行政院所屬各機關因公出國人員報告書

（出國類別：訓練）

參加進步型沸水式模擬器操作訓練出國報告

服務機關：行政院原子能委員會

出 國 人 職　　稱：簡任技正兼科長　科長

姓　　名：陳建源　　牛效中

出國地區：日本

出國期間：92 年 4 月 12 日至 92 年 4 月 27 日

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摘　　要

核能四廠係採用進步型沸水式(ABWR)核能機組，其儀控系統採用數位化、電腦化及自動化軟體控制，信號傳輸採用網路多工技術，並納入人因工程技術考量，因此其主控制室之配置在人機介面（MMI）方面與傳統沸水式第六代核能電廠（BWR）主控制室的佈置完全不同。有鑑於核四廠運轉員模擬器運轉訓練將於 93 年開始，而一號機運轉人員執照考試將於 94 年上半年間舉行，為使本會考官接受更廣泛的 ABWR 模擬器操作訓練，因此經由日本發電技術檢查協會的協助，經過日本經濟產業省的同意，由日本 BWR 訓練公司（BTC）安排為期兩週的 K-6 模擬器操作及評估訓練課程，以充分瞭解 K-6 模擬器操作的特性及 K-6/7 運轉人員訓練及資格檢定之具體作法，以供本會未來管制核四廠運轉人員訓練及考照作業之參考。此外，BTC 訓練公司更安排學員前往參觀東京電力公司所屬柏崎刈羽六號、七號機、福島一廠、二廠及福島縣地區廠外緊急應變中心，瞭解日本核能電廠發生核子事故時其緊急應變中心作業概況。

由日本 K-6/7 運轉模擬器訓練的經驗，可提供我國核四廠運轉人員模擬器訓練規劃一套良好典範，值得我國借鏡。

目　錄

壹、前言

核能四廠係採用進步型沸水式(ABWR)核能機組，其儀控系統採用數位化、電腦化及自動化軟體控制，信號傳輸採用網路多工技術，並納入人因工程技術考量，因此其主控制室之配置在人機介面(MMI)方面與傳統沸水式第六代核能電廠（BWR）主控制室的佈置完全不同。有鑑於核四廠運轉員模擬器運轉訓練將於 93 年開始，而一號機運轉人員執照考試將於 94 年上半年間舉行，為使本會考官接受更廣泛的 ABWR 模擬器操作訓練，因此經由日本發電技術檢查協會的協助，經過日本經濟產業省的同意，由日本 BWR 訓練公司（BTC）安排為期兩週的 K-6 模擬器操作及評估訓練課程，以充分瞭解 K-6 模擬器操作的特性及 K-6/7 運轉人員訓練及資格檢定之具體作法，以供本會未來管制核四廠運轉人員訓練及考照作業之參考。此外，BTC 訓練公司更安排學員前往參觀東京電力公司所屬柏崎刈羽六號、七號機、福島一廠、二廠及福島縣地區廠外緊急應變中心，瞭解日本核能電廠發生核子事故時其緊急應變中心作業概況。

貳、行程概要

4 月 12 日　台北－東京－刈羽村 BTC 訓練中心

4 月 13 日～4 月 25 日　ABWR 模擬器訓練

4 月 26 日　刈羽村－東京

4月27日　東京返回台北

參、訓練紀要

整個模擬器操作訓練課程表如附件一。包括三個主要部份；

一、課堂介紹

包括介紹 ABWR 運轉人員訓練、K-6 模擬器人機介面、簡介 ABWR 電廠系統、反應器達臨界之操作程序、反應器正常啟動（包括加熱/加壓操作、模式開關切換、主汽機啟動、併聯及升載操作）、主飼水由馬達驅動泵切換至汽機帶動泵之操作、由增加爐心流量升載（包括反應爐內置泵之控制）、降載操作、K-6/7 主要系統的控制連鎖關聯性（interlock）、電廠暫態變化（包括反應爐急停、汽機跳脫、主蒸汽隔離閥關閉）、EOP 導則介紹及模擬器操作訓練評估作業等，計八個主題，每個主題四小時，合計三十二小時。

二、模擬器操作

模擬器操作訓練主要係依據 ABWR 模擬器訓練導則如附件二，其課程內容包括下列各項。

(一)模擬器盤面熟悉

包括熟悉前盤（包括重要緊報示窗、系統警報、大銀幕顯示及整廠顯示）、主要控制盤包括7個CRT、50個平面顯示畫面盤(Flat

Display，簡稱 FD)的功能及操作畫面，主控制室如圖一所示。尤其是瞭解 RFC（FD11）、RC&IS（FD12）、APR（FD13）、FDWC（FD14）及 EHC（FD21）之功能及畫面操作，主控制室盤面佈置圖如二所示。

(二)啟動機組反應器達臨界操作

依據 ABWR 模擬器訓練導則 STP-1 操作。雖然可以利用 APR 自動模式選棒及抽棒，但其訓練仍以手動模式抽棒，檢定亦以手動抽棒達臨界為評估依據。冷機起動在棒序第 4 組，第 3 群棒位置 38 時達臨界。

其 SRNM 之設定點與核四廠之比較如下：

廠名 / 功能	K6/7	核四廠
阻棒	週期＜20 秒	＜26 秒
急停	＜10 秒	＜11 秒

判定反應器是否達臨界之方式為，若運轉員在連續 120 秒時間內未採取任何抽棒動作，而週期維持在一穩定狀態，此即為臨界之狀態，啟動操作評估表如附件三。

(三)反應器加熱/加壓至額定

依據 STP-2 及 3 導則操作。必須注意符合加溫率小於 55℃/小時之規定，以及利用爐水淨化系統洩水閥控制水位維持在正常

水位設定點（1180mm）。由常溫加熱/加壓至反應爐飽和額定壓力6.52MPa之重要步驟包括：

1. 0.38MPa：將 RCIC 置於備用狀態。
2. 0.69MPa：汽機格蘭蒸發器（Turbine gland Evaporator）開始暖機。
3. 0.69MPa：HPCS 置於備用狀態。
4. 0.69MPa：主汽機復歸（開始控制閥加熱作業）。
5. 1.03MPa：汽機旁通閥打開，進入反應器壓力控制模式。
6. 1.9MPa：SJAE 啟用。
7. 3.9MPa：啟動馬達帶動反應器飼水泵，並維持一台冷凝水泵、兩串冷凝水除礦器及一串冷凝水過濾器使用中。
8. 6.52MPa：達到反應器額定壓力條件。

