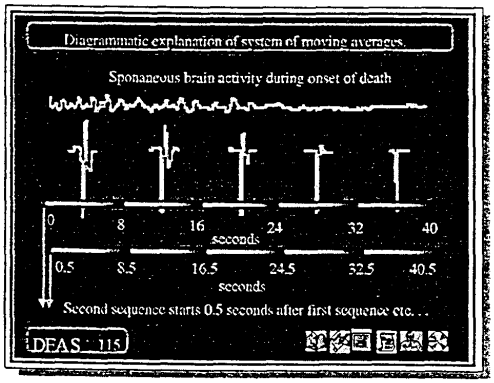
A visually evoked response (VER) how do we do it . .

The VER that we use to determine the time to loss of brain responsiveness, is not only very small it is of a short duration. The usual sweep duration that we employ examines the first 150 ms (150 / 1000 sec) after the stimuli is delivered. This short duration coupled with its small amplitude forces the researcher to look into methods of 'filtering' out the background activity. One such method is signal averaging, which is simply explained in the diagram.



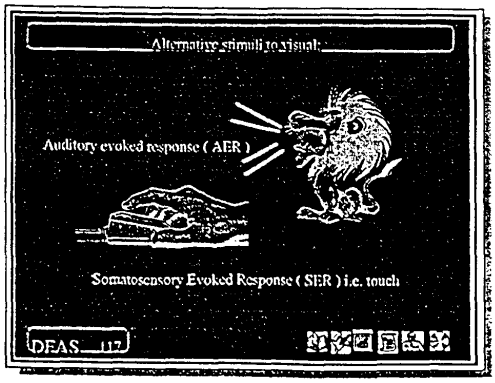
A visually evoked response (VER) filtering unwanted activity . .

VER's are built up into a recognisable response over a period of time. The length of this period depends on the number of stimuli per second, plus the number of stimuli required to produce a reproducible, recognisable response. This period may be 8 sec, containing 16 individual flashes at a stimulus rate of two flashes per sec or longer. The 8 sec period of EEG produces one VER. This time constriction is the major drawback in using a system that is designed to determine the precise moment in time when an animal 'dies'.



Diagrammatic explanation of the system of 'moving averages'

If 16 epochs are averaged together starting at Time = 0 and the stimulus frequency used is 2 flashes per sec., the time period covered would be 8 seconds. Therefore the period covered by the average would be 8 seconds and that single averaged evoked response would represent that 8 sec epoch. If the second sweep of 16 epochs is started at 0.5 seconds, it would finish at 8.5 seconds. The third sweep starts at 1 second, the fourth at 1.5 seconds, etc. the exact time when the response is lost can be determined to the nearest 0.5 second. More recently, computer software has been written to undertake this analytical process.

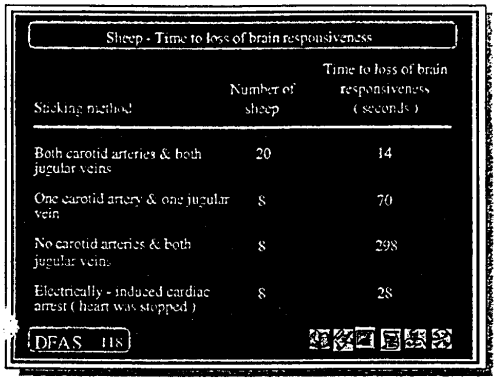


Alternatives to a visual stimuli

The VER was chosen because: (a) it was present during surgical anaesthesia (b) represents a very basic pathway therefore relatively long lasting at death and (c) was relatively large and straightforward to record. However it is not the only stimulus that can be used to evoke a response.

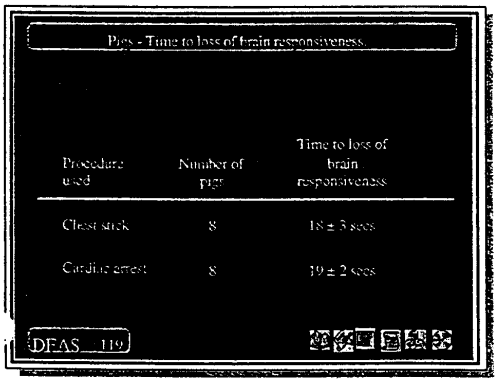
If the stimuli is a click or sound then we measure the Auditory Evoked Responsiveness and similarly if we stimulate a peripheral nerve electrically we record Somatosensory (or touch) Evoked Responses. The visual pathway is very basic as there is perhaps only a single synapse (junction) between the eye and the visual cortex whereas, the somatosensory pathway is far more complicated, involving neurones within the spinal cord, brain-stem, ascending reticular formation, etc.

Sheep : time to loss of brain responsiveness



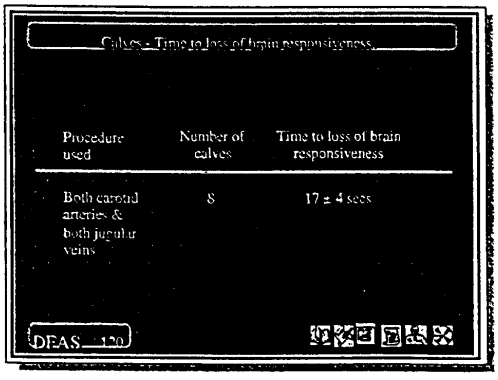
The times shown in the table were determined using a system of moving averages and are the average value for each sticking method. The different sticking methods were carried out under anaesthesia and their accuracy was verified at the end of each recording session. A bilateral neck cut severing both carotid arteries and both jugular veins resulted in the fastest time of 14 sec. Taken in isolation, this method could be considered as the most humane of the four methods tested however, as we shall see later these results should not be viewed in isolation. An inaccurate stick that might miss the vessels on one side of the neck prolongs the time to brain death by a factor of 5 times. Whereas, if the carotids are missed altogether the time is extended to nearly 5 min. Cardiac arrest produced an average time of 28 sec but also promoted the start of death to the point of stun.

Pigs : time to loss of brain responsiveness



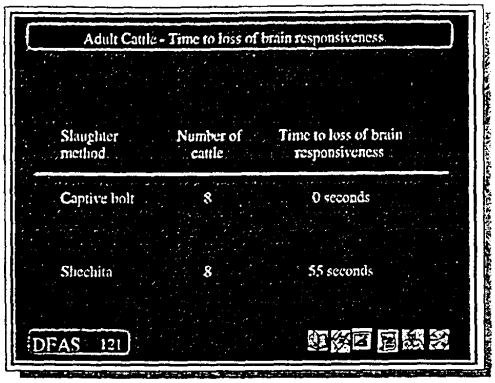
With pigs the usual method of sticking is a chest stick which severs the major vessels of the brachio-cephalic trunk very close to the heart.
For pigs there was no significant difference between a chest stick, and cardiac arrest. The animals die due to a lack of oxygen reaching the neural tissues of the brain. This is achieved either by voiding the blood from the carcass through the sticking wound or by electrically stopping the heart and thereby halting the circulation of oxygenated blood.

Calves : time to loss of brain responsiveness



The time to loss of brain responsiveness to a visual stimuli in calves showed little difference from that shown with sheep and pigs demonstrating a time to loss of brain responsiveness of 17 seconds. The use of full anaesthesia and mechanical ventilation with these experiments, would tend to exaggerate the times to loss of brain responsiveness when compared to sticking an animal that has been stunned. Research in New Zealand would suggest that there is a synergistic effect of stunning followed by sticking that would reduce the time to death. These animals were anaesthetised for ethical reasons, to allow accurate severance of blood vessels in the neck to be made and, to compare the effect of different slaughter methods within and between species.

Adult cattle : time to loss of brain responsiveness

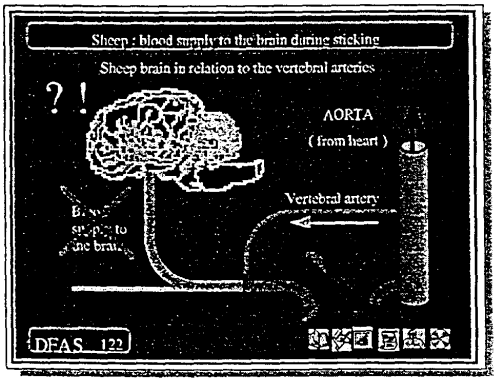


Captive bolt stunning was carried out with a "Cash Magnum 9000" with a red (4 grain) cartridge and resulted in immediate (<1.5 ms) and complete loss of brain responsiveness. If the response is obliterated immediately the effectiveness of the stun is 'guaranteed'.

Shechita resulted in the severance of both carotid arteries and both jugular veins together with all the soft tissues ventral to the spine. The time to brain death with this sticking method was on average 55 sec but the range of times varied greatly (20 - 102 sec).

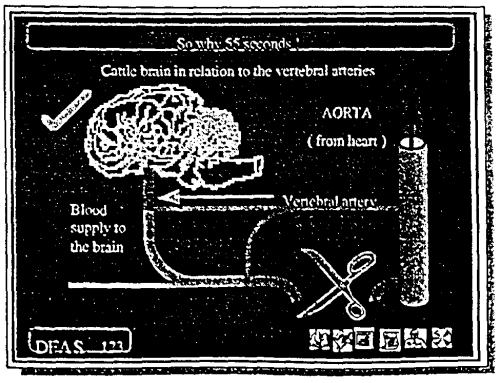
Why is there a significant difference between the time to loss of brain responsiveness in adult cattle and in sheep, pigs and calves?

Sheep: Blood supply to the brain during sticking



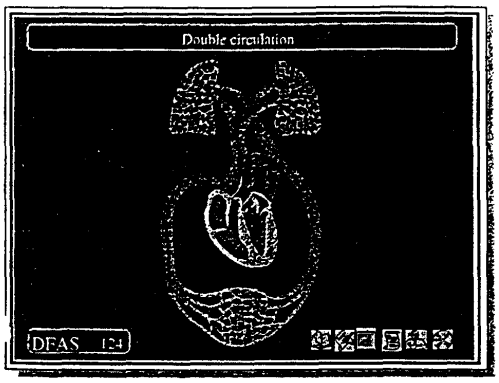
In sheep, oxygenated blood is supplied to the brain via the carotid arteries (left and right) that arise from the brachiocephalic trunk close to the heart. The vertebral arteries also contribute to brain blood perfusion but have no direct connection with the brain. The vertebral arteries in sheep and pigs contribute to the supply via the carotid arteries. Therefore, when the blood vessels in the neck of a sheep are severed at sticking there is no significant contribution of blood to the brain from these vertebral arteries and provided both carotid arteries are severed, the animal will die quickly.

Blood supply to the brain during sticking (Cattle)

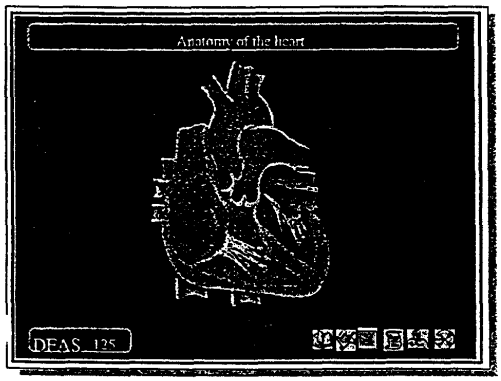


In cattle and deer, the anatomy of blood vessels in the neck in relation to the head are different from that of sheep and pigs. In sheep the vertebral artery has no direct connection with the brain, whereas in calves it corresponds directly through an anastomosis. Therefore, after severance of the vessels in the neck of cattle and deer, this artery can still supply blood to the head in the event of occlusion of the cut carotid arteries. This is the major anatomical cause for delayed loss of brain function in cattle.

Blood circulation

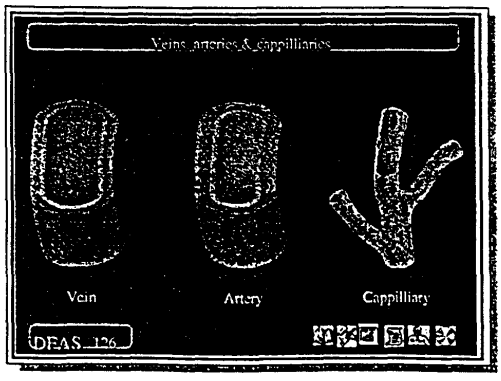


The diagram is a representation of the circulatory system in mammals. The blood within the system is held in the heart, veins, arteries and capillaries. The red vessels represent oxygenated blood and the blue vessels represent deoxygenated blood. Oxygen is carried in the blood from the lungs and is pumped by the heart to the head and body. The whole system operates under pressure, known as blood pressure which is measured in mm of mercury and a normal human B.P. would be 120/80. The first pressure is the systolic pressure that is produced when the heart muscle contracts, while the second pressure is the diastolic pressure that is produced when the heart relaxes.



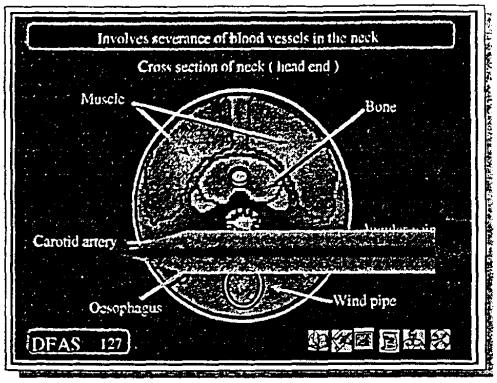
The heart is a specialised muscle, that is able to pump blood out into the circulation provided the chambers are full when the muscle walls contract. As the ventricles of the heart contract, the blood is forced out into the circulation and the heart muscle relaxes and blood is forced (passively) into the chambers due to venous return. This venous return is the diastolic pressure (about 80 mm Hg - normal human) that is essential to maintain the pumping action of the heart. If major blood vessels are severed at sticking, the blood pressure quickly falls to zero and the venous return is lost. The heart muscle will continue to contract rhythmically for several minutes but it will cease to function as a pump.

Veins, arteries and capillaries



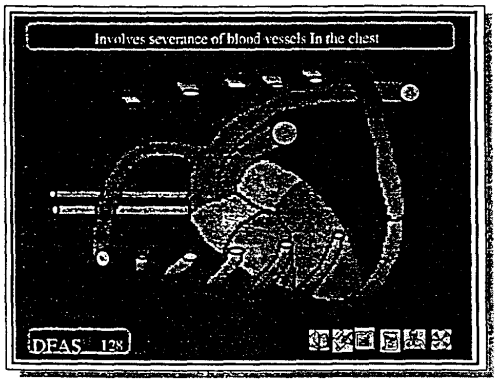
The circulatory system can be compared to your central heating system in your house. If you cut the pipe that supplies your central heating pump with water, the circulation will stop. The pump will continue to operate but because the supply of water is removed it ceases to function normally and there is no circulation. The blood circulation requires both a beating heart and a supply of blood, under press, for normal function. The blood vessels that supply oxygenated blood to tissues need to operate at higher (systolic) pressures. These vessels are the arteries which have a thick muscular wall to withstand the higher pressure. Veins carry deoxygenated blood back to the heart under lower pressures and are less muscular than arteries. Capillaries are a single cell thick and permit oxygen, nutrients, etc., to move from the blood to tissues and vice versa.

Involves severance of the blood vessels in the neck



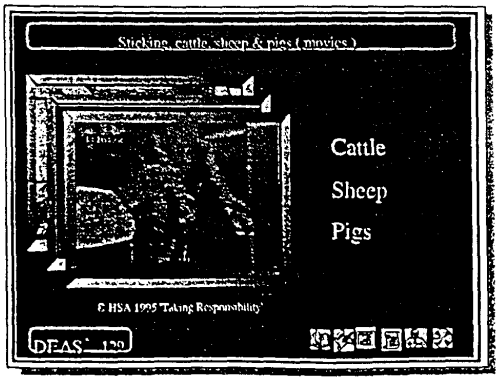
The diagram depicts a typical cross-section through the neck of an animal. The carotid arteries lay buried deep in the ventral tissue of the neck close to the cervical vertebrae. These are the vessels that should be severed if a neck cut is made. The knife should be long enough to sever all the soft tissues ventral to the vertebra with a single cut. A double-edged knife offers advantages over a single-edged knife but, it is the skill of the operative that is important to ensure a correct cut is made. Verification of the blood vessels that are severed should be made regularly by blunt dissection, to ensure the accuracy of the methodology employed.

Thoracic stick



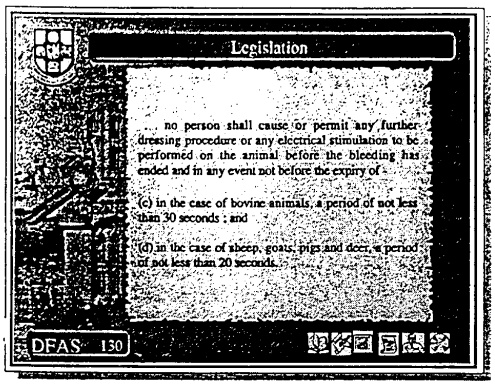
Research has demonstrated that the use of a thoracic stick is beneficial in all species. The knife should be inserted ventral to the sternum and the major blood vessels close to the heart and sometimes the heart itself are cut. The technique results in a massive haemorrhage through the wound that results in an immediate loss of blood pressure. A thoracic stick is also recommended following a cardiac arrest stun. The animal should already be dying however, access close to the major source of blood within the animal will improve the rate of blood loss which may be beneficial to carcass or meat quality.

Sticking cattle sheep & pigs



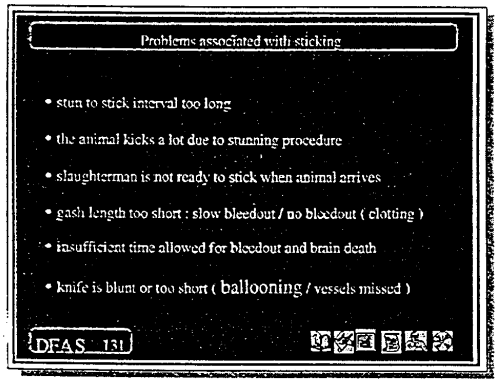
The movies demonstrate the correct techniques for effective sticking in cattle, sheep and pigs. The video clips can be used for training staff and are found on the Humane Slaughter Association video, 'Taking responsibility.' This training package can be very useful to AWOs who are in a position to train other staff at their plant.

Legislation - 'time to die'



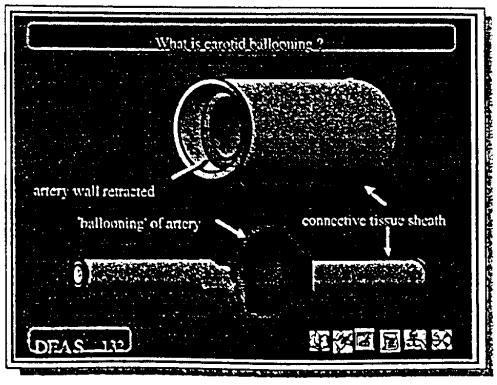
Legislation (WASK, 1995) specifies that the bleeding period after sticking should be more than 30 seconds for cattle and more than 20 seconds for sheep, pigs, goats and deer. These times are to allow bleeding to end and time for the animal to die before any further dressing procedure is carried out. It is interesting to note that electrical stimulation is also included in this category. Researchers would argue that recent findings would categorise deer with bovine animals and that the time for bovines and deer should be extended to one minute.

Problems associated with sticking



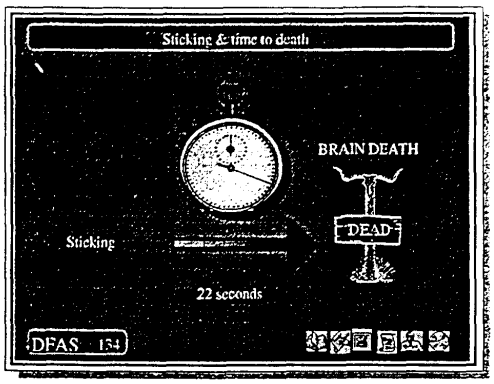
Excessive kicking at sticking and incorrect/inadequate cuts during religious slaughter are two major causes of delays in the time between stunning and brain death. Excessive kicking can be caused by the type of stunning method employed and/or the current duration used with electrical stunning which, can hinder the sticking operation. In addition, inadequate sticking can occur due to short wound lengths (less than 2"). Incorrect sticking during religious slaughter can miss some blood vessels and other unknown factors may cause clots at the ends of arteries which lead to a slow rate of blood loss.

What is carotid ballooning ?



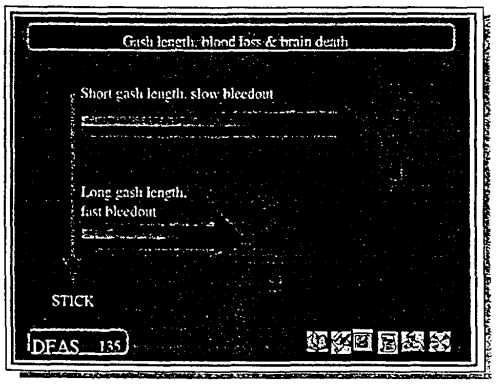
Carotid ballooning is a condition that produces an occlusion of the severed carotid artery and prevents the normal rate of blood loss. Blood clots can occur, when blood vessels are not cut cleanly perhaps due to incorrect sticking or the use of a blunt knife. The blood clots can be identified by palpating the severed vessels where the size of a clot is about the same size as a thumbnail. In the case of cattle, the carotid occlusion will allow a resurgence of blood pressure in the brain through an enhanced contribution from the vertebral arteries and the time to loss of brain function can be extended significantly. Carotid balloons can be produced when required in cattle through the use of a blunt knife however, they have also been recorded following Shechita where the sharpness of the blade is beyond doubt.

Sticking & time to death



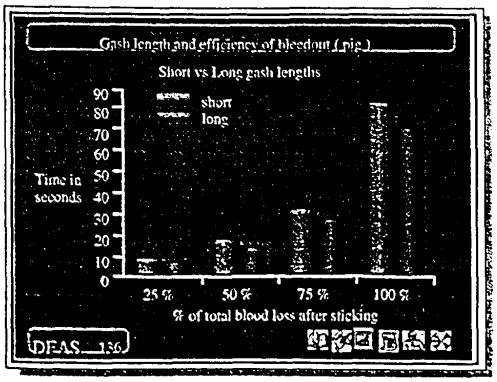
On average, a pig will take 19 seconds to die following an accurate thoracic stick. As stated earlier, a pig will begin to recover from the stun (head only) after the end of the clonic (kicking) phase. This is signified by the return of rhythmic breathing. Given that a maximum of 22 s is required to produce brain death, the length of insensibility produced as a consequence of the stun must exceed the time between stunning and sticking plus 22 s. This time of 22 s is a conservative estimate that was found in anaesthetised pigs. Animal welfare considerations should err in favour of the animal as we have not considered the effect of an inaccurate stick on the time to brain death.

Gash length, blood loss & brain death



Research at Langford has shown that the bleedout obtained using a 'short' sticking wound will increase the time taken for an animal to bleed when compared to a longer gash length. This would result in an extension of the time taken for the brain to die due to the maintenance of some blood pressure within the circulation. In practice, inadequate sticking does occur and should be avoided since it can cause serious welfare problems on the line. By ensuring a gash length of not less than 4 inches and by cutting the major vessels, this problem can be avoided.

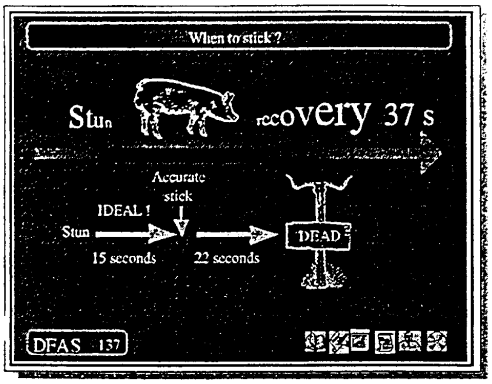
Short *vs* long gash lengths



Research was conducted to determine the effect of gash length on the extent and rate of bleedout. The vessels and organs severed through the use of different gash lengths were identified post-mortem. The time to 25, 50, 75 and 100% of total blood loss was significantly extended through the use of a short gash length. It was noticeable that the damage produced to major blood vessels and organs depended on the depth of the cut. The effect of these two treatments on the time to loss of brain responsiveness was examined using VERs which reinforced the earlier findings.

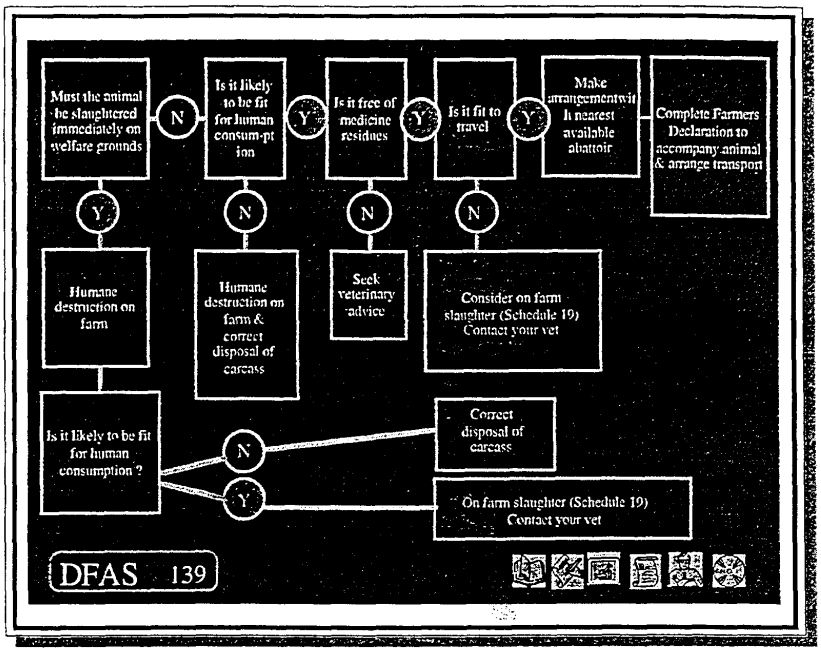
There is concern that hygiene requirements may compromise welfare concerns. The desire to produce a small entry wound to prevent scald water from entering carcasses has resulted in animals regaining consciousness during bleeding because the cut was too small.

When to stick ?



WASK (1995) defines stunning as..any process which causes immediate loss of consciousness which lasts until death.
The minimum time to return of rhythmic breathing movements following the electrical stunning of pigs is 37 s. Experimental work has shown that the maximum time from an effective stick to loss of brain responsiveness is 22 s. 37 - 22 = 15 s. If the same calculation is undertaken for sheep a similar maximum stun-to-stick time will result. Therefore the recommended maximum stun-to-stick time for pigs and sheep is 15 s. One of the reasons why delays can occur is the requirement of moving stunned animals out of sight of animals of the same species before slaughter.

Animal Welfare



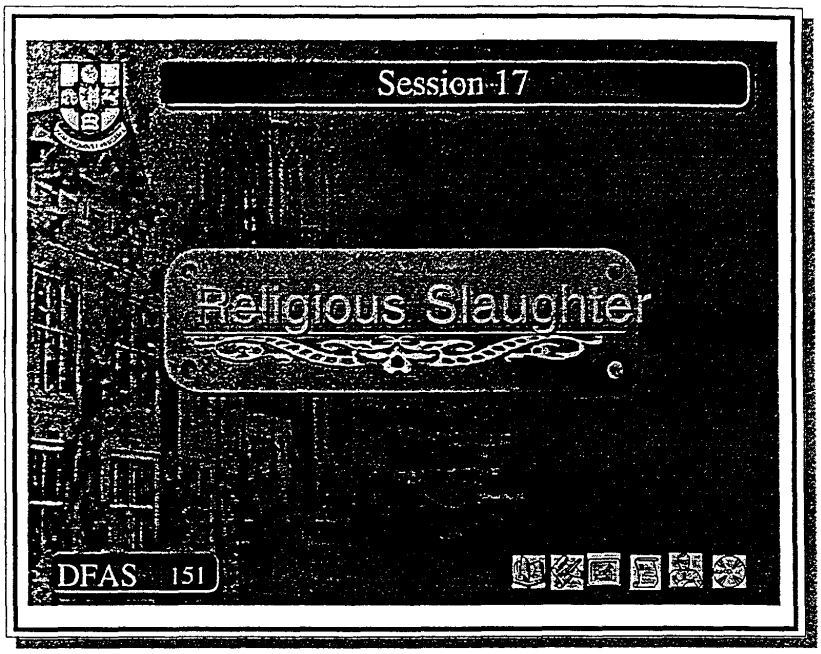
Notes

The BVA:AWF issue guidelines for the correct treatment of casualty animals. Whether an animal is fit to travel is a very important question and the answer to the following questions should be YES before an animal is transported to an abattoir:

1. Can the animal be loaded/unloaded without using force?
2. Can the animal bear weight on all four legs?
3. Are the nature and duration of the journey acceptable?
4. Will the animal arrive at the abattoir without significant deterioration?
5. Will the abattoir accept the animal?
6. Are the vehicle and driver suitable?
7. Is suitable padding and bedding provided?

If the answer to any of these questions is NO the animal must not be transported.

Animal Welfare



Notes

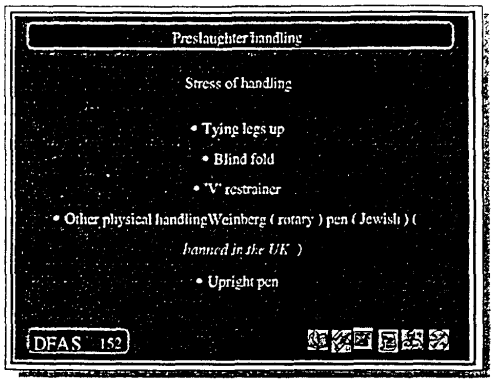
Three questions need to be addressed when considering religious slaughter from a scientific viewpoint :

(1) Is the preslaughter handling procedure more stressful than for normal slaughter ?

(2) Is the neck cut painful when applied and/or during bleedout before consciousness is lost ?

(3) Is consciousness lost rapidly ?

Religious Slaughter : The stress of handling



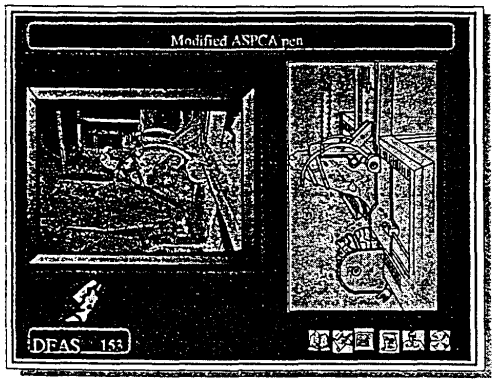
Preslaughter handling, in particular, the use of restraining apparatus needs to be carefully considered to prevent stress. "Restraining pen" is defined in WASK (1995) as a pen or compartment which is-

(a) suitable for restraining for slaughter by a religious method in an upright position any ox, bullock, cow, heifer or steer or any calf which is too large to be restrained manually on a cradle or on a table;

(b) constructed so as to permit one animal at a time to be confined in it without discomfort and so as to prevent any substantial movement of the animal forwards, backwards or sideways once it has been placed in position for slaughter;

The use of the rotary (casting pen, Weinberg apparatus) . now illegal as is tying legs or the use of blindfolds.

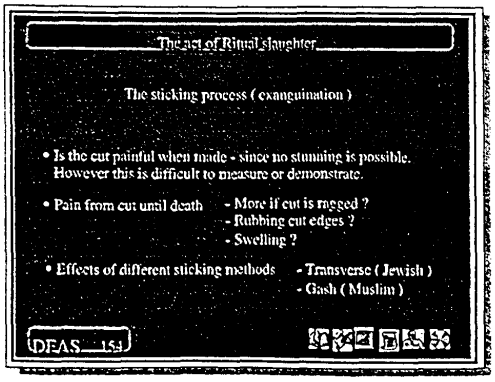
Modified ASPCA pen



The Jewish method (Shechita) requires a single reciprocating cut across the neck using a special knife. The Muslim method can however, use an ordinary slaughter knife and the cut can be a gash stick. The efficiency of sticking is absolutely crucial in terms of welfare as the times to loss of sensibility can vary considerably especially in cattle. The formation of carotid balloons has been recorded with religiously slaughtered cattle therefore, the time to loss of brain responsiveness can be extended.

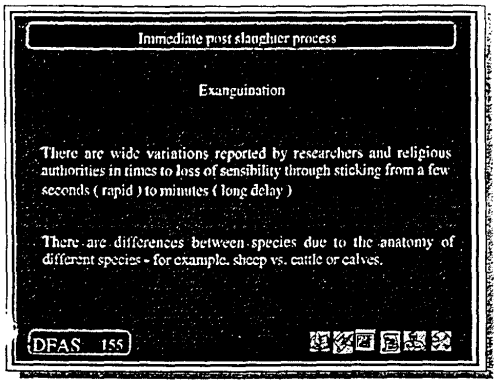
The American Society for the Prevention of Cruelty to Animals (ASPCA) has developed a monorail conveyor with he restraint and chin-lift apparatus that for high throughpu American plants is claimed to result in effective low-stress religious slaughter.

The Act of Ritual Slaughter



The measurement of pain is normally a subjective assessment that relies on the pain threshold of individuals. Direct measurement of pain has not been attempted following ritual slaughter in animals. Human experience would suggest that a cut from a very sharp knife is not immediately painful, it is when a cut is ragged and not clean or, the edges of a cut rub together or, the cut tissues swell that 'we' are aware of a sensation of pain. The previous section on sticking concluded that a thoracic stick was the optimum method to exsanguinate an animal and that with a chest stick, blood pressure would fall very quickly and any contribution that the vertebral artery made to cerebral circulation would be negated.

Immediate post-slaughter process



Research carried out by Clyde Daly and colleagues in Germany examined the time to loss of both visual and somatosensory evoked responses in cattle slaughtered by Shechita. The time to loss of evoked responses was about 55 s and demonstrated the important contribution that the vertebral arteries can make when the blood vessels in the neck are severed.