行政院及所屬各機關出國報告
(出國類別：實習)

赴澳洲學習電力系統運轉、維護模式報告

服務機關：台灣電力公司
出 國 人 職　　稱：十二等變電所所長
姓　　名：白雲年

出國地區：澳洲
出國期間：91.12.1~91.12.10
報告日期：92.1.10

C09200227

行政院及所屬各機關出國報告提要

出國報告名稱：赴澳洲學習電力系統運轉、維護模式報告

頁數 37 含附件：□是■否

出國計畫主辦機關/聯絡人/電話
台灣電力公司/人事處/陳德隆/02-23667685

出國人員姓名/服務機關/單位/職稱/電話：
白雲年/台灣電力公司嘉南供電區營運處/龍崎變電所所長/06-5551397

出國類別：□1.考察□2.進修□3.研究■4.實習□5.其他

出國期間：91.12.1~91.12.10　　出國地區：澳洲

報告日期：92.1.15
分類號/目

關鍵詞：ADCS：區域調度中心
BCT:套管比流器
DI:數位輸入
MAP BOARD:系統圖資顯示板
OSC:示波器
SERVER:伺服器
TCG:可燃性氣體檢出裝置
AI:類比輸入
CVT:電容藕合比壓器
EMS:能源管理系統
OLTC:有載分接頭切換器
RTU:資訊末端設備
SCADA:遙控及資料收集系統

內容摘要：

・出國目的
・澳洲國家人口面積及參加實習地點簡介
・澳洲三個輸電公司設備量與台電比較
・澳洲電力系統分割簡圖(以 SPI-POWERNET 公司爲例說明)
・輸電公司營運重點
・澳洲電力系統管理架構圖
・運轉業務描述(以台電供電系統比較)
・ADCS 業務描述
・電算業務描述
・維護業務描述(以台電供電系統比較)
・出國實習感想
・建議事項

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3.變壓器矽膠石改用非藍色系列產品

4.ADCS MAP BOARD 有汰換機會時改採投射式系統

5.解決電容器組經常故障之問題

6.30 年主變繼續運轉是否參照澳洲做延壽檢查，建議列入變壓器小組專題討論項目

7.輸電鐵塔建立直昇機停留點

一、出國目的

1、 任務說明

1.1 瞭解民營化輸電公司運轉、維護模式之運作，供本公司民營化轉型參考。
1.2 收及設備外部診斷技術應用，供同仁參考以加強防範事故於未然。
1.3 維護週期、項目、及品質與國外輸電公司比較取其優點供訂定制度參考。
1.4 供電系統近年來事故發生率一直無法有效壓制，加上產業界對供電品質要求日趨嚴格，因此赴澳洲就運轉、維護面收集資料並與本公司現況比較取其優點供現場運用。
1.5 供電系統近三年變電設備事故較難擬定對策之項目如 200MVA 69KV 側負載弧光接地發生時，主變受損機率偏高，GIS 包封容器內部電弧故障、161KV 電容器組故障率偏高等問題，因此收集其他電力公司防制事故對策及維護品質的管制供本公司參考。

2、 實施要領

2.1 與參訪輸電公司運轉、維護主管討論交換維護心得。
2.2 赴變電所實際觀察維護及運轉之執行狀況。
2.3 赴變壓器製造廠與製造部門討論變壓器短路試驗之相關要求。
2.4 赴絕緣油試驗室參觀比較絕緣油試驗之項目及標準。

3、參訪時程及地點

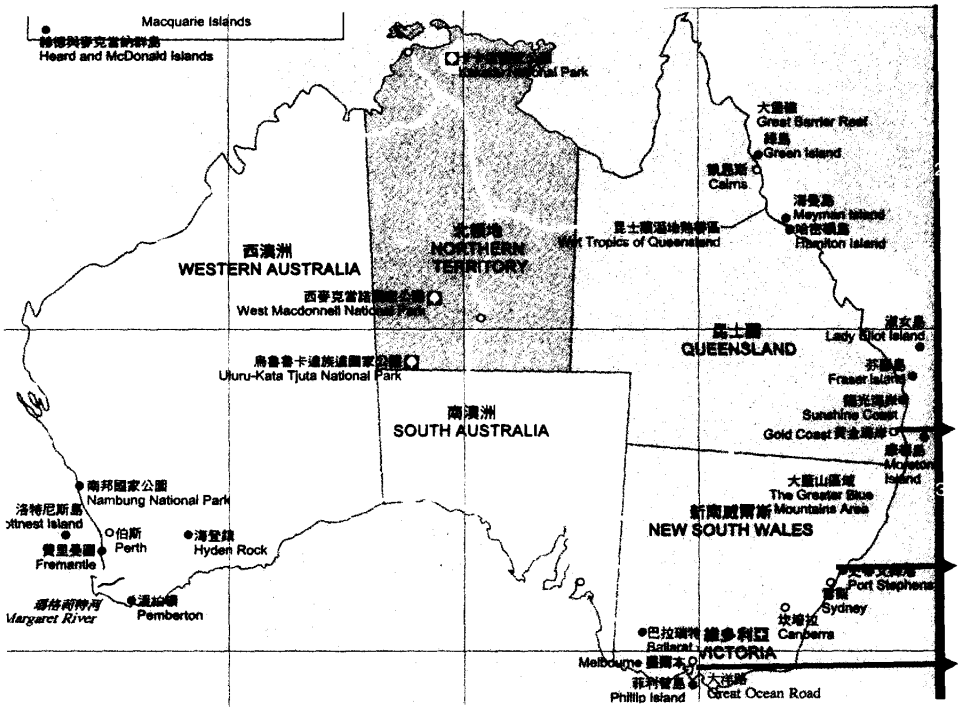
12 月 1 日~4 日：參訪布里斯本 Powerlink 輸電公司
12 月 5 日~7 日：參訪墨爾本 SPI-Powernet 輸電公司
12 月 8 日~10 日：參訪雪梨 TransGrid 輸電公司

二、澳洲國家人口面積及參加實習地點簡介

1.人口：**1950** 萬人。

2.面積：**7682300M²** 。

3.人種：**94%**歐洲血統、**4** %亞洲人、**1.5** %原住民。



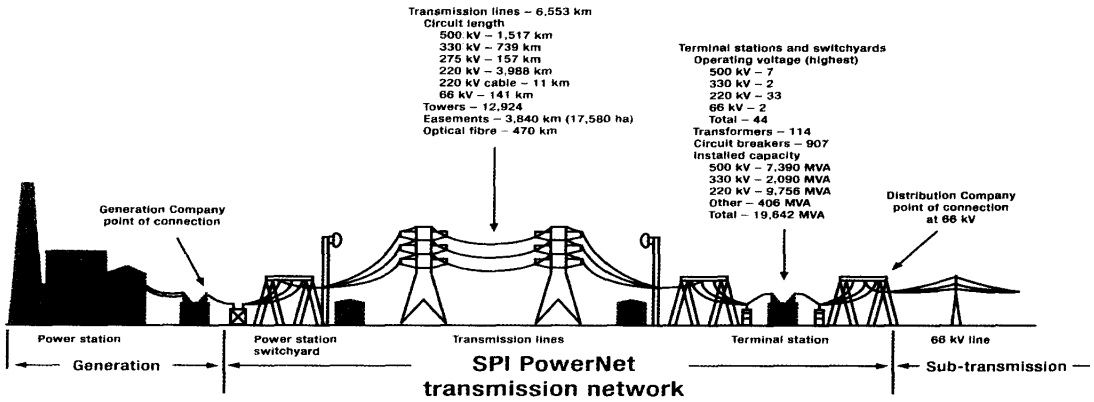
布里斯本 Power link
輸電公司

雪梨 TransGrid
輸電公司

墨爾本
SPI-Powernet
輸電公司

澳洲爲一畜牧業發達國家，用電之型態與台灣工業生產爲主有很大不同，但在維持供電品質之要求是相同的，由於文化上之差異，其維護運轉管理也有一些差異性，因此本次實習是以客觀之態度做評估，我國的維護運轉工作也並不比其他國家差，相信同仁的努力是值得驕傲。

三、澳洲電力系統分割簡圖(以 SPI-POWERNET 公司爲例說明)



1.澳洲電力公司分割成三大部分：**電廠、輸電系統、配電系統。**

2.輸電系統範圍涵蓋電廠內部開關廠→輸電系統→66KV 出口(配電系統)。

3.各系統界限分明。

四、澳洲三個輸電公司設備量與台電比較

公司名稱	CB(台)	Transformer(台)	輸電線路長度(KM)	變電所數(所)
台電	5970	530	13376	142
Powerlink	821	123	11076	92
TransGrid	1226	203	12152	76
SPI-Powernet	907	114	6552	44

五、輸電公司營運重點

1.特點：

台電供電系統→責任中心(防止事故爲主要責任，無營收直接壓力)。

澳洲輸電公司→**利潤中心**(防止事故之外，營利爲最重要指標)。

2.營運概況：

營運系統分爲內部系統營運與對外營業兩大部分，本節所述爲對外營業項目，其他章節則探討內部營運系統。

Business Development Operations：

・電網資產管理服務

・設備運轉狀況監視系統產品研製

・風險評估(設備)

・高壓設備(斷路器、變壓器等狀態及壽命評估)

・電網訴訟調查

・絕緣油試驗服務

・電網(變電及輸電)維護服務

・電網及發電廠開關場監視設備服務

・採購服務

Business Development Engineering：

- 變電所整場設計、施工、監造
- 高壓設備顧問
- 設備擴充工程
- 電網開發建造及工程營造

- SCADA 工程設計監造
- 設備外部診斷、監視系統監造
- 控制及通訊系統
- 電網規劃及擴充
- 電力系統分析
- 系統穩定度調查

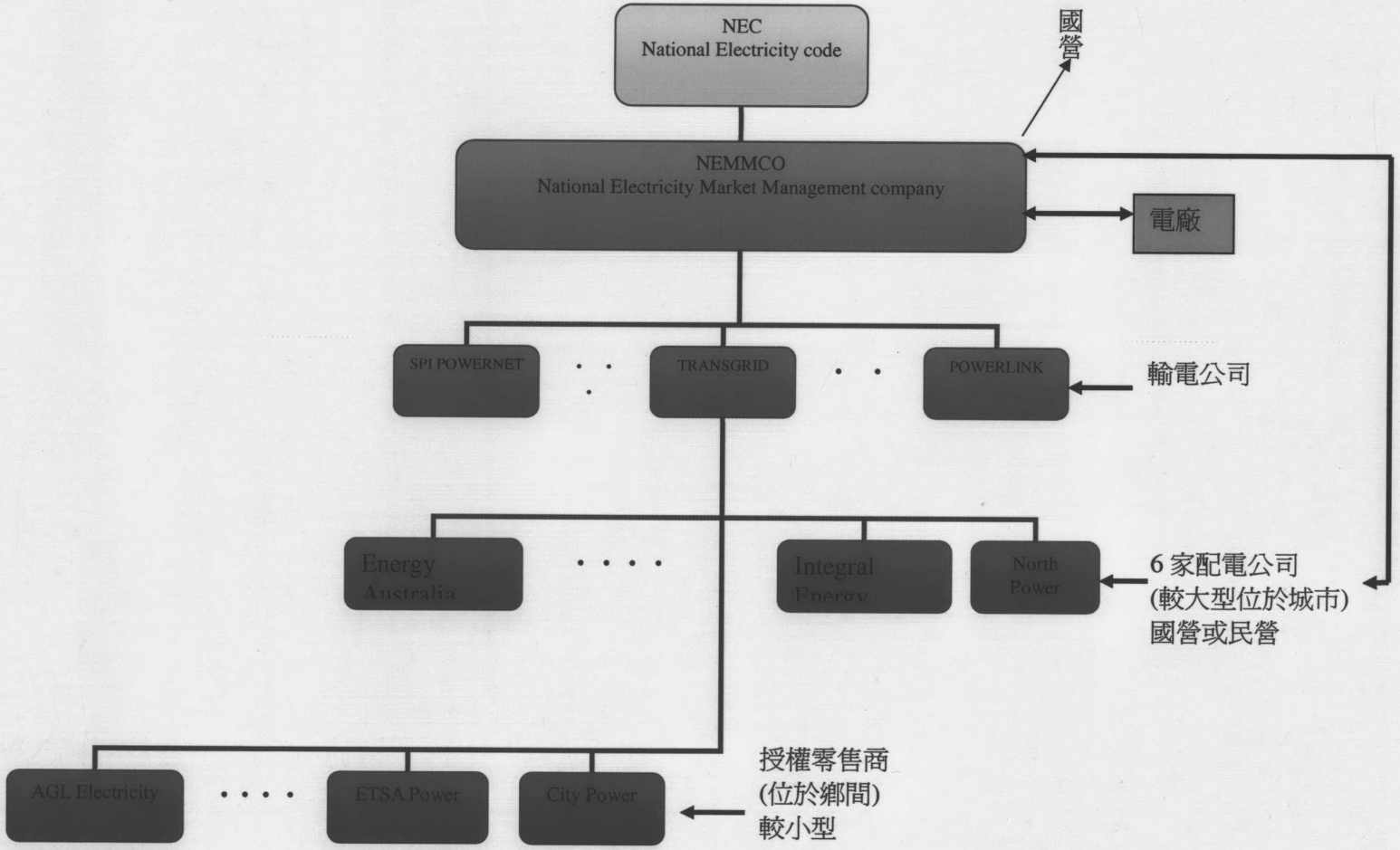
澳洲輸電公司除了本公司系統運作外，尚須承攬外界工程，特別是對外刊物附加下列說明顯示對外營業採單一窗口制度(以 **Powerlink** 公司爲例)

Our business development representatives would be pleased to meet with you to discuss the needs of your organization. From routine maintenance services to complex network developments, we are confident that Power link can enhance the cost-efficiency and reliability of your power transmission assets.
Please contact either Ian Nichols or Henry Hawes.

六、澳洲電力系統管理架構圖

澳洲電力系統是依據國家電業法(National Electricity Code)作最高指導原則，下設國營國家電力市場管理公司，掌管電力市場運作，其中包含發電、輸電、配電系統，電價結構管控，電力發展指標訂立等業務。輸電公司負責將電廠電力輸送至配電公司，其中財務管理運作變成一相當重要業務，如自配電公司收費及付費給電廠，輸電利益計算等。配電公司數量很多如 Powerlink 有主要配電公司 7 家，另外在偏遠地區亦有授權零售商 20 家，負責小區域售電業務。

參考下圖：


NEC
National Electricity code
國營
NEMMCO
National Electricity Market Management company
電廠
SPI POWERNET
TRANSGRID
POWERLINK
輸電公司
Energy
Integral
North
Power
6 家配電公司
(較大型位於城市)
國營或民營
AGL Electricity
ETSA Power
City Power
授權零售商
(位於鄉間)
較小型

七、運轉業務描述：(以台電供電系統比較)參訪三家輸電公司都有自屬ADCS，運轉方面業務大都由 ADCS 負責，實務上已無運轉部門名稱。

1、巡檢股業務

事故判斷：以 Power link 公司爲例，管理中心設有事故分析資深工程師負責事故判斷及自動化巡視工作，巡檢股業務隸屬維護部門。

1.大量採用資料傳輸系統遙傳資料至管理中心，資料種類如下：數位攝影系統、設備之 DI、AI 狀態、OSC 資料、線上型 TCG 資料、 礙子污染監視、線上型局部放電設備等。

2.爲儲存及應用大量資料，變電所大都裝設 SERVER ，使用自有通訊設備連結至管理中心。

3.廣泛應用電腦工具輔助業務管理。

4.遠距離變電所事故經判斷有異狀則通知契約廠商至現場巡視或處理，城區變電事故由公司員工處理 。

註：澳洲輸電公司幅員廣大，遠端變電所距離控制中心有高達 400 公里者。

2.策劃股業務

由專責部門負責系統規劃類似本公司系規處。

3.調度股業務

全屬於 ADCS 運作範圍，無調度部門組織，涉及輸電公司與輸電公司系統並聯問題，則由國家電力市場管理公司負責。

4.電控股業務

合併在維護部門。

5.電驛維護

獨立部門維修公司內部之電驛系統外兼承接國內外業務。

八、ADCS 業務描述

1.ADCS 管轄變電所數量(以 TransGrid 公司爲例)

500KV 2 所、330KV 36 所、220KV 3 所、132KV 40 所合計 81 所。

TransGrid 公司使用小型化控制已有 20 年經驗，目前正逐年汰換，新設備陸續接入施工中 ABB 主機系統。

2.值班人員設置方式：

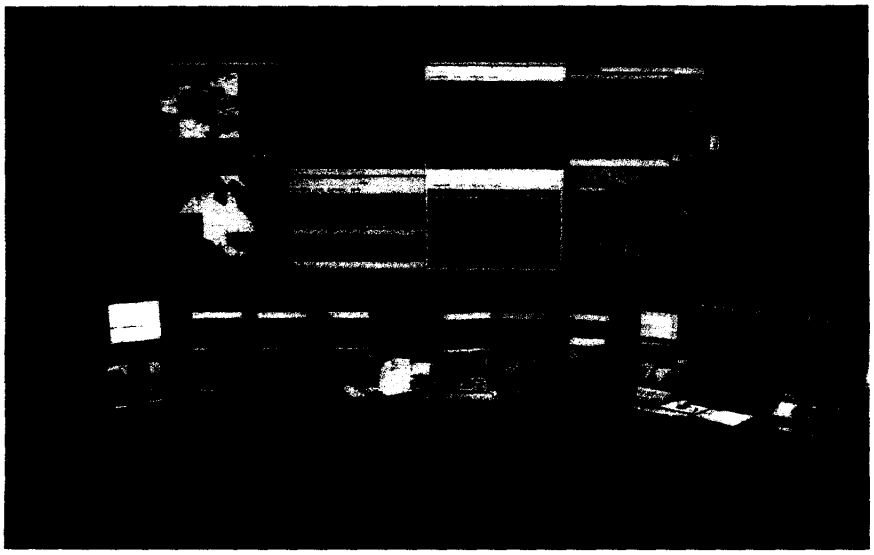
以 TransGrid 公司爲例值班主任白天 2 人，夜間 1 人上班(因系統尚未完全加入緣故)，另以 Powerlink 公司爲例 92 個變電所設值班人員四人輪班。

3.值工師(manager)工作：

負責審定操作程序，編定訓練計畫。平時還須 RUN 系統模擬程式找出瓶頸點及複雜之操作程序可能造成問題弱點等工作。

4.Map board 之應用情形：

各輸電公司大都採投射式 map board，值班人員可多元化監視系統動態，包含電力量、開關狀態、現場攝影機畫面、各種類比圖形等(參考附圖)。



5.值班人員誤操作處理原則：

由評判委員會提出加強訓練時數，值工師出題訓練及測驗，如經訓練還是無法改善再續出事故則可能被解雇。

6.輪班制度

和本公司類似不再敘述。

九、電算業務描述

1.採用系統

A、Powerlink 公司

1.採用 CAE 系統(與本公司二期自動化工程相同)。

2.投射式 MAP BOARD。

B、SPI-POWERNET 公司

1.ABB 系統。

2.Convention MAP BOARD 與本公司相同，採用馬賽克構成。

C、TransGrid 公司

1.ABB 系統。

2.投射式 MAP BOARD。

2.硬體維護(主機及 RTU)

A、採發包給原廠維護(主要配件由原廠提供，減少專用人力及節省備品費用)。

B、簡易部分自己維護。

3.軟體維護

A、軟體主系統(OS 作業系統由原廠維護，因更改 OS 茲事體大，須由原廠執行較妥)。

B、成立 DATA BASE 管理部門由課長(MANAGER)級負責，工作含 RTU firmware 更新。

4.自動化規劃業務：

類似電控會組織除自行業務規劃外尚須承包國內外工程。

5.能源管理系統〔Energy Management System (EMS)〕：

包含下列項目：

FULL SCADA FACILITIES、網路分析副系統、運轉計劃應用軟體、開關操作管理系統、系統模擬軟體等。

十、維護業務描述(以台電供電系統比較)

1.維護型態

偏遠地區維護點檢、巡檢、事故處理交由契約廠商辦理，爲維持工作品質，維護管理部門經常對契約廠商訓練，以提高廠商工作能力，契約廠商維護工作以積點計價(三輸電公司都以積點計價)。自有人力工作範圍大都在都市週邊，偏遠地區必要時再支援。

2.新技術應用

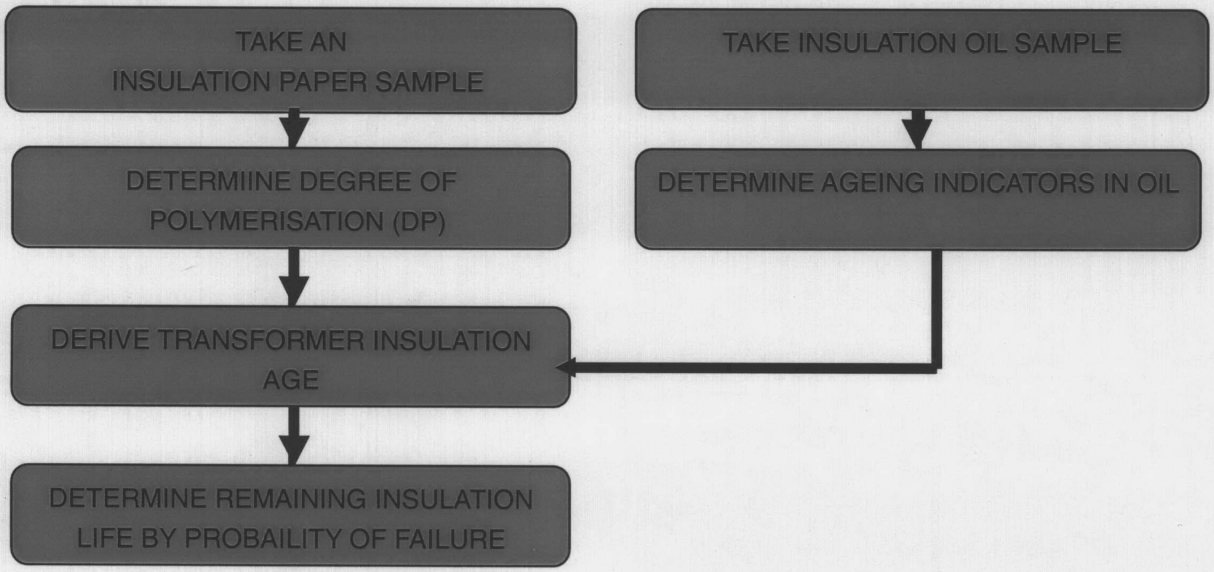
2.1、電纜絕緣油試驗：

SPI-POWERNET 具有 14000 個油樣檢測紀錄，作爲故障分析 DATA BASE 對電纜維護有相當助益(本公司目前尚未有相同做法)。

2.2、變壓器絕緣油試驗項目：

變壓器絕緣油試驗除傳統氣體分析(DGA)及電氣試驗外，另外亦做絕緣紙強度試驗、糠醛試驗、OLTC 絕緣油雜質分析試驗，本公司在這方面僅 DGA 試驗較成熟外其他試驗都在起步階段。

2.3、變壓器使用壽命判斷技術



變壓器壽命判斷方法簡述：

超過 30 年主變停機進行延壽檢修時，利用線圈重新締緊機會取出變壓器絕緣紙樣品，檢測絕緣紙聚合度及張力試驗作絕緣壽命判斷。另採取變壓器絕緣油利用糠醛試驗法判斷絕緣紙壽命。綜合兩種方法判斷變壓器絕緣壽命。(糠醛試驗原理另參考下述解釋)

糠醛試驗定義：

變壓器之絕緣材料是由木料及絕緣紙等有機物配合其他無機物構成，其中有機物經化學分析到最後就是葡萄糖結構，絕緣材料在變壓器中劣化後其聚合度下降，纖維會析出於油中，因此檢測油中葡萄糖含量愈多則代表絕緣紙劣化程度

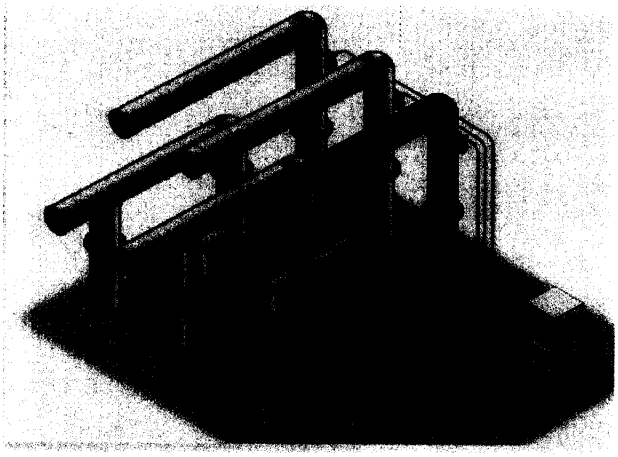
愈嚴重。

2.4、變電所活線作業推廣：

由法國進口活線作業車，對重要線路及變電所設備不易停電者採用活線作業，活線工作電壓可至 330KV，此爲輸電公司減少停電對策，高壓活電作業在澳洲輸電公司已有很強技術經驗。

2.5、GIS 局部放電偵測系統：

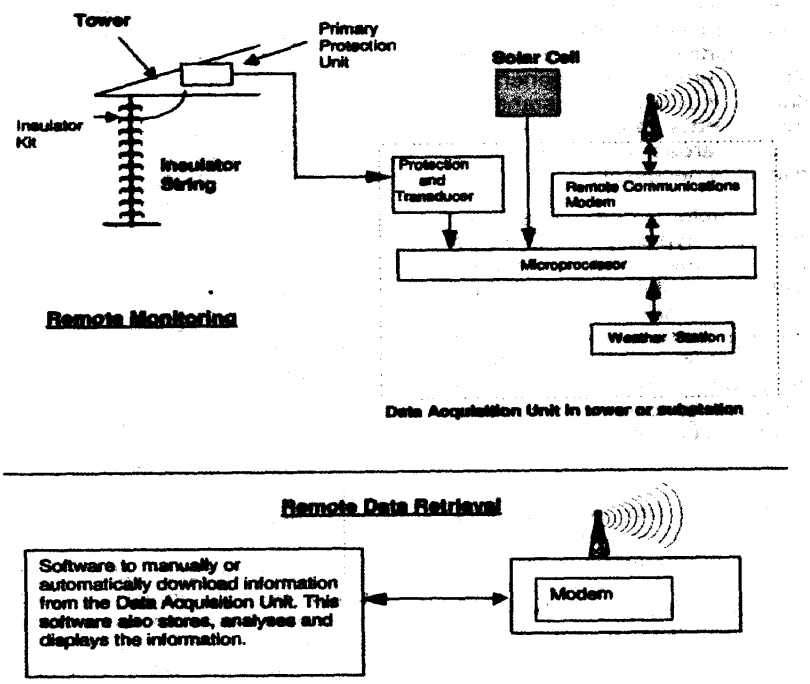
採用特殊感測元件安裝於間格器(spacer)位置截取局部放電高頻訊號及早檢出問題點早做處理以提升 GIS 運轉安全性(安裝位置參考附圖)。目前此型局部放電偵測系統在 Powerlink 公司，尚在試用階段，其他公司則未使用，但移動式局部放電儀器，各公司都採用，做法與本處情況大同小異。



註：感測元件裝設於 spacer 位置主要目的，是因高頻局部放電訊號可較易經由高分子化學材料傳導到感測元件。反之將感測元件裝置金屬外殼則高頻局部放電訊號將受到衰減。

2.6、線上型礙子污染偵測系統：

檢出礙子污染造成放電電流脈衝配合雨量計、溼度計判斷污染程度作爲礙子清洗判斷參考。(請參考結構圖及簡單原理)此項污染偵測系統在澳洲高鹽害地區輸電線路已採用多套，Powerlink 公司研發此系統成功後，亦銷售至其他東南亞國家及中國大陸。

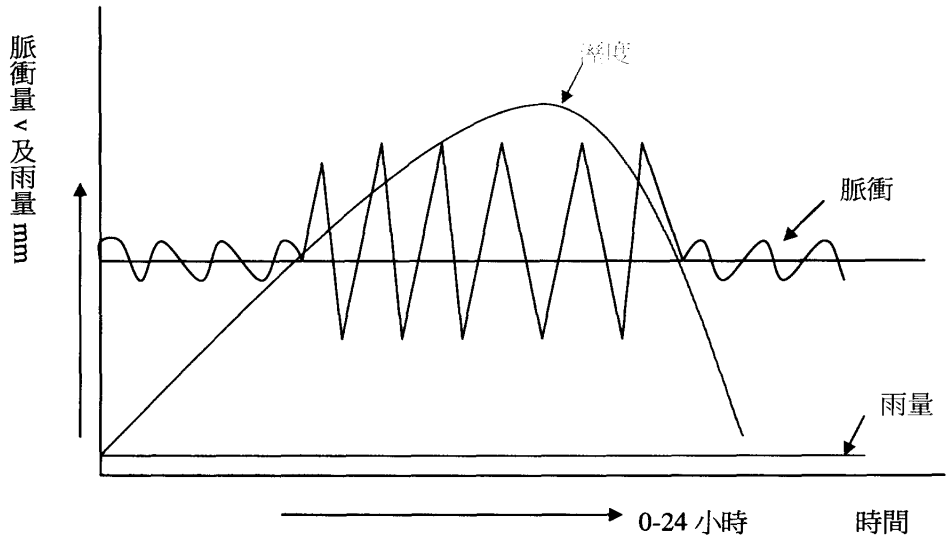


Overview of the LCM Pollution Monitoring System for Overhead Line Insulation

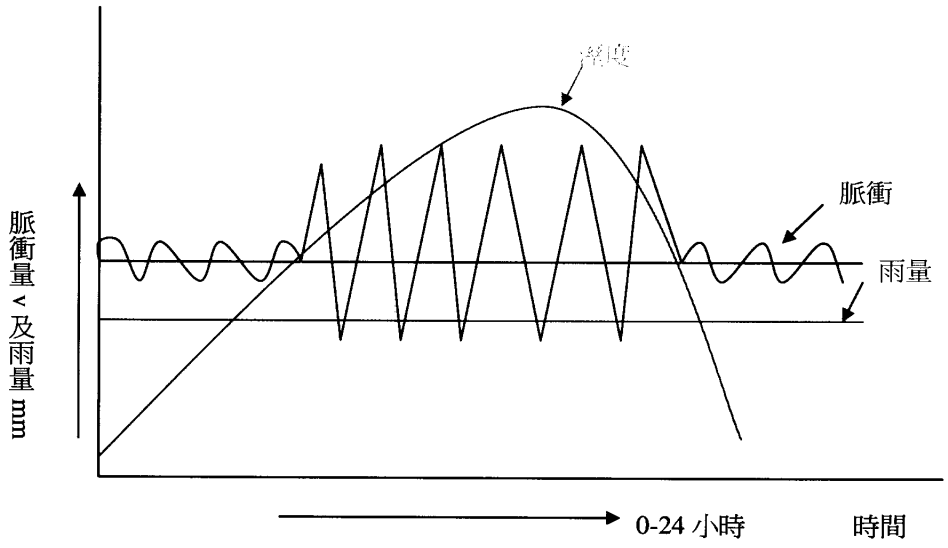
線上型礙子污染偵測系統工作原理概述：

在高污染地區輸電鐵塔或變電所，於送電礙子串最靠近接地端部位多一只礙子，該礙子中心鐵棒裝設一只電流感測元件(類似比流器原理)，截取礙子表面污

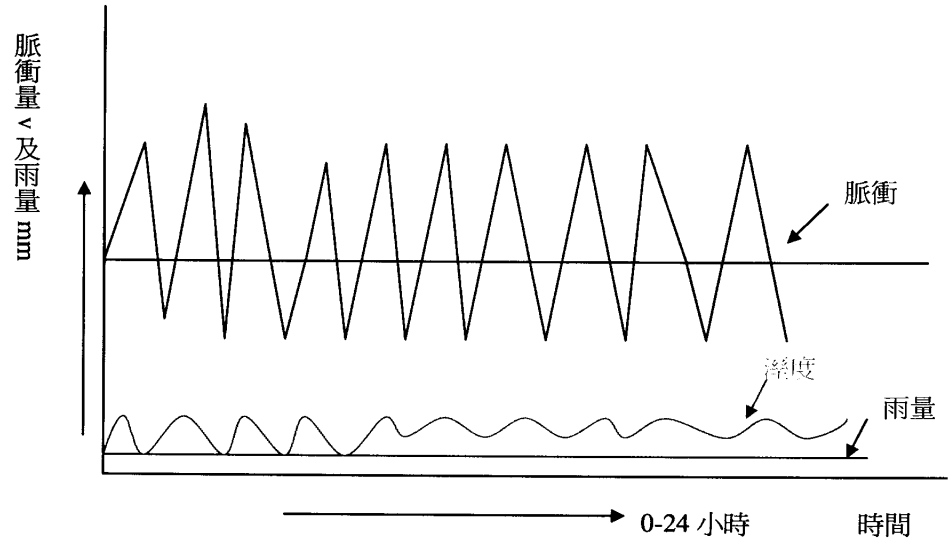
染物放電電流脈衝，此脈衝電流經第一段保護迴路(類似放電間隙)送至轉換器及第二段保護迴路(突波吸收器)，此轉換器內部裝設高頻濾波器(high pass filter)，電路僅取用高頻放電訊號，並轉換成數位訊號送至微處理機分析，得到結果採用大哥大通訊迴路傳送到維護人員辦公室供分析。爲判別造成放電脈衝是真正由污染物造成或由濕氣、下雨引起，在設備現場亦裝有溼度感測元件及雨量計，此兩種裝置亦分別提供電氣訊息送至微處理機。(判斷污染方法請參考下列檢圖說明)



A、濕氣引起脈衝非污染造成



B、濕氣及下雨造成脈衝



C、污染造成脈衝(雨量與濕氣低但有持續高脈衝)

2.7、CVT、CT 監視系統：

因澳洲採用大量獨立 CT ，經常發生事故，無較好對策，因此自行研發監視系統，Power link 公司爲克服此問題，目前正研發監視系統，而 TransGrid 公司對 CT、PT 防制事故方面則已朝光纖系統發展，在台電則較少此類事故，因台電大都採用 BCT 其絕緣系統問題較少。

2.8、採用 PASS(PLUG AND SWITCH SYSTEM)取代傳統 ABS 及 CB

註：

PASS 技術(GAS INSULATED SWITCHGEAR WITH INTEGRATED DIGITAL CONTROL AND PROTECTION DELIVERED THROUGH FIBER OPTIC CONNECTIONS)瓦斯絕緣開關經由光纖連結數位控制及保護系統。

優點：

2.8.1、減少圖面數量。

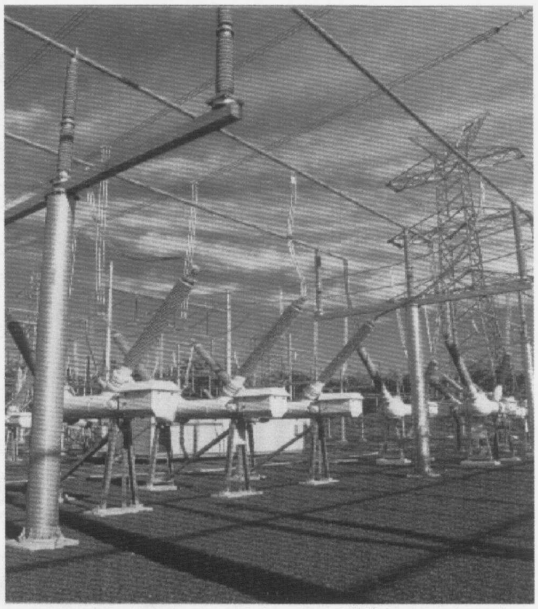
2.8.2、減少現場佔地面積。

2.8.3、BUS 佈局改變成簡單化。

2.8.4、不再使用 ABS。

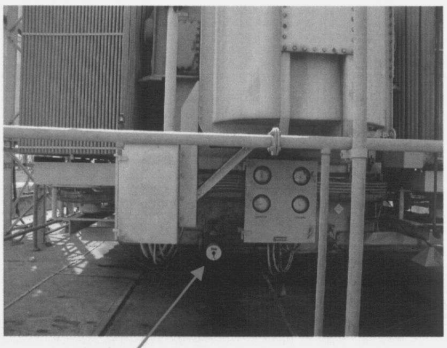
2.8.5 、減少高壓側引線端子及控制電纜。

此種做法與目前台電瓦斯組合式開關 GCS 相同，但其控制及保護系統則較先進，利用光纖傳送控制指令及警報等訊息。

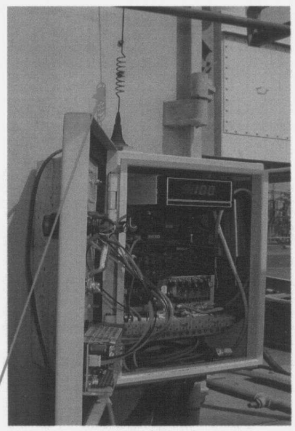


2.9、數位化巡檢系統：

在自動化變電所裝置小區域網路 LAN(A LOCAL AREA NETWORK)然後銜接至大型網路 WAN(WIDE AREA NETWORK)再送至總公司管理部門 ，其主要功能是收集設備監視用數位攝影機視訊及外部、診斷系統數位數據、線上型 TCG 資料、礙子洩漏電流監視系統、局部放電系統、RTU STATUS 等。



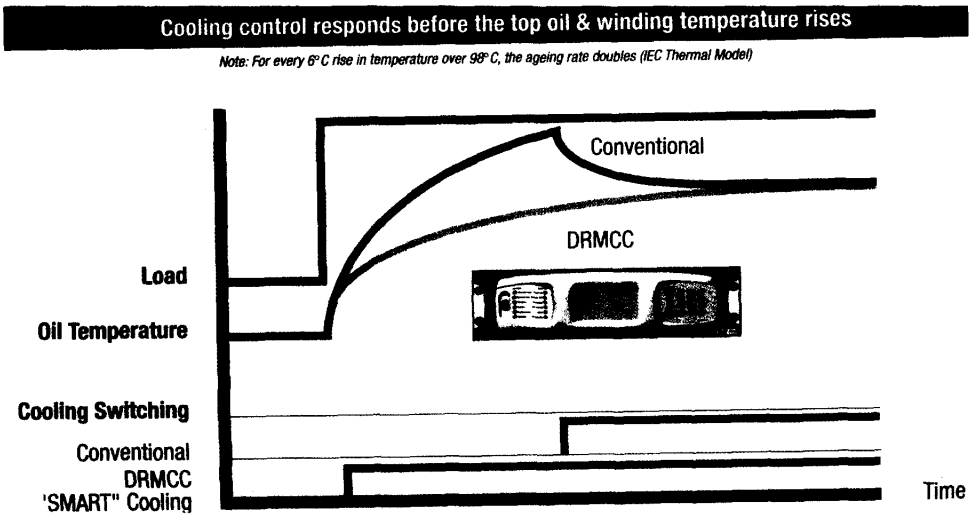
TCG 裝置



TCG 資料用大哥大傳送至主系統

數位攝影系統安裝中

2.10、變壓器冷卻系統採用智慧型自動啓動裝置：



此項裝置其功能簡單的說就是變壓器負載在未昇高之前，冷卻系統就先啓動，可使油溫上升率下降，除此之外亦可做電風扇定期更換組別，不長期固定使用

同一組。此項試驗在民國 71 年龍崎 E/S 曾經應用 APPLE II 電腦試驗一段時間，但因人員調動，管理人力無人銜接未繼續使用。因台灣電力變壓器負載經常在滿載邊緣，風扇全部啓動不夠還加噴水，不像澳洲每個變電所負載率僅 50%左右，因此這種裝置在台灣應用效果如何尚值得研究。

3.以經濟考量控制維護成本：

設備汰換、新設、維修所需經費皆須經過成本效益評估才執行，以俗語稱「錢花在刀口上」，此觀念在台電民營化後將會出現，因爲一切將以利潤爲優先考量。目前供電系統亦有類同方式「汰舊換新評鑑」，只不過是澳洲電力公司較會精打細算。

4.員工維護工作範圍：

除了本公司設備維護外，亦須承接國內外維修工程，以目前實績來看澳洲輸電公司工作範圍已遍及東南亞各國及中國大陸。

5.維護週期與項目：

在維護策略方面各輸電公司皆定出維護週期及項目，但執行上相當具有彈性，比較台電做法本公司似較嚴苛，茲以 TransGrid 公司提供之設備維護資料做參考依據說明如下：

5.1.變電所設備週期性維護：

5.1.1.一般性開關場巡視至少 3 個月一次。

5.1.2.油及氣衝斷路器外檢 4 年，內檢 12 年或操作 800 次，GIS 斷路器外檢 8

年，內檢 16 年或操作 2500 次。

5.1.3.主變 OLTC 4 年外檢，內檢 4~8 年，切換次數則依廠牌而定。

5.1.4.主變套管、線圈 4 年檢查一次。

5.1.5.主變及 OLTC 絕緣油每年檢查一次，濾油則視需要(澳洲 OLTC 大都未裝濾油機經常發生 OLTC 事故)。

5.2.變電所設備非週期性維護：

設備發生事故、弱點檢修、入廠大修都屬於非週期性維護，上述之問題一旦造成之後就需進行評估作業，考慮項目如更新、經濟性、安全性、環境考量、老化等因素，確立方向後再作維修，不符成本則不修或更新，此點和台電相似。

5.3.變壓器及電抗器維護重點：

變壓器及電抗器之運轉使用年限與 OLTC、套管、線圈鬆脫、冷卻系統、油品質以及油中含濕氣量多寡有很大關連性。依變壓器、電抗器維護數據及使用情況決定是否大修，但一般而言變壓器及電抗器使用壽命大都以 30 年爲使用年限如發現維護紀錄不良，但需再繼續使用就得進行細部檢查，爾後每 20 年做一次同樣檢查，檢查項目如下：

5.3.1.絕緣油更新或改善品質。

5.3.2.乾燥降低絕緣紙內之水氣。

5.3.3.締緊線圈鬆脫部位。

5.3.4.更換可能故障之套管。

5.3.5.有載分接頭切換器包含滲漏及切換器內部組件檢修。

5.3.6.更新或檢修冷卻及控制系統。

另外 TransGrid 公司亦對某些特定變壓器做下列維護工作以延長使用年限：

★ 使用 20 年後變壓器爲防止油袋內絕緣油氧化及受潮，油袋內絕緣油須做檢查(因油袋內絕緣油與主體絕緣油僅靠一油閥導通對流有限)。

★ OLTC 操作次數每年 15000 次以上者換油(澳洲 OLTC 極少裝置濾油機，故 OLTC 常發生事故)。

★對 OLTC、套管、絕緣油及經常重載變壓器裝設外部診斷設備(台電在本項之管理優於澳洲，特別是 OLTC 及套管事故低的很多)。

★調配負載輕地區變壓器至負載高地區使用，延長變壓器使用壽命。

5.4.斷路器維護重點：

TransGrid 公司過去使用大量少油量及氣衝斷路器，因備品來源及故障率高目前已逐步汰換，1975~1987 年間安裝 SF6 斷路器之漏氣及生鏽問題已經開始出現，該公司也已進行維修等工作。線上型斷路器診斷系統也在研發中，但使用案例僅在局部放電及 SF6 氣體密度監視。

5.5.其他設備維護週期及原則如下：

5.5.1 保護及指示用變比器

TransGrid 公司的變比器維護政策依據常規檢查及測試檢出任何須注意部分。線上監視系統有時也被應用，比壓器輸出發生電壓不平衡警報，顯示故障可

能已發生，此比壓器則須安排檢修或更換，案例發生後該所其他同型設備則被納入監視範圍。(CVT 各相電壓差警報台電尚未採用，此點可參考)

5.5.2 同步電容：(台電約在 15 年前拆除調相機)本項不討論。

5.5.3 靜態乏補償器：利用高壓閘流體控制電容器使用數量目前本公司未採用本項不討論。

5.5.4 氣體絕緣開關場(GIS)：

TransGrid 公司安裝於 1979 年之 GIS，因早期技術已較落伍，且備品取得無法保證。但在 1995~1996 年間曾拆檢設備，發現情況還很好。但以長遠觀點來看仍須準備備品因應點檢需求爲要務。(此項與台電相似，如 S/S 早期製造 GIS 消弧室已停產，但爲防萬一，已購買數具當備品存臥龍 D/S 備用)。

5.5.5 並聯電容器：

TransGrid 有 77 套電容器設備，應用不同電壓等級從 66KV 至 330KV。所有電容器組自 1980 年以來凡含有 PCB(多氯聯苯)者一律更換，所以目前有 90% 的電容器組是 1980 年以後才安裝的(台電供電系統已全面替換完成現場已無 PCB 電容器)。

5.5.6 電池及充電機：

電池：電池之使用與本公司大同小異，不再敘述。但電池維護上則依靠常規點檢及放電容量試驗檢查特性，一般以容量低於 70%，或使用達 20 年則進行更換。目前供電系統電池組是否都按規定做放電試驗，須再加強宣導。

充電機：充電機之汰換則以備品無法取得時再更新不另訂更換週期。

5.5.7 避雷器：

避雷器維護通常以四年爲週期，老舊避雷器需要更頻繁檢查及衝擊波測試才能了解特性，但必須考慮其經濟性及有效性。使用 35 年避雷器則以更新爲原則，老式使用間隙式避雷器目前已逐步更新中，此項與台電相似。

5.5.8 套管：

TransGrid 公司套管共有 1685 支，大都安裝於變壓器及電抗器上使用，大都爲導體貫穿式，所有高壓套管大都是電容式，構造則爲紙浸油、樹脂纏繞紙材、紙充填飽和樹脂等。不管硬式或油浸式套管都會受電氣性之熱及機械應力破損，大體上而言，使用壽命以 30 年計。但套管因故障造成變壓器火災遠大於套管本身故障造成之損失，故套管之檢查亦是相當重要。通常套管之量測與變壓器維護一齊進行，套管大都經由中間抽頭試驗端子測量 DDF(介質消散因數 $\tan\delta$)，如果無抽頭試驗端子則量測將造成困難，此種情形只有啓開變壓器蓋板才能量測。

5.5.9 其他變電所設施：

隔離開關、接地開關、電纜、照明、動力迴路、消防系統、保安系統發現問題點即檢查維修，必要時以更新爲原則不另訂週期。

5.5.10 變電所建物及財產維護：

房舍、柵欄、道路、土木結構、排水系統、外觀環境區域及其他公用設施經

檢查維修有必要時以更換新品或打掉重做。(屬於一般思考模式不另訂週期)

6、輸電線路及電纜維護、工安環保、品質政策：

此項目不屬本次實習範圍，但爲使線路及其他部門維護同仁了解國外做法，已將收集資料交由本處相關部門參考，本報告則另附件供參考。

7、保護系統

7.1 依電驛種類訂定定期維護週期如下表

保護電驛系統	種類	維護週期
測距	傳統型或電驛無自我測試功能者 其他形式者	6 年細部維護 3 年一般性檢查 6 年細部維護 每年做自動復閉測試(電驛接點驅動跳脫)
變壓器及電抗器	單系統 雙系統	4 年細部維護 4 年細部維護
匯流排	全部	6 年細部維護 3 年一般性檢查
其他保護系統(電容器等)	全部	同上項

7.2 非定期維護

電驛用保護系統經由定期維護發現損壞或送電中不動作，此問題發生後電驛是否更新或檢修則依實際情況判定。

7.3 電驛系統更新原則：

電驛再什麼情況需更新，TransGrid 公司訂定下列原則供判斷：

7.3.1 電驛使用年限，一般以 20 年爲基準，考慮汰換。

7.3.2 電驛故障率高低－包含電驛故障紀錄及對系統造成之影響。

7.3.3 電驛使用位置及系統需求－包含電驛反應速度及電驛性能適用需求。

7.3.4 電驛檢修能力及檢修費用。

7.3.5 電驛正常維護及故障維護費用。

十一、出國實習感想

1.民營輸電公司員工亦兼具商業手腕：

澳洲輸電公司無論公營或民營已相當具備商業色彩，員工須走出去尋找業務，因此技術人員除須具備高超技術及獨立作戰能力外亦須兼具商業手腕。

2.員工須具備高超技術能力：

台電民營化後應與澳洲相類似，因此供電同仁對如何提升技術能力，如何提升自身產能，如何培養出獨立作戰能力，則是從現在起須努力方向。

3.民營化輸電公司以營利爲最高指標：

民營化輸電公司其資產管理政策，以營利爲最高指標。因此降低維護成本，減少停電損失，降低事故率，爲未來民營化供電系統之重要工作。

4.工作講效率，避免誤操作：

工作能力不彰，連續誤操作等問題最後結果只有走路一條，爲保住工作須更加充實學識與技術領域。

5.現場設備，業務管理電腦化：

因輸電公司爲節省人力，採用許多高科技設備，此類設備大都採電腦化結構，在參訪三家輸電公司，除現場技術廣泛使用電腦外，辦公室自動化亦相當發達。

有關此點同仁對電腦應用須多加用心，以因應自動化管理需求。

6.現場開關場管理：

開關場管理方面，本公司對設備外觀及點檢設備之嚴謹度都不比澳洲差，證明同仁們的能力受肯定，未來民營化轉型應可面對挑戰。

7. 變電所工安管理方面，與本公司比較差異點敘述：

A.人員入所無論階級或公司內、外人員，一律朗讀該所目前不安全處所及不良環境應注意安全事項並簽名後始可進入。

B.安全護具(安全帽、繩、工具等)需備妥檢查及清點後始可入所工作。

C.有環保問題材料禁用(藍色矽膠石不採用，改採粉紅色矽膠石，當水分飽和時，則還原爲透明無色膠體) 。

8.變壓器之短路試驗經參觀 Wilson 變壓器製造廠交換意見後，該公司亦未做短路試驗，但如發現變壓器設計裕度太低，則調整軟體設計因素值，此方法與目前變技課決策相似。

十二、建議事項

1.加強 OA 應用：

以目前台電 OA 之硬體設備規模並不比澳洲差，但在軟體方面應用及整合則略遜一疇，以 Power link 爲例，將各部門之間業務相互需求資料建立清單，須隨時更新並掛在網上，其他部門有需求時則自行截取，此項做法供電系統亦已具備但利用者不普遍，應加強宣導使用。

2.維護週期與制度檢討：

澳洲電力設備維護週期普遍比台電長，雖然文化不同，但在供電安全方面確是一樣的。供電處在 90 年以編定新版設備維護週期與項目，已實施一年多，現場使用效果如何應做檢討修正，否則過度維護是屬於浪費，維護不足則危及設備安全。

3.變壓器矽膠石改用非藍色系列產品：

目前藍色矽膠石之變色劑是採用氯化鈷爲原料，因氯化鈷已被列爲致癌物質，澳洲已全面更換成非致癌性粉紅色產品(乾燥時顏色粉紅，吸濕變成透明膠體)。爲了同仁健康建議總處研究更換(另附附件)。

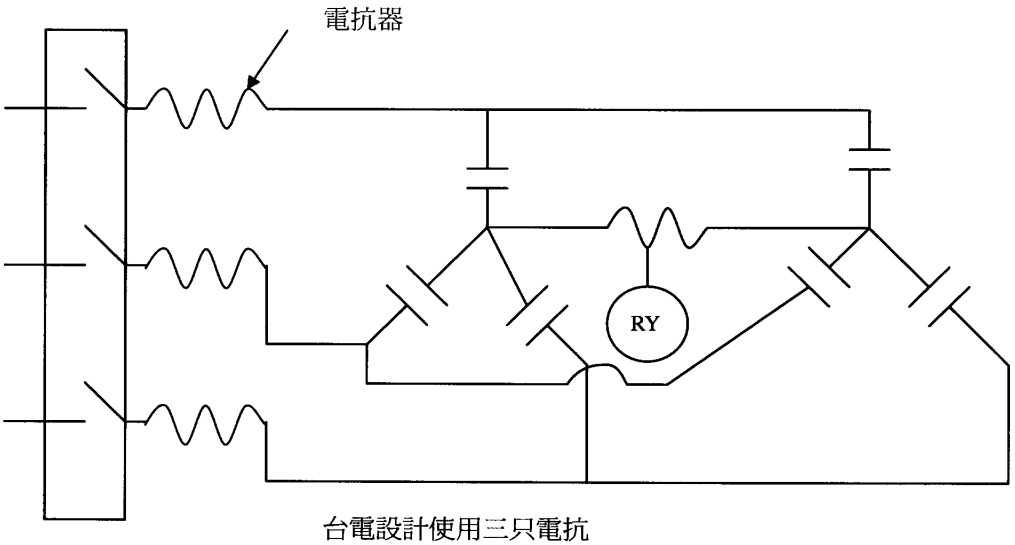
4.ADCS MAP BOARD 有汰換機會時建議改採投射式系統：

目前系統 ADCS MAP BOARD 採用傳統馬賽克組成，運轉期間只提供指示燈訊息告知有問題變電所，無法兼具其他功能，而投射式除了具備傳統式功能外，亦可利用分割畫面查看變電所由數位攝影機傳回圖像了解設備運轉情形及顯示電力量變化曲線圖、條狀圖等功能，可多重應用，建議如有更新主機機會考慮改用投射式 MAP BOARD。

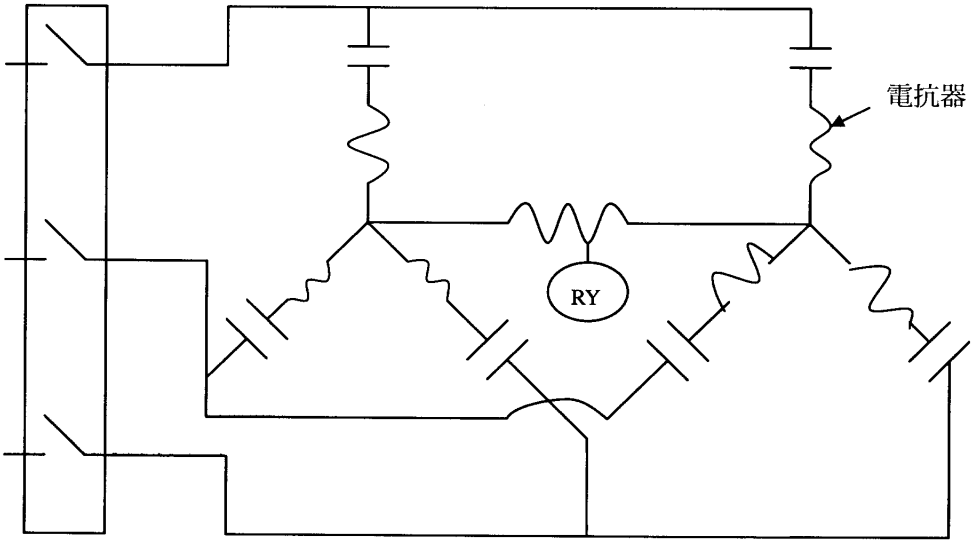
5.解決電容器組經常故障之問題：

台電 161KV 系統過去安裝多組電容器組，加壓後毛病不斷，除了電容器品質有問題外設計上也有檢討空間，依 TransGrid 公司之經驗安裝在 330KV 系統電容器組極少有故障案例。經深入了解其結構是有不同(另參考下圖)，台電也可以用

澳洲模式做爲設計參考。



台電設計使用三只電抗



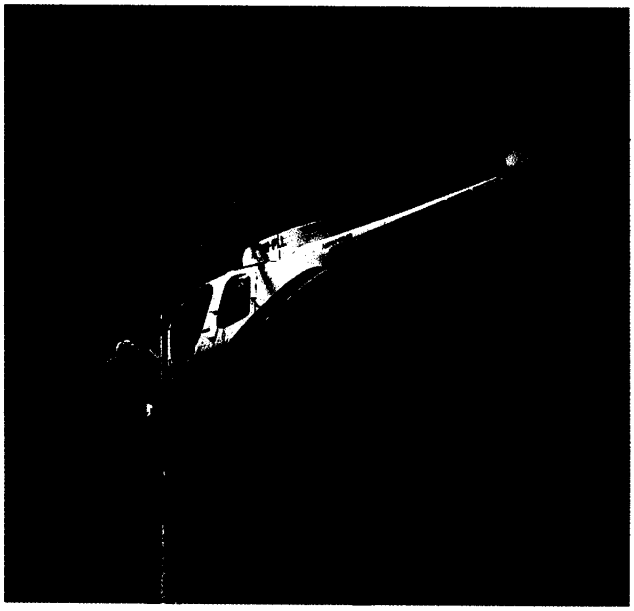
澳洲設計使用 6 只電抗

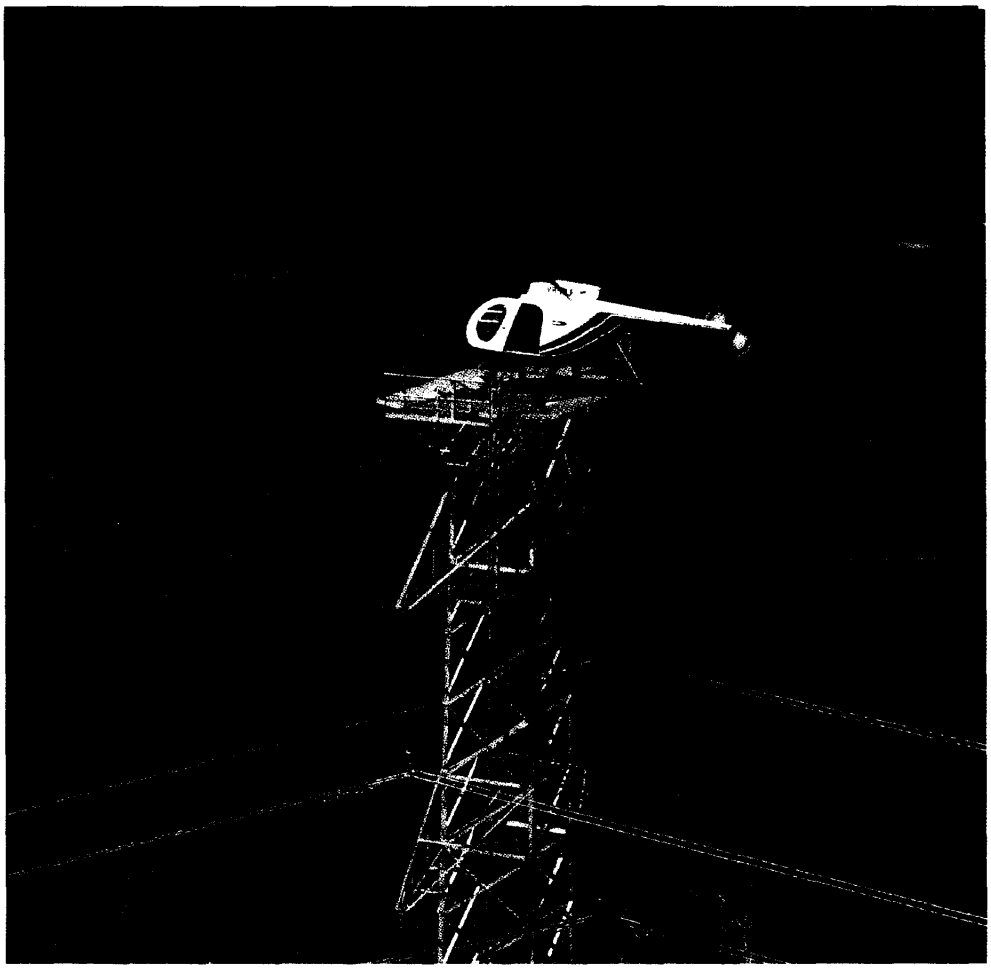
6.30 年主變繼續運轉是否參照澳洲做延壽檢查，建議列入變壓器研究小組專題討論項目

供電系統第一代超高壓自耦變壓器再三年將屆 30 年，依 90 年度變壓器研究小組決議事項，是已提到由各區自行組成評估小組檢討零配件老化更新問題，但這些項目，大都屬於輔機配件，各區後續執行結果如何及變壓器內部絕緣系統應檢查項目是否也參考本報告第十項維護業務描述第 5.3 項及 2.3 項所述之方法再做評估，此項看法建議列入變壓器研究小組專題討論項目。

7.輸電鐵塔建立直昇機停留點

澳洲輸電公司之輸電線巡視及維護大量採用直昇機，特別是高山、湖泊輸電鐵塔頂端建立直昇機平台供浮動停留。對人員及工具搬運相當方便，也節省搶修時間。此項做法提供輸電維護部門參考(參考下圖)。





矽膠石附件

Improving Silica Gel Reactivation

Silica gel desiccant reactivation is a common operating procedure regularly used and performed to remove moisture from saturated material.

Silica gel is used throughout industry to adsorb moisture and maintain low relative humidity thereby preventing product contamination and degradation. Silica gel is capable of adsorbing up to thirty percent of its own weight of water vapour.

The majority of Transformer Breathers used by the power generation industry contain indicating silica gel. Silica gel is available in two primary types indicating and non-indicating. The indicating property is achieved by impregnation with cobalt chloride salt which is sensitive to water vapour.

See caution note as cobalt chloride impregnated silica gel is now carcinogenic.

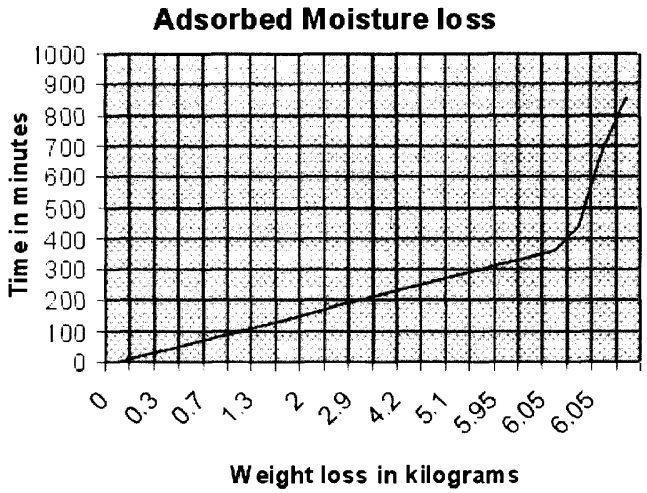
Ineffective reactivation control can result in Transformer Breathers being maintained by up to three times more than is necessary.

Shorter maintenance periods have an impact on both time and cost.

The use of valved Transformer Breathers has eliminated the need to maintain the oil seal fluid level and combining this with improved reactivation contributes to further savings by extending the average maintenance period.

This article suggests a number of simple improvements to improve the practice and procedures for reactivation of silica gel.

The Brownell 1005 reactivator being filled with cobalt chloride impregnated silica gel.



Graph indicating the rate of moisture loss during reactivation from the Brownell 1005 desiccant reactivator.

Indicating Silica Gel

Indicating silica gel is used throughout the power generation and transmission industry for Transformer Breathers to protect the heat transfer cooling oil from moisture (condensed water) contamination. One of the principal reasons for the use of indicating silica gel is its ability to release adsorbed moisture when heated to a temperature of over 100°C. This means it can recovered and used again. Indicating silica gel can theoretically be reactivated

a number of times. This will depend on several key factors including the environmental conditions during use the reactivation temperature and reactivation procedure.

The Brownell 1005 reactivator being filled with Envirogel.

Although this may seem a simple procedure inadequate control and poor process techniques can have a major impact on maintenance schedules by reducing the average time between reactivation and replacement of exhausted indicating silica gel. Indicating silica gel is a silica-based material capable of adsorbing 25% of its own weight in moisture. The most widely used indicating silica gel was impregnated with cobalt chloride that gives the silica gel its activity saturation indicator changing from a blue colour to pink when a 10-12% moisture loading (by weight) of the desiccant is exceeded.

Warning

Cobalt chloride impregnated silica gel has now been classified as carcinogenic.

Beaded indicating silica gel is the best material to use in transformer breathers as it provides high resistance to attrition (dusting breakdown) during handling and regular bed packing

providing uniform flow rate characteristics. The saturation indicator changes from a blue colour to pink when the silica gel requires reactivation or replacement. The saturation indicator can be directly related to the equilibrium relative humidity of the fluid (oil). Maintaining the moisture level of oil to a maximum of content of 15 PPM is a typical requirement.

The Brownell alternative to cobalt impregnated silica gel is **ENVIROGEL ENVIROGEL** can be safely reactivated.

Warning

It is an essential safety requirement that the outlet exhaust vent from the reactivation equipment is piped to the outside of the building/room into an adequate ventilated space.

If you require any specific advice for reactivation of desiccants please call our help lines or e-mail for assistance to partridgem@brownell.co.uk

The Problems

One or a combination of the following factors can affect effective reactivation;

1. Failure to achieve an equal temperature of more than 100 C throughout the entire Silica gel desiccant.

2.An inadequate supply of hot air to carry away the moisture driven off during reactivation.

3.Considering the reactivation process is complete when the activity indicator of the Silica gel displays an active colour.

4.Overheating during reactivation which can cause damage to the desiccant

5.structurereducing the moisture adsorption capacity.

6.Use of the wrong type of equipment for reactivation.

7.Attempting to reactivate silica gel, which has been contaminated with oil.

8.Not storing reactivated silica gel in a sealed airtight container.

Industrial Examples

There are a number of examples of poor reactivation processing currently used in industry. Many poor reactivation procedures derive from a less than clear understanding of simple procedures and controls required which will considerably improve the reactivation process. Many users consider placing silica gel in a warm oven as an adequate method to remove headsorbed water.

The use of gas ovens should be avoided and microwave cookers are likely to damage the structure of the silica gel.

The Effects

Silica gel which has been subjected to temperatures in excess of 150°C is likely to be discoloured to a brown or blackened state. If the silica gel has been subjected to overheating the adsorption capacity will have been adversely effected. If silica gel that has been contaminated with oil is reactivated the adsorption capacity will be effected and the oil contamination could be readily transferred to silica gel contained in the reactivation unit. Silica gel, which has a brown colour and emits odour during storage or reactivation, is often

an indication of contamination. The reactivation of contaminated desiccant causes the oil to solidify within the structure of the desiccant resulting in a 50% reduction in adsorption capacity.Health and safety consideration must always be given to the reactivation of silica gel. It is an essential safety requirement that the outlet port of the reactivation equipment is vented to an atmosphere which is external of the workshop or facility where the process is being carried out.The use of an adsorption filter may also be necessary if there is a risk that unidentifiable contaminates may be expelled during reactivation.

Silica Gel Activity Saturation Indicator.

One of the most important factors from the above to understand is the meaning and purpose Of the activity indicator. When new or replacement desiccant is supplied by the manufacturer the desiccant will have a maximum moisture loading of 2% by weight.

The desiccant will therefore adsorb 10% moisture loading which will cause the activity indicator to change from a blue to pink colour. At this time the desiccant must be recharged or replaced. The activity indicator changes colour on a narrow band of approximately 2% moisture content and this is the primary cause of poor desiccant reactivation.

When the desiccant is heated the activity indicator will change from its saturated colour to its active colour early in the reactivation process as a consequence of the narrow change band.

If the desiccant is considered to be reactivated at this time the residual moisture loading could be as high as 10%. The desiccant has therefore not been reactivated to remove the adsorbed moisture to the 2% level as supplied by the manufacturer.

When the desiccant that has been poorly reactivated is used the activity indicator will change rapidly from the active colour to saturated indication depending on the duty cycle and the

weather.

The desiccant will require reactivation and so the cycle begins again at much shorter Intervals than the original desiccant charge.Any of the above factors for poor desiccant reactivation will have a similar result of the activity indicator changing rapidly following reactivation. Improving the reactivation process is simple and often only requires a modification to existing procedures.

The Solution

When reactivating desiccant it is vital that the activity indicator is not used to control the process as previously discussed.

1. As a general rule saturated desiccant will require a minimum of 4-6 hours at a temperature of between 105-130°C throughout the entire desiccant bed for the reactivation process to be effective and reduce the adsorbed moisture to less than 2% by weight.

Caution

Some desiccants are seriously damaged and can release toxic chemicals if overheated.

2. Reactivation should be carried out in a ventilated electric oven. A sealed oven will limit the moisture liberated and prevent efficient reactivation. Gas ovens and microwave cookers are also not suitable for reactivation.
3. Devices that pass warm air through the desiccant bed changing the activity indicator to blue should be avoided.
4. Ideally after reactivation the desiccant must be placed in a sealed container and allowed to cool. The reactivated desiccant should not be stored in a warm oven at

60°C as this will cause partial saturation of the desiccant although the activity indicator may remain stable.

5. There are a number of proprietary reactivation equipment's available on the market. Typical equipment should be able to reactivate 25 kilograms of saturated silica gel using a standard 13amp domestic supply.
6. To validate reactivation efficiency a fundamental weight loss test conducted before and after processing will provide the amount of moisture loss data.
7. A supply of pre-heated air is an integral requirement for an efficient reactivation process. For saturated desiccant a minimum air flow of between 5-10 cubic feet per minute.

Conclusion

The process of reactivation requires the application and achievement of a number of simple controls for optimum efficiency. By following and adopting the above reactivation practice and procedures we are confident you will record improvements for the maintenance time and performance of the silica gel.

輸電線路維護類附件

Bushings

TransGrid has a bushing population of approximately 1685 bushings. They are predominantly installed in transformers and reactors and are the means by which a HV conductor passes through earthed metal work. All HV bushings are of a condenser construction and generally take one of the following forms: Oil impregnated paper; Resin bonded paper (SRBP); Resin impregnated paper.

As is the case with any solid or liquid insulation, aging and degradation of insulating properties will occur as a result of prolonged electrical, thermal and mechanical stresses and it is these factors that will generally determine the life expectancy of bushings. Generally a service life of 30 years could be expected from bushings provided other factors do not come into play. SRBP bushings by the nature of their manufacture have a much higher level of failure than the other types as a result of delamination of the layers and void formation.

Bushing failures often have far reaching effects that extend beyond the loss of bushing itself as often a failure may lead to the loss of a transformer through fire.

Maintenance on bushings is generally integrated into the transformer maintenance and involves the measurement of DDF via a test point located on the flange. Where no such test point exists assessment of the bushings condition becomes difficult unless it is removed from the transformer.

Control Systems

By 2002-3, the Yass 330kV substation will need to undergo a major refurbishment of its control and alarm schemes including the replacement of most of its switchyard cabling. Depending on the technology adopted, this replacement work may also include all the protection and metering schemes. However, more recent plans for Yass now indicate that the complete substation may need to be replaced by 2004-2005 and therefore any proposed refurbishing work will be cancelled.

The techniques and refurbishing methods proposed for Yass will now be considered for other 330kV substations such as Sydney South by 2004 and Sydney West, Sydney North, Canberra and Dapto in future years.

Other Substation Plant

Other equipment such as disconnectors, earth switches, cables, light and power circuits, fire fighting equipment, security equipment, etc. are all monitored and refurbished or replaced as required.

Substation Property and Buildings

All buildings, fencing, roads, civil structures, drainage systems, landscaping, environmental buffer zones and other services are monitored and refurbished or replaced as required. Redundant buildings in need of extensive maintenance will be progressively demolished.

2. Transmission Lines

Routine Maintenance

A routine maintenance strategy is in place to ensure that all transmission line structures are regularly inspected. The inspections aim to detect likely component aging or defects such that remedial work can be undertaken to ensure no loss of supply will occur. The location of the assets, past performance and the material or form of construction determines the inspection intervals.

Inspection cycles have been reviewed and categorised into maintenance regimes based on past performance, current condition and line importance. All transmission lines are visually inspected at least once per year.

A summary of maintenance requirements is shown in the table below:

Construction	Risk Category	Inspection Requirements
Steel Tower, Steel Pole & Concrete Pole	High	Annual Ground Patrol Annual Aerial Patrol 10 yearly Detailed Aerial Patrol
	Medium	Ground & Aerial Patrols in alternate years 10 Yearly Detailed Aerial Patrol
	Low	3 yearly Ground Patrol In other years an aerial patrol 10 yearly detailed Aerial Patrol
Wood Pole	High (Structural Concerns)	Staggered Program including: • Groundline inspection & treatment 3 yearly • Climbing inspection 3 yearly • 3 yearly aerial patrol
	High (Vegetation Concerns)	Groundline inspection & treatment 6 yearly Climbing inspection 6 yearly Ground inspection in years no climbing or groundline inspection Annual aerial patrol
	Low	Groundline inspection & treatment 6 yearly Climbing inspection 6 yearly Alternating ground & aerial patrols in years no climbing or underground inspection

Non-Routine Maintenance

A major facet of the non-routine maintenance is easement vegetation control where growth rates of plants and trees are largely a function of climatic conditions and as such cannot be predicted very far in advance. Where necessary suitable access to the lines is provided and maintained.

In some instances type defects, such as insulator degradation, can be identified and extra resources channelled to determine the extent of the problem or to apply corrective action.

Major Operating Projects

No major issues exist with transmission lines that require rectification in the short term. A number of emerging medium to long term issues have been identified. Detailed long-term strategies are being developed to manage these emerging issues.

A number of current minor issues and their strategies are shown below.

Insulators

Where problems are identified with insulators, or where insulators are in excess of 25 years old, batches of that type of insulator are taken out of service for testing. Should testing confirm a type problem then a strategy is developed to deal with it. Conversely, if the problem is an isolated one, then a watching brief will be maintained on that type of equipment.

Overhead Earthwire Replacement

Earthwire is replaced due to fault rating limitations or corrosion problems. Fault rating limitations have occurred on sections close to substations where fault levels have risen over time. There has been a program over several years to uprate these sections to meet their expected duty cycle. Other lines will be reviewed when upgrading of lines/substations is proposed.

Galvanised steel earthwire close to marine or industrial environments suffers from accelerated corrosion. Amongst the most susceptible are the lines between Sydney and Dapto, which are showing significant, pitting of the steel strands. Replacement is programmed for completion by the end of 2001.

Vibration Dampers

Some 132 kV lines were originally installed without vibration dampers. Fatigue of strands has occurred due to the lack of damping capability on the spans, which in some cases has lead to the conductor failure. A strategy has been developed whereby all remaining undamped lines are fitted with dampers in accordance with current design practice.

Wood Poles

Wood poles are generally replaced following detection of significant defects during routine maintenance. In the past less than 1% of the pole population has been replaced each year. However, the defect rate is anticipated to increase to 4% over the next ten years as the wood poles reach their average life expectancy. A strategy has been established to replace wood poles with steel or concrete poles which will reduce the anticipated 'peak' in replacement rates and provide infrastructure with low maintenance and long life. Significant rot has been identified in poles on several lines requiring considerably higher replacement rates and these lines are programmed to be the first in the replacement strategy.

Composite Wood Pole Structures

A number of wood pole transmission lines were uprated in the past by the use of wood pole extension joined to the existing poles by steel jointing sleeves. These composite pole structures raised the conductors allowing increased thermal rating of the circuit.

A number of issues have arisen with respect to these structures including pole rot occurring behind the jointing cylinder. A strategy has been implemented to replace these structures at high-risk locations. A progressive program is to be undertaken to rebuild these lines to steel or concrete construction as their condition warrants.

Grillage Foundations

Early practice in steel tower construction, particularly where access was difficult, was to place a steel quadraped on the bottom of each tower leg and back fill with earth. Over time the reaction of the acids in the soil have slowly corroded the zinc coating and now the steel of many towers. Early strategies here have focussed on encasing the leg with concrete to prevent further corrosion. A more cost effective and quicker method using sacrificial anodes has been developed to protect the remaining steel of the tower foundations. All applicable steel towers are expected to be treated by 2003.

Concrete Poles

Corrosion of the steel reinforcing in concrete poles has been noticed in areas with high water tables of high saline content.

A small number of existing poles will need to be replaced within the next 10 years.

3. Underground Cables

The 330kV Sydney South – Beaconsfield West Cable 41 circuit was commissioned in 1979. The cable and cable accessories were manufactured and installed by Sumitomo/Japan under Contract 2609 (Mitsui). This is currently TransGrid's only high voltage cable (outside substation boundaries), until the commissioning of the next 330kV cable 42 from Sydney South to the new substation at Haymarket in late 2003.

Routine Maintenance

Routine maintenance is carried out in accordance with the TransGrid Underground Cable Maintenance Policy. The principles involved include:

- Cable route patrol and maintenance
- Reading and recording of cable fluid pressure gauges
- Checking of accuracy of cable pressure alarms
- Sampling and testing of cable fluid
- Inspection of cable sealing ends
- Testing of cable outer sheath and link box maintenance
- Monitoring of joint movement

The frequencies of these activities are set out in the Policy.

Non-Routine Maintenance

Due to the nature and location of the underground cable in public roads and footways, various defect repairs and modifications not covered by Routine Maintenance are carried out. These need to be assessed on a case-by-case basis.

Major Operating Projects

Temperature Monitoring and Real-Time Rating

The thermal rating of Cable 41 has recently become important for a number of reasons:

- Increased loading, particularly during summer days, has meant that currently applied cyclic ratings are being reached on a number of occasions. In addition, contingency considerations mean that the ability to obtain outages on other critical items of plant in the Sydney area is becoming increasingly limited;
- Investigations by TransGrid have identified the capacity for safely increasing the rating of the cable under a number of operating conditions; and
- Recent information on the thermal impact of deeply buried sections of cable has identified the potential for "hot spots" in the cable that could accelerate cable paper deterioration at these locations and affect long-term cable reliability.

Preliminary assessments have indicated that the maximum operational benefit and risk control will be obtained by the implementation of a real-time cable rating system. This system is designed to measure cable sheath and soil temperatures at a number of critical locations and to compute normal and emergency cable ratings available in real time. This work is expected to be completed by 2003.

Oil System Modifications

A number of oil system modifications are required. In summary these are to:

- Increase the surplus oil volume in the cable oil system to improve cable security;
- Replace or refurbish oil pressure gauges;
- Evaluate differential pressure gauges, and if successful implement a differential (phase to phase comparison) pressure alarm system which is expected to be considerably more sensitive than the current system;
- Overhaul pressure alarm switches.

This work will be completed by 2002.

Civil Works

The civil structures associated with the Cable 41 circuit are beginning to deteriorate. Remedial work is necessary to prevent more extensive damage resulting from the problems being neglected.

These repairs are scheduled for completion by 2002.

7. Environmental Strategies

TransGrid's Environmental Plan describes the elements of its Environmental Management System and the Business Units responsible for those elements, while TransGrid's Environmental Manual describes the procedures and practices involved.

Environmental Aspects of Substations

Substations may impact on the environment through their visual appearance, noise emission or escape of oil.

Native trees and shrubs are planted around substations, to promote native species and reduce the visual impact of substations.

Noise emissions from transformers are reduced by construction of suitable enclosures or walls where necessary. A program for replacing air-blast circuit breakers with quieter SF6 circuit breakers is in place.

TransGrid substations are designed and sited to minimise their impact on the environment. All sites have environmental response systems designed to ensure that, in the event of equipment failure, the surrounding environment is unaffected. Major oil-filled plant, such as transformers, is located within bunds. Secondary, and on some sites tertiary oil containment systems are installed, to prevent the escape of oil from the substation to the surrounding environment.

Environmental Aspects of Transmission Lines

Before construction of a new transmission line, extensive community consultation takes place.

An environmental impact statement is prepared, which assesses all the known possible environmental impacts of the construction and the operation of the line following construction. The statement is publicly exhibited and submissions from interested parties are encouraged. A program for managing construction and maintenance of the line following construction is then implemented, based on the findings of the Environmental Impact Statement and submissions received.

Procedures for maintenance of transmission line easements have been developed with the aim of minimising environmental impacts. Low growing native shrubs and trees are encouraged on easements.

A database is used to assist with easement maintenance. It contains all relevant environmental information about each easement, including the location of rare and threatened flora and fauna species and habitats, protected lands and rivers, archaeological relics, heritage sites and property owner requirements.

Environmental Initiatives

TransGrid is involved in a number of environmental projects.

TransGrid sponsors nine shade-houses throughout NSW, as part of Rotary's "Trees for 2000" program. Local school children raise native seedling in the shade-houses. Landcare groups plant the seedling in places needing vegetation.

TransGrid is also providing sponsorship for Greening Australia's "Corridors of Green" and "Greengird" projects. TransGrid's contribution has helped provide 1,000 trees for planting by school children along the Barton Highway between Yass and Canberra. Property owners, local Landcare and community groups in Yass area are involved in the "Greengrid" project, planting trees and shrubs to enhance the local environment and augment the habitat of the Superb Parrot.

The Illawarra Greenhood Orchid, Pterostylis gibbosa, is a rare and endangered species of plant, found near Lake Illawarra. TransGrid, together with the National Parks and Wildlife Service, the University of Wollongong and the Wollongong Native Orchid Society, is protecting and preserving the Orchid and its habitat.

TransGrid is the sponsor of the Kooragang Wetlands Rehabilitation Project, in the Newcastle area. A new visitors centre shows the importance of Coastal Wetlands to the local environment.

TransGrid has joined the Greenhouse Challenge, a joint initiative developed by industry and the Federal Government, to encourage organisations to reduce emission of greenhouse gasses. TransGrid has identified a number initiatives that will be undertaken as part of the program, including reducing usage of paper products, minimising energy use where possible and promoting tree-planting. A co-operative agreement will detail TransGrid's commitment to implementing the initiative. Each year, TransGrid will report its progress to the Australian Greenhouse Office.

設備管理政策附件

(含有環保問題設備之處理原則)

4.4 Asset Disposal Strategies

4.4.1 Introduction

Assets are of value to TransGrid only in so much as they continue to cost effectively support the delivery of the required service. Once these assets no longer provide the required level of service their worth lies only in the benefits to be gained from their disposal.

Asset disposal is therefore the final stage in the asset life cycle and its proper planning and management is an integral part of TransGrid's Network Management Plan.

TransGrid's Asset Disposal Strategies mainly encompass two broad types of assets. The first involves real property holdings and the second involves general assets such as buildings, structures, plant and equipment.

Although real property assets normally have high values and their disposal often involves more complex planning and financial issues, the general disposal processes followed within TransGrid are very similar to the disposal of all other types assets. Therefore this Section of the Asset Management Plan outlines these general disposal strategies.

4.4.2 Asset Disposal Planning

TransGrid's Asset Disposal Planning involves a detailed assessment of those assets identified in the Planning/Capital Investment Strategies and Asset Management Strategies that are no longer required, or no longer effectively meet their service delivery outputs at the lowest long term cost to TransGrid. This allows TransGrid to cull redundant assets that might otherwise reduce efficient and effective service delivery.

Disposal planning incorporates two separate elements:

- the detailed assessment of assets identified as surplus, and
- the analysis and implementation of the physical Disposal of the assets.

An asset is identified as surplus when one of the following occurs:

- the asset is not required for the delivery of service, either currently or over the longer planning time frame,
- the asset becomes uneconomical to maintain or operate which could be due advances in technology, social expectations, changing demographic patterns or the economies of scale made possible by new service capacity,
- the asset wears out or becomes uneconomical to repair or refurbish.

Once an asset is identified as surplus, its physical disposal will depend on one or more of the following:

- whether or not there are net disposal benefits to TransGrid, either in financial or other terms such as management, supervision and storage,
- whether or not there are secondary (non core) service obligations associated with the asset which dictate its retention, for example heritage, open space or other social environmental considerations,
- whether or not disposal can be carried out without adverse impacts on the physical environment,
- compliance with any Legislative requirements such as for Asbestos and Polychlorinated Biphenyls (PCBs),
- whenever considered likely that some under-utilised or surplus assets may be of significant value to other agencies such as NSW Electrical Distributors, such agencies are advised of the asset's availability.

4.4.3 Asset Disposal Strategy Process

TransGrid's Asset Disposal Strategy Process is a structured and systematic process aimed at ensuring the asset portfolio comprises only of assets that effectively meet their service delivery requirements at the lowest long term cost. The processes involved are therefore directly linked with TransGrid's Service Delivery Strategies, TransGrid's Planning/Capital Investment Strategies and TransGrid's Asset Management Strategies.

The Disposal Strategy has five discrete stages, the main aspects of which as are follows:

Stage 1 - Assess in detail those assets identified by the Planning/Capital Investment and Asset Management Strategies as being Surplus to service delivery requirements.

Stage 2 - Assess the advantages or otherwise to TransGrid, TransGrid's Shareholders or the Community in divesting the Surplus assets.

Stage 3 - Identify any opportunities for increasing asset value.

Stage 4 - Identify related disposal requirements (auction, tender, private treaty or scrap) and processes including probity requirements.

Stage 5 - Prepare and implement appropriate Disposal Plan that satisfies all safety and environmental requirements.

The majority of TransGrid's aged Surplus assets are normally scrapped or sold for material salvage and depending on the materials used in the design and construction of the assets a number of procedures have been established to facilitate this process. Many of these processes are contained within TransGrid's Waste Management standard.

4.4.4 Waste Management

TransGrid's waste management procedures have been established in accordance with both NSW and Australian legislation requirements including the NSW Protection of the Environment (Operations) Act 1997 and the Waste Minimisation and Management Act, 1995. This involves the appropriate disposal methods for various waste and materials, the licensing of TransGrid sites and facilities and direct dealings with the Environmental Protection Authority.

Within TransGrid, specific asset disposal strategies concerning certain types of materials include the following:

Disposal of Polychlorinated Biphenyls (PCB),

The NSW PCB Chemical Control Order 1997 requires that:

i) Owners of PCB contaminated materials must carry out a survey by 1st January 1999 to identify items of equipment and articles containing PCB. TransGrid has basically completed this task.

ii) Concentrated PCB material (i.e. PCB greater than 10%) must be removed from priority areas within 2 years of completing the survey, and from other than priority areas within 5 years of completing the survey. TransGrid completed the removal and destruction of all concentrated PCB materials (1,155 tonnes) by January 1999 at a cost of $5.7M.

iii) Scheduled PCB material (i.e. PCB greater than 50 ppm) must be removed from service, or processed in-situ to reduce the PCB concentration below 50 ppm, within 5 years of identification. For TransGrid, this requires that scheduled PCBs must be either removed from service or processed by 2004 and strategies are in place to replace meet this requirement.

iv) Non-scheduled PCB materials (i.e. PCB less than 50 ppm) are not required to be removed from service within any legislative time-frame, however once removed from service appropriate disposal methods are required. Since 1999 TransGrid has disposed of 211 tonnes of non-scheduled material at a cost of $626,000

Disposal of Chemical Fluid Dow C4

One of the Non-PCB fluids introduced for Power Capacitors in 1980 was the chemical "Dow C4" and within TransGrid 24 capacitor banks contain this fluid (total of 985MVAr). This fluid requires special precautions for safe handling and paper disposal. Hence significant expenditure is being incurred at the moment to dispose of any failed Dow C4 capacitors.

However, from approximately 2010 a number of these Dow C4 filled capacitor banks will be approaching the end of their expected life span. A Disposal Strategy will need to be developed as the replacement program could take up to ten years to complete and require significant resources. This aspect does not impact on the period of this Plan.

Disposal of Batteries

TransGrid has quantities of large station and communication batteries that comprise of Lead Acid or Ni-Cad. These batteries have a normal life span of approximately 20 years and their retirement is determined by the Maintenance Battery Policy and Battery Maintenance Procedures.

Disposal of Ni-Cad and Lead Acid batteries is a requirement of TransGrid's Procurement Specification for Batteries and thus forms part of the contract. The old Ni-Cad cells are returned to Australian manufacturer's works for shipment overseas for recycling while the Lead Acid units are recycled within Australia. The whole operation is carried out in accordance with the relevant dangerous goods and environmental regulations.