(四)反應器提升至 5%

依據 STP-3 導則持續抽棒，當功率達 2%時開始執行汽機帶動反應器飼水泵之汽機暖機作業，當反應器功率 5%以上時，將反應器模組開關切換至運轉（Run Mode）模式。

(五)啟動汽機及併聯作業

1.依據 STP-4 及 STP-5 導則執行。當反應器功率達 10%時啟動汽機，在啟動汽機之前應先確認下列參數：

(1)冷凝器真空度＜6.7Kpa。

(2)汽機輔助系統和參數（例如汽機轉速、汽機控制油、潤滑油、汽機控制系統油泵等）。

(3)EHC 控制盤之最大蒸汽流量限值＜117%。

(4)控制閥內部金屬溫度＞250℃，控制閥內面及外表之金屬溫差小於 45℃。

(5)發電機冷卻水系統、氫氣系統可用性。

(6)負載限值設定在 8.4%。

(7)將汽機振動監視系統顯示於 CRT。

2.由汽機高壓側第一級內部溫度來決定汽機加速率；

(1)溫度＜93℃　加速率為 50RPM/分鐘。

(2)93℃至 177℃　加速率為 75RPM/分鐘。

(3)＞177℃　加速率為 150RPM/分鐘。

3.當汽機轉速至 100RPM，查看各汽機閥是否全關。

4.當汽機轉速至 1000RPM 時停止頂起泵(LOP)。

5.當汽機轉至 1000RPM 時確認軸承油壓已建立，並停止慢車齒輪油泵（TGOP）及汽機馬達取油泵（MSOP）。

6.建立蒸汽分離再熱器（MSH）第一級抽汽通路。

7.執行汽機超速保護測試。

8.繼續抽棒直到反應爐功率達 15%功率，反應器水位維持正常水位及反應爐壓力在 6.58MPa，並確認負載值設定在 8.4%，汽機旁通閥打開、EHC 控制模式選擇「序列」模式。

9.確認下列狀符合

(1)激磁斷路器 52E 自動燈亮。

(2)自動電壓調整器 AVR 可用。

(3)主變壓器和匯流排隔離相裝置（IPB）風扇在自動位置。

10.將 52E 斷路器轉至投入（CLOSE）位置，並確認 IPB 和主變壓器風扇啟動。

11.注意將發電機電壓緩慢升至 27KV，且維持各相間電壓平衡。

12.將併聯開關 R26 投入，當系統與汽機之頻率調至約超前時自動投入併聯。(按 K6/7 廠安裝有自動併聯系統）如要調

整汽機與電力系統同步，可由 EHC 控制及 AVR 來調整控制汽機轉速，以達與電力系統同步。

13.將負載升至 10%負載。

14.將發電機氫氣純度控制改至發電機側(此為 K6/7 廠特殊設計)。

15.如果汽機係冷機啟動必須執行汽機熱透（Heat Soak）作業至少 20 分鐘。

16.將負載限值提升至 109%，並將負載控制器置於 APR 追隨模式。

17.由 CRT 查對發電機封油系統、定子線圈冷卻水系統、定子冷卻水系統是否正常。

(六)主飼水泵由馬達帶動泵切換至汽機帶動泵

1.K6/7 有兩台馬達帶動飼水泵（MD-RFP，每台容量 25%）及兩台汽機帶動飼水泵(TD-RFP，每台容量 25%)。從啟動至 20%功率時，由一台 MD-RFP 提供飼水泵。

2.當功率達 20%時準備啟動第二台冷凝水泵及完成廠內負載切換。

3.增加冷凝水除礦器和冷凝水過濾器串數（由 4 床增至 6 床及 2 串增至 3 串）。

4.啟動第二台低壓冷凝水泵（LPCP）和高壓冷凝水泵（HPCP），並將第三台 LPCP(C)置於備用（即泵由 pull to Lock 位置改為 Auto，並將其出口閥打開）及 HPCP(C)置於備用（即泵由 pull to Lock 位置改為 Auto，並將其出口閥打開）。

5.開始執行 RFPT(A)控制閥熱機，復歸 RFPT(A)後待其高壓及低壓控制閥全開後，跳脫 RFPT(A)連續執行前述步驟兩次，直到高壓關斷閥內部溫度與主蒸汽溫度相等，約需 30 分至 60 分鐘。

6.查對 T/D RFP (A)系統狀態及符合啟動狀態之排列後，啟動 T/D-RFP(A)。

7.啟動第一台 T/D-RFP(A)後觀察下列狀況：

(1)最小流量閥全開。

(2)潤滑油溫設定由 32℃升至 46℃。

(3)慢速迴轉齒輪自動停止。

(4)泵速升至 2000RPM 維持 5 分鐘。

8.確認飼水控制系統之狀態如下：

(1)主控制器在自動模式。

(2)水位在一元控制。

(3)M/D-RFP(A)控制器在自動模式。

(4)T/D-RFP(A)控制器在手動模式。

(5)在FD14盤畫面選擇[T/D＋M/D]及事序模態，並選擇M/T切換。

(6)則當T/D RFP(A)出口閥全開，T/D RFP(A)控制器流量設定點逐漸增加，直到偏差指示為零時，將T/D RFP(A)改為自動模式。

(7)將M/D RFP(A)控制器改為手動模式，並將其設定點值逐漸降為0%。

(8)將M/D RFP(A)跳脫，並置於備用狀態。將其大、小出口閥均打開，並將M/D RFP(A)控制器在偏差為0%時置於自動模式。

(七)利用增加爐心流量升載操作（STP-7）

1.當功率達30%時，水位控制由單元控制改為三元控制，並開始執行第二台T/D RFP(B)暖機作業。

2.利用抽棒提昇功率至50%，在達50%功率前應先啟動兩台LPDP及兩台HPDP泵。低壓洩水泵(LPDP)及高壓洩水泵(HPDP)係K-6/7廠特殊之設計。HPDP及LPDP提供56%的總飼水流量回流至飼水及冷凝水系統；包括由HPDP回流至飼水泵吸水口(36%)、由LPDP回流至高壓冷凝水泵吸

水口(14%)及冷凝器(6%)。

3.啟動第二台 T/D RFP(B)。

4.抽控制棒達到預定之負載組態。

5.確認 RFC、APR、NMS、MRBM、ATLM、EHC、RRS 及程序電腦系統功能均正常。

6.確認 RFC 系統控制模式為「功率自動控制」、「Gang 自動」RC & IS 在「全自動」、APR 的爐心流量控制選在「發電機功率控制」及程序電腦選在「功率控制」。

7.由 CRT 確認 BP39「功率上升」允許燈亮，輸入目標功率 1356MWe 及升載率 270MWe/小時。

8.壓下自動化功率上升按鈕，則爐心流量與功率會逐漸上升直到爐心流量及功率均達 100%。

(八)由 100%功率降載作業（SDP-1）

1.依據 SVP-1：HPCF 系統手動操作測試程序書，執行 HPCF 偵測試驗。

2.依據 SVP-2：EDG 手動操作測試程序書，執行 EDG 偵測試驗。

3.依據 SDP-1：由 100%功率降載至 10%功率。

4.依據 SDP-2：由 10%功率降載並執行機組與系統解聯作業。

5.依據 SDP-3：由 7%功率執行降低功率及降壓至次臨界。

6.依據 SDP-4：當反應器壓力達 0.98MPa 以下，執行反應器停機冷卻系統模式操作。利用調整 RHR 熱交換器出口閥和旁邊閥之流量以控制降溫率＜55℃/小時。

(九)AOP 案例操作

1.演練機組在 100%運轉，發生 T/D-RFP(A)故障，以及 M/D RFP(A)故障造成反應器急停，觀察機組之反應狀況（反應器側及汽機側），並操作反應器急停復歸作業，並找出造成急停之原因。

2.觀察機組在 100%運轉下，T/D-RFP(A)發生故障跳脫之暫態變化。功率會瞬間下降一些，M/D-RFP(A)會待其取水口壓力建立後自動啟動提供飼水。

3.演練 Div III D/G 故障、HPCF(B 串)故障，以及喪失外電之事故。

4.演練喪失所有交流電源事件之處理。

5.演練喪失所有飼水泵事件之處理。

(十)EOP 案例操作

1.演練喪失高壓注水（RC/L：反應器槽控制/水位控制）事故

處理。

2.演練 ATWS（包括 MSIV 關閉和 MSIV 打開兩種狀況）事故處理。

3.觀察喪失高壓注水事件（由講師演練）處理。

4.一次圍阻高壓力控制（PC/P）事件處理。

(十一)ABWR 核能電廠運轉員訓練及檢定

BTC 訓練公司係於 1971 年 4 月由日本 10 家電力公司、東芝和日立公司聯合投資成立，資本額 3 億日圓，目前有 5 座各種 BWR 及 ABWR 之模擬器（BWR-47，84MWe；BWR-5，1100MWe；BWR-4，784MWe；BWR-5，1100MWe 及 ABWR-1356MWe）其中二座在福島訓練中心，三座在柏崎訓練中心。

訓練之制度包括(一)基礎訓練班：針對助理運轉員基礎訓練(第一段 4 週、第二階段 6 週、第三階段 6 週共計 16 週)內容包括課堂課、模擬器操作及考試。(二)再訓練班：針對值班操作員、主控制室運轉員，分成初級(10 天)、中級(8 天)及高級(9 天)，內容包括模擬器操作、課堂課及考試，係每兩年執行一次。(三)高級運轉員班：針對值班工程師級人員，目的在強化運轉技術、溝通、協調、指揮能力，訓練期間 8 天。

基礎訓練班為基層設備操作員、助理值班員及值班反應器運

轉員必經之訓練，課程內容涵蓋；(1)基礎反應器物理和電廠設計。(2)電廠系統和設計功能。(3)運轉操作程序。(4)電廠熟悉。(5)模擬器操作訓練（包括正常起動、升降載、設備故障及緊急操作程序書）。至於整個值班的團隊溝通、協調及合作的訓練，則每一班每年有一次為期一天的訓練。

根據 BTC 訓練中心講師的說明，日本核能電廠運轉員之訓練法規依據為 1987 年公佈之發電用核子反應器設置、運轉相關管制規則第 12 條要求：「核子反應器之運轉人員（responsible operator）（通常指當值長）應報經濟產業省核准。運轉人員應接受適當的訓練，訓練人員應在合格運轉員的監督下執行操作作業」。

目前運轉人員之訓練方案係依據 JEAG-4802（2002 年版）：日本核能電廠運轉人員訓練導則執行，其內容要求與美國 ANSI/ANS3.1 之要求相似。

至於運轉人員於訓練後之檢定考試包括筆試（4 小時）（涵蓋反應器技術、運轉原理、操作程序書、運轉規範等）、模擬器操作（4 小時）（涵蓋 AOP、EOP 程序書使用）。各電力公司均委託 BTC 訓練公司執行訓練及檢定考試，並將檢定考試成績送各電力公司，由各電力公司決定運轉員適任與否。

至於每一值所需之當值長應取得經濟產業省（METI）頒發之

資格，其考試包括筆試、口試及模擬器操作考試三部份。筆試與前項訓練檢定考試相似，但口試則係由四位考官執行口試，其組成包括二位模擬器考官、一位退休之當值長及一位大學核工教授組成。而模擬器操作考試係由兩位考官組成。日本核能電廠每一值運轉人員僅一位當值長（相當於值班工程師）需取得國家核發之執照，其考試是由經濟產業省授權委託財團法人火力原子力發電技術協會執行。圖三為 ABWR 運轉人員訓練架構。

(十二)值班團隊操作表現評估

日本各核能電廠之值班人員團隊係由當值長、助理當值長(相當於值班主任)、資深運轉員（相當於反應器運轉員）、助理反應器運轉員、主要設備運轉員（相當於 BOP 運轉員）及設備操作員組成。

BTC 訓練公司於 2002 年接受日本各電力公司之委託，針對沸水式核能電廠 169 組值班團隊績效評估。其評估作法係依據 NUREG-1021 文件導則，選擇由各團隊依據事先設計好之事件情節，例如喪失冷卻水事故或喪失廠外電源等，由各團隊演練在相同事件情節之下對緊急狀況之處理，並由 BTC 公司兩位資深講師就下列六項要點執行評估：

1.瞭解異常狀況能力。

2.對電廠反應的預測能力。

3.控制盤面操作能力。

4.整個團隊的溝通能力。

5.整個團隊的管理指揮能力。

6.符合運轉導則之能力。

由整個 169 組團隊操作表現評估分析結果顯示，共同的團隊有待加強之處為整個團隊的管理指揮能力。

肆、參訪紀要

本次赴日受訓期間，除課堂及模擬器實際操作訓練外，BTC 並安排職等先後參觀東京電力所屬之柏崎刈羽電廠、福島一廠及福島二廠，此外亦參訪日本原子力安全保安院所屬之福島原子力災害對策中心，以下僅就參訪經過及心得簡要說明如後：

一、參訪東京電力核能電廠

由於此次參訪東京電力所屬核能電廠期間，適值日本政府因先前發生之營運中檢測問題，要求東京電力所屬十七部機機組停機檢查，因此除於參訪柏崎刈羽電廠時，曾透過觀景窗觀看進步型沸水式機組主控制室及反應器廠房之作業外，並未能赴現場親身體驗，故此次參訪各電廠時均以其所屬之維護技能或運轉訓練中心為主，此外，在福

島一廠時，亦參訪其廠區內之用過核燃料儲存設施。

以此次所參訪東京電力各核能電廠之訓練中心而言，其令人印象深刻之共通點，在於其訓練中心均擁有大量核電廠之實體設備或模型，舉凡核電廠使用之機械設備如各種形式泵浦、閥門、管路、壓縮機等，儀電設備如斷路器、馬達控制中心、保護電驛盤、汽機電子液壓控制盤、數位儀控盤等均以實體供學員訓練之用，部分電氣儀控設備甚至可以模擬實際運轉操作或維修狀況，供學員訓練時實際演練之用，其他設備尚有包括焊接及非破壞檢驗之實作訓練設備、控制棒模型、新燃料檢查台、輻射量測及分析設備等等。相信日本核電廠將大量實體設備或模型使用於訓練中，對於受訓學員當能產生加深印象之功效，對於訓練效果之增進當然也不言可喻。針對訓練及檢定之對象，職等曾詢問電廠訓練中心人員，是否包括承包商之技術人員，依其所言，電廠訓練中心並不對承包商人員進行技術檢定，此或許與日本核電廠維護主要均由原製造廠負責有關，惟其指出，電力公司之政策對於電廠所在地附近之高中畢業生，只要其有意願，電廠訓練中心也會安排其接受相關訓練課程，受訓合格後，如果其有進一步願意在核能相關領域發展，電廠也會引介其至相關之承包商工作，此種作法，也不啻是另一種與核電廠所在地居民建立和諧關係之方式。

此外，在參觀柏崎刈羽電廠時，其原子爐維修訓練設施亦令人印相深刻，該設施是完全模擬反應器廠房設施及狀況之全比例模型，其

目的為增進維修品質及抑低維修工作之人員劑量，但為配合該廠之機組配置狀況，因此其反應爐壓力容器模型採一半為 BWR-5 型態，另一半則屬 ABWR 之型態，在反應爐壓力容器模型內部則設置 BWR-5 噴射泵四台（其中一台與廠內實物完全相同，另三台僅為外型之模型），ABWR 之內至再循環泵（RIP）一台及可微調控制棒驅動機構（FMCRD）5 台（其中一台與廠內實物完全相同，另四台僅為外型之模型），此外爐內亦設置 BWR-5 及 ABWR 之爐心側版各半，至於在爐底部分則裝置 RIP/ FMCRD 更換機及工作平台，受訓學員可利用電話與位於另一樓層之更換機及工作平台控制台人員聯繫，控制台操控人員亦可透過閉路電視監看爐底作業狀況，受訓學員藉此方式實際模擬現場爐底 RIP/ FMCRD 之維修作業狀況。目前該設施之訓練仍以 ABWR RIP/ FMCRD 維修作業為主，未來訓練項目將逐步增加營運中爐內檢測、噴射泵檢修及爐心相關作業等項目。

由此次參訪東京電力所屬電廠訓練中心之概況，可以看出東電對於人員訓練不惜資本投入重金，其重視及用心，頗值得國內核電廠參考及學習。加上此次造訪福島一廠時，接待人員亦引導參觀其預定新建機組，目前正在進行地質探勘之預定地，此亦顯示日本電力公司對於其未來核能之發展仍抱有甚大之興趣及信心。

二、福島原子力災害對策中心

JCO 事件發生後，日本國內對於核能電廠安全及核子事故緊急應

變作業均認為有加強之必要，故於 2001 年成立原子力保安院，除核能電廠安全及核物料屬其主管範圍外，其他一般工業安全亦為其負責之事項。在核子事故緊急應變部分，原子力保安院在日本全國十九處靠近核子設施之處成立保安檢查官事務所及原子力災害對策中心（NUCLEAR EMERGENCY RESPONSE OPERATIONS FACILITY 或稱 OFFSITE CENTER），本次 BTC 安排職等參訪位於福島縣雙葉郡大熊町之福島原子力災害對策中心，該中心即負責其鄰近之福島一廠及福島二廠相關機組之緊急應變事務，其所在之建築物一樓為保安檢查官事務所，平日負責福島一廠及二廠之例行視察業務，二樓即為原子力災害對策中心。一旦發生核子事故時，即由內閣首相宣布進入緊急狀態等級並於首相官邸設置『原子力災害對策本部』及事故所在地設立『原子力災害現地對策本部』，此時位於廠址附近之原子力災害對策中心即成為事故資訊及研判之中心，包括中央政府、地方政府、專家及電力公司相關人員均進駐於此處，藉由此中心所獲得之資訊，研商事故發展及處理對策，整個中心功能編組大致分為醫療組、住民安全組、營運支援組、放射線組、公共事務組、行政組、一般支援組等。在硬體設備上，該中心配備緊急柴油發電機、電話通訊系統、衛星通訊系統、視訊會議系統、網際網路、事故機組狀況顯示、環境輻射狀況、氣象資料、環境輻射預測系統及輻射量測儀器等設備，此外並配置數個大型顯示幕將蒐集所得之機組參數、氣象、環境輻射等資訊即時顯示。職等參訪該中心時，看到所有設備包括個人電腦、通訊

設備、以及各任務編組工作位置等均預先劃分及標示，污染人員處置及動線亦均有所規劃，顯示日本政府在事故應變上確實投入甚多規劃之努力，在硬體之投資亦甚為可觀。

據職等詢問該中心官員，其表示日本政府目前每年會選擇一處原子力災害對策中心進行全面性之防災演習，動員層面包括中央內閣層級及地方政府等相關單位，至於其餘十八處則仍須進行小規模之演習，動員層面縮小至不含內閣層級，福島原子力災害對策中心官員並提供一卷全面性防災演習之錄影帶供職等參考。

伍、結論與建議

一、K-6/7 之 ABWR 模擬器雖與我國核四廠模擬器系統設計有些不同，但其基本架構與人機界面，操作畫面、警報示窗及控制室佈置等均相似，因此提供了良好操作人員對 ABWR 核能電廠數位化、電腦化及自動化人機界面的熟悉訓練，值得台電公司繼續派員前往參加短期訓練，以吸取 K-6/7 廠運轉員訓練之經驗。

二、K-6/7 模擬器訓練之教材提供我國核四廠運轉人員模擬器訓練規劃一套良好典範，值得核四廠參考。

三、K-6/7 模擬器訓練之檢定作業方式及相關檢定技術文件提供我國 ABWR 運轉員資格考試作業重要參考。

四、日本沸水式核能電廠運轉員執照效期為三年，第三年時應執行模

擬器再訓練一次約一週，效期最長為六年，即更新執照一次後，即需重新考測模擬器操作，再檢定合格方可予以再發照，此種作法頗值得國內參考。

五、日本東京電力公司運轉人員培訓制度頗值得國內參考，所有值班人員均由設備操作員(Equipment Operator 簡稱 EO)崗位培訓開始，歷經助理反應器值班員、反應器值班員、資深值班員、助理值班工程師、值班工程師等職位，每一職位有一定停年及訓練，如果運轉人員達到停年上限，表現不佳或不具備升遷條件，且年紀超出限制即調離該崗位職務，因此其 EO 年紀可維持在三十五歲左右。一般運轉員退休(離)年限為六十歲，而值班工程師服勤年限為五十五歲。

六、日本核能電廠委託 BTC 訓練公司，於 2002 年依據美國核管會出版之 NUREG-1021 文件，針對日本各核能電廠值班團隊 169 組進行值班團隊操作能力評估，以期作為提升值班團隊技術能力和加強訓練方向之參考，此點對於提升運轉人員能力和降低人為疏失相當有俾益，值得台電公司參考。

附件一

Training Course Schedule

BWR Operator Training Center Corporation

Name of Training : ABWR Training and Evaluation Course

Duration : 14th Apr. 2003 - 25th Apr. 2003

1st week

Date	Time	Session	Location		Theme of Training	Charge of Training	Remarks
4/12 Sat	12:30 16:30		Narita Kashiwazaki		* Check In & Facility guide	Kawai	
4/13 Sun	09-10		Class Room C		*Orientation	Noji, Kawai Ikehara	
	10-16				*Stay in Niigata Center	Noji, Kawai Ikehara	
4/14 Mon	10-12 13-15	CL-1	Class Room C	1.1	* Introduction to BTC & Current Activities at BTC	Murata	
				1.2	* Current Training Activities in Taiwan Nuclear Industry	(trainees)	
				2.1	Feature of ABWR	Noji	(Miyanaga)
				2.2	Man Machine Interface	Mitsumori	(Miyanaga)
				3	Operational knowledge for normal plant startup (1)	Mitsumori	(Noji) (Miyanaga)
				3.1	ABWR Plant System		
				3.2	Reactor Critical Approach Procedure		
	15-19	SI-1	ABWR Simulator	S2.1	ABWR Control Panel Familiarization	Mitsumori Noji	(Miyanaga)
				S3	Normal Plant Startup-1		
				S3.2	Reactor startup to reaching criticality (manual mode) ditto (auto mode)		
4/15 Tue	10-12 13-15	CL-2	Class Room C	3	Operational knowledge for normal plant startup (2)	Suzuki	(Miyanaga) (Noji)
				3.3	Reactor heatup		
				3.4	From "reactor heatup" to "mode switch change over"		
				3.5	Main turbine startup		
				3.6	From "Generator synchronization" to "Load transfer"		
	15-19	SI-2	ABWR Simulator	S3	Normal Plant Startup-2	Mitsumori Suzuki	(Shiyama)
				S3.3	Reactor heatup		
				S3.4	From "reactor heatup" to "mode switch change over"		
				S3.5	Main turbine startup		
				S3.6	From "Generator synchronization" to "Load transfer"		
4/16 Wed	10-15	CL-3	Class Room C	3	Operational knowledge for normal plant startup (3)	Suzuki	
				3.7	Feedwater Pump Transfer from MDRFP to TDRFP		
				3.8	Power Ascension by Increase of Core Flow (RIP Control)		
				4	Surveillance Tests on Power		
				5	Abstracts of Shutdown Process		
	15-19	SI-3	ABWR Simulator	S3	Normal Plant Startup-3	Mitsumori Noji	(Shiyama)
				S3.6	Load Transfer		
				S3.7	Feedwater Pump Transfer from MDRFP to TDRFP (Auto & Manual)		
				S3.8	Power Ascension by Increase of Core Flow (RIP Control) from 60% Power (Manual & Auto)		
				S4	Various Operations at 100% Power and Surveillance Tests		
4/17 Thu	8:30- 12:30	ST-1	K-6/7 Site	6	Site Tour of K-6/7	Kawai	
				6.1	Visit of K-6/7 Control Room		
				6.2	Visit of K-6/7 Reactor Building	Kawai, Noji	
				6.3	Visit of K-6/8 Turbine Building		
	15-19	SI-4	ABWR Simulator	S5	Normal Shutdown-1	Mitsumori Noji	(Ishikawa)
				S5.1	Power Descension		
				S5.2	Generator / Turbine Off-line		
				S5.3	Reactor Subcritical		
				S5.4	Reactor Power at 10%		
				S5.5	Reactor Subcritical		
				S5.6	Depressurization		
4/18 Fri	8-12	SI-5	ABWR Simulator	S5	Normal Shutdown-2	Mitsumori Noji	(Ishikawa)
				S5.7	Shutdown Cooling In-service at a pressure of 0.7MPa		
				S5.8	Condenser Vacuum Break		
				S5.9	Condenser Vacuum-up Operation		
				S7	Transients Caused by Single Equipment Failure		
	13-17		Fukushima Center		* Move to Fukushima Center	Noji, Kawai	
	18-20				* Welcome Party with Namie Rorary Club		
4/19 Sat	09-12 13-17		Fukushima Center		BTC-FC(Technical discussion and facility tour) Site Tour for Off site center and Fukushima-Daiichi site	Noji, Kawai Ueda	
4/20 Sun	08-18		Fukushima-Kashiwazaki		* Move back to Niigata Center	Noji, Koshi	

1/2

Training Course Schedule

Apr. 09, 2003
BWR Operator Training Center Corporation

BTC

Name of Training : ABWR Training and Evaluation Course
Duration : 14th Apr. 2003 – 25th Apr. 2003

2nd week

Date	Time	Session	Location		Theme of Training	Charge of Training	Remarks
4/21 Mon	8–10	CL-4	Class Room C	8	**Plant Major Interlocks**	Koshi	(Shiyama) (Noji)
				9	**Plant Behaviors during Basic Transients**		
				9.1	Reactor Scram		
				9.2	Turbine Trip		
				9.3	Inadvertent MSIV Closure		
	10–12			10	**Operations Guideline for the Basic Transients**		
				10.1	Basic Response Guideline for Reactor Scram with MSIV Open		
				10.2	Basic Response Guideline for Reactor Scram with Closed MSIV		
	13–17	SI-6	ABWR Simulator	S10.1	**Basic Scram Recovery** Observation on the Plant Behaviors during Scram Confirmation on the Manipulations and Monitoring Observation on the Standard Performances by Instructors Practice of the Plant Operation during Turbine Trip with MSIV Open Condition	Noji Watabe	(Koshi) Operators : (Oosawa) (Ishikawa) (Miyanaga)
4/22 Tue	8–10	CL-5	Class Room C	11.1	**Plant response & operational procedure on typical transients** Plant Behaviors and Procedural Response for the Typical Abnormal Transients	Koshi	(Miyanaga) (Watabe)
	10–12						
	13–17	SI-7	ABWR Simulator	S10.2	**Required Responses for the Transients with Closed MSIV** Observation on the Plant Behaviors during MSIV Closure Confirmation on the Manipulations and Monitoring Observation on the Standard Performances by Instructors Practice of the Plant Operation during Turbine Trip with Closed MSIV Condition	Noji Watabe	(Koshi) Operators : (Imaizumi) (Ishikawa) (Sueoka)
4/23 Wed	8–10	CL-6	Class Room C	11.2	**EOP Guideline Review**	Mitsumori	(Noji)
	10–12	ST-2	K-Site	6	**Site Tour of K-6/7**	Kawai, Noji	
				6.4	Tour around the K-site Yard, Maintenance Training Center and Exhibition Hall		
	13–17	SI-8	ABWR Simulator	S11.1	**Practice for the Typical Transients** Loss of AC Power Loss of All Feedwater Pumps Loss of Coolant Accident	Watabe Mitsumori Noji	Operators : (Imaizumi) (Ishikawa) (Miyanaga)
				S11.2	**Practice for the Typical EOP Phenomena** Loss of High Pressure Injection Means PCV Pressure Uncontrollable ATWS		
4/24 Thu	8–10	CL-7	Class Room C	12.1	**Performance Evaluation System for Individual Trainees**	Kobayashi	(Noji)
	10–12			12.2	**Performance Evaluation System for Shift Team**		
	13–17	SI-9	ABWR Simulator	S11	**Practical Response for the Transients**	Kobayashi Noji	Operators : (Imaizumi) (Miyanaga) (Sueoka)
				S12.1	**Evaluation Practice of Operational Performances**		
4/25 Fri	8–10	CL-8	Training Replay System	12.1	**Replay and Review the Participants Performances**	Kobayasi	(Noji)
	10–12		Class Room C	12.1	**Simulated Evaluation Practice**		
	13–14	SI-10	ABWR Simulator	S12.2	**Evaluation Practice of Team Performances**	Kobayashi Noji	Operators : (Shiyama) (Imaizumi) (Oosawa) (Miyanaga)
	15–17			S13	**Wrap up Session**	Mitsumori Noji	
4/26 Sat	7:30		Kashiwazaki-Nagaoka for Tokyo		Checkout and leave for Tokyo		

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BTC 図書番号 5-0-90-09-R0 分類：Aa

ABWR Simulator Training Guide

BWR Operator Training Center Corporation

Table of Contents

Normal Startup Process

Normal Shutdown Process

STP-1 Attaining Reactor Criticality (1/2) BP 5 to BP 6

No.	Guide	Location
1	Confirm that following systems are normally functioning: - Startup Range Neutron Monitor (SRNM) - Rod Control & Information System (RC&IS) - Rod Worth Minimizer (RWM) - Automatic Power Regulator (APR) □	CRT[ANN] Indication>3cps FD12 [RC&IS] FD13 [APR]
2	Confirm reactor conditions: - Reactor water level: 1180mm - Reactor coolant temperature: >80℃ □	CRT 302
3	Select BP 5 [Reactor Startup 原子炉モード起動] BP: Break Point □	CRT 501
4	Notify Reactor Startup using paging system □	
5	Change over the Reactor Mode Switch position from [Refueling 燃料交換] to [Startup 起動] □	Main Panel
6	Select the mode of rod control as follows: －Operation Mode: Select Semi-automation [半自動] －Rod Selection Mode Select Gang-mode [ギャングモード] －Rod Drive Mode Select Continuous[連続] □	FD 12 [RC&IS]
Note	Procedures of this guide are based on Semi-automation mode operation. For full-automatic operation of control rod withdrawal by kick signal from process computer, following steps are required. －Select RC&IS Operation Mode Automation [全自動] －Select RC&IS Selection Mode Gang-mode [ギャングモード] －Push PB [Power Control 出力制御] PB: Push Button	FD 12 [RC&IS] [Automation console 自動化コンソール]
7	Select BP 6 [Reactor Start-up 原子炉起動]. □	CRT 501
8	Withdraw the control rods in semiautomatic mode by pushing PB [Withdrawal 引抜]. □	Main Panel

STP-1 Attaining Reactor Criticality (2/2) BP 5 to BP 6

No.	Guide	Location
9	During CR manipulation, closely monitor the neutron level responses.	CRT 401
10	Change the rod drive mode to step mode[ステップ] , when the reactor is approaching criticality □	FD 12 [RC&IS]
11	Confirm that the reactor has reached criticality. －Reactor power increases steadily at a period of 100 ~200sec without additional control rod withdrawal. □	
12	Notify the plant personnel that the reactor has reached criticality by the paging system □	
13	Record following data at the time of attaining reactor criticality －Time of criticality attained －Control rod positions －SRNM indications －Reactor period －Reactor coolant temperature □	CRT401[rod-positions] CRT302[SRNM], reactor water temp.
14	Monitor SRNM indications increase and the range changes according predetermined levels. □	CRT 307

STP-2 Reactor Pressurization 1 (1/3) BP 7 to BP 9

No.	Guide	Location
Note	Procedures of this guide are based on Semi-automatic mode operation. If full automatic operation of control rod withdrawal by process computer is desired, following steps must be down. －Select RC&IS Operation Mode Full-Automation [全自動] －Select RC&IS Selection Mode Gang-mode [ギャングモード] －Push PB [Power Control 出力制御] PB: Push Button －Set the following data Target reactor pressure Rate of coolant temperature change (<55℃/hr) □	FD 12 [Automation console 自動化コンソール] CRT 501
1	Select BP 7 [start of reactor pressurization 原子炉昇圧開始] □	CRT 501
2	Continue CR withdrawal according to the predetermined sequence. Note1: During reactor pressurization, the reactor should be pressurized by the specified coolant temperature change rate. Note2: Reactor water level is maintained at the normal water level (1180mm) by dumping water through CUW dump valve controlled by Feed Water Control System □	CRT 401[control rod position] [CRT 303] Temperature-change-rate < 55℃/hr
3	Confirm the reactor pressure has reached at 0.38 MPa. □	
4	Start warming of the Turbine Gland Steam Evaporator. －Select TGS Operation Mode Switch[sequential actuation 連動], then push PB [evaporator warming 蒸化器暖機]. □	Main Panel CRT [Turbine aux. Stem タービン補助蒸気]
5	Place RCIC system in standby condition. 1) Using the operational guide on CRT 501, place [RCIC in Stand-by 待機]. －Push PB [Isolation valve reset 隔離弁リセット] for RCIC Isolation signal reset. －Open warming valve F048 for steam line warming. －Open inboard isolation valve F035 on the steam line. －Close warming valve F048. －Open partially outboard isolation valve F036. 2) After completion of pressure equalization between reactor and RCIC steam line, implement following. －Open outboard isolation valve F036 －Open RCIC turbine main stop valve F068 3) Adjust RCIC Flow Set to 182 m^3/hr. □	CRT 501 Main Panel FD02 [LDS 2/4] FD 03 [RCIC]

STP-2 Reactor Pressurization 1 (2/3) BP7 to BP9

No.	Guide	Location
6	Select BP 8 [Reactor Pressurization 原子炉昇圧Ⅰ]on CRT 501. □	CRT 501
7	Continue control rod withdrawal □	CRT 402 [rod position]
8	Confirm the reactor pressure has reached at a pressure of 0.69 MPa. □	
9	Change steam supply source for TGS evaporator from the house boiler to the evaporator. －Select TGS Operation Mode Switch[sequential 連動], then push PB [transfer to evaporator 蒸化器切替] □	CRT [TGS(1)] Main Panel
10	Select BP 9 [first HPCP start, HPCP 1 台目起動] □	CRT 501
11	Starting High Pressure Condensate Pump (HPCP) A －Select PB[sequential 連動] and Push PB[start 起動]. Confirm following actions proceed automatically on CRT. －HPCP(A) control switch change to [auto 自動] －HPCP(A) minimum flow valve fully open －HPCP(A) discharge valve fully close －HPCP(A) start －HPCP(A) minimum flow valve on [auto 自動] －HPCP(A) discharge valve fully open －HPCP(A) aux. Oil pump stop, CS on [auto 自動]. □	Main Panel CRT[復水系(2)]
12	Put HPCP(B) in standby. Push HPCP operation mode PB [sequential連動], then push PB[standby 待機]. －HPCP(B) CS placed in[auto 自動] □	Main Panel
13	Check EHC operation mode prior to the main turbine reset. －Speed Control : [sequential 連動] selected Note: Procedures of this guide are based on Semi-automatic mode operation. Following step is required for full-automatic operation by kick signal from process computer. －Push PB [EHC speed control 速度制御] on. □	FD 23B[Automation progrss 自動化進行] [Automation console 自動化コンソール]
14	Push PB[reset リセット] to reset the main turbine trip condition. □	Main Panel

STP-2 Reactor Pressurization 1 (3/3) BP7 to BP9

No.	Guide	Location
15	Confirm following alarms light on. －Alarms －System status indications －Valve actuations □	 FD23A, FD 21 FD23A, FD23B
16	Select [CV warming 暖気] on FD 23B [Automation Progress 自動化進行] . □	FD23B
17	Check the status of CV chest warming on CRT 702 and FD 23B/[MSV valve test, MSV 弁テスト]. □	CRT702,FD23B[MSV 弁テスト]

STP-3 Reactor Pressurization 2 (1/3) BP 10 to BP 16

No.	Guide	Location
Note	Note: Procedures of this guide are based on Semi-automatic mode operation. If full automatic operation of control rod withdrawal by process computer is desired, following steps must be down. －Select RC&IS Operation Mode Full-Automation [全自動] －Select RC&IS Selection Mode Gang-mode [ギャングモード] －Push PB [Power Control 出力制御] PB: Push Button －Set the following data Target reactor pressure Rate of coolant temperature change (<55℃/hr) □	FD 12 [Automation-consol e 自動化コンソール] CRT 501
1	Select BP 10[reactor pressurization Ⅱ原子炉昇圧Ⅱ] on CRT 501 □	CRT 501
2	Continue control rod withdrawal with the predetermined rod sequence Note 1: During pressurization, the reactor should be pressurized by control rod withdrawal so as to maintain the rate of the coolant temperature change at a constant value. Note2: Confirm that the reactor water level is maintained at the normal water level(1180mm) by dumping water through CUW dump valve controlled by Feedwater Control System □	CRT 402 for rod position monitoring CRT 303: Rate of temperature change <55℃／hr
3	Confirm that the turbine bypass valve will start to slightly open at a pressure of 1.03 MPa. Also confirm alarm on TBV opening. □	Large Panel [Important alarms 重要警報 / TBV open]
4	Select [reactor pressure setting 原子炉圧力設定] and gradually increase the setting to close bypass valve until it is fully closed. □	FD21[pressure/load set 圧力/負荷制御]
5	Preset for automatic reactor pressure following: －Select control[sequential 連動] "On" －Select [EHC pressure control 圧力制御] when full automatic control in use. □	FD23B[Automation Progress 自動化進行] [Automation-consol e 自動化コンソール]
6	Select BP 11[reactor pressure control 原子炉圧力制御] on CRT 501 □	CRT 501

STP-3 Reactor Pressurization 2 (2/3) BP 10 to BP 16

No.	Guide	Location
7	Select and put the pressure control into the pressure setting following mode on FD 23B[Automation Progress 自動化進行コンソール]. □	FD 23B
8	Confirm the automatic reactor pressure increase and the pressure setting follows as the pressure increases. □	CRT 303
9	Start SJAE warming －Push SJAE PB[sequential 連動]. －Push [SJAE warming 暖気] on.	Main Panel CRT [turbine aux. Steam sys タービン補助蒸気系]
10	Select BP 12[reactor pressurization 原子炉昇圧Ⅲ] on CRT 501. □	CRT 501
11	Continue control rod withdrawal according to the predetermined rod sequence □	CRT 402 for rod position monitoring
12	Confirm the reactor pressure has been reached at a pressure of 1.9 MPa. □	
13	Select BP 13[transfer of air ejectors 空気抽出器切替]. □	CRT 501
14	Set the SJAE and Off Gas System operating modes as follows: －Select SJAE operating mode[sequential 連動] on FD 47/OG master. □	Large Panel FD 47
15	Transfer from the starting SJAE to the main SJAE －Push PB[AO/OG starting modeⅣ 起動 モードⅣ]	Main Panel
16	Monitor operating status of the SJAE □	CRT [SJAE] CRT [turbine aux. Steam system タービン補助蒸気系]
17	Confirm operating status of the Off Gas system Adjust SJAE first stage air inlet valve (N21-MO-F405), if the condenser vacuum adjustment is required. □	CRT [OG(2)]
18	Select BP14[reactor pressurization 原子炉昇圧Ⅳ] on CRT 501. □	CRT 501
19	Continue control rod withdrawal according to the predetermined rod sequence. □	CRT 402 for rod position monitoring

STP-3 Reactor Pressurization 2 (3/3) BP 10 to BP 16

No.	Guide	Location
20	Confirm the reactor pressure has been reached at a pressure of 1.9 MPa. □	Large Panel
21	Pre-check for starting Motor Driven Reactor Feed Pump (A) －MDRFP line up －Status of Feedwater Control system Select[sequential 連動]. Select[給水制御] (feedwater control) when full-automatic control in use. －Select MDRFP operating mode in [sequential 連動] □	CRT [Feed Water 給水系] FD 14 [2MD RFP] [Automation-Consol e 自動化コンソール] Main Panel
22	Select BP15 [MDRFP starting MDRFP 起動] □	CRT 501
23	Put additional one condensate filter and two condensate deminelizers in service. － Push PB [in service 採水]of [CF]/[CD] system master. □	Main Panel
24	Push PB [MDRFP starting 起動] to start MDRFP(A) and observe following automatic actions to proceed: －MDRFP flow controller in manual, 0% setting －MDRFP discharge valves(small and large) fully closed －MDRFP minimum flow valve fully opens －MDRFP starts －MDRFP small discharge valve fully opens after 60 sec of the pump starting －MDRFP flow controller in auto. Mode at 0 deviation □	Main Panel CRT [Feed Water 給水系]
25	Put the flow controller of MDRFP (A) in auto. by selecting [sequential 連動] and [MDRFP starting transfer 起動切替] － select [increase 増] － change into [auto 自動] at 0% deviation □	FD 14/2MDRFP
26	Put MDRFP (B) in standby mode －Push MDRFP(B) PB[stand by 待機] on. □	Main Panel
27	Select BP 16[reactor pressurization V原子炉昇圧V] □	CRT 501
28	Continue control rod withdrawal according to the predetermined rod sequence □	CRT 402 for rod position monitoring
29	Confirm that the pressure setting following mode is disengaged at a pressure of 6.52 MPa. □	FD 21[pressure & load control 圧力負荷制御]

STP-4 Startup of Main Turbine (1/3) BP 22 to BP 25

No.	Guide	Location
1	Check the status on the reactor: Reactor water level: 1180 mm Reactor pressure: approx. 6.58 MPa APRM indication: approx. 15% □	[CRT 305]
2	Pre-check on the main turbine-generator for startup: －Condenser vacuum : <6.7 kPa －Turbine aux. Systems and parameters －Generator aux. Systems Following CRTs are useful. [CRT/trend/ turbine speed トレンド/主タービン編/回転数] [CRT/parameters/turbine control パラメータ/タービン制御系] [CRT/parameters/ turbine lube. oil パラメータ/タービン潤滑油系] [CRT/ TGS(1)] [CRT generator gas system 発電機ガス系] [CRT/generator cooling system 発電機冷却系] □	[CRT 703]
3	Set maximum steam flow limit at 117%. －Increase [maximum flow limit 最大流量制限] on FD21[EHC control panel ｺﾝﾄﾛｰﾙﾊﾟﾈﾙ]. □	FD 21
4	Confirm that the completion of CV chest warming. －CV inner wall metal temp. >250℃ －CV temp. difference between inner and outer surface <45℃	[CRT 702] [FD 23B]
5	Confirm EHC control mode on [FD23B Automation Progress 自動化進行]. －[EHC speed control 速度制御] is set in [Sequential 連動] －[EHC load control 負荷制御] is set in [Sequential 連動] □ NOTE : Procedures of this guide are based on Semi-automatic mode operation. For full-automatic operation of CV chest warming disengage and initial load limiter setting by kick signal from process computer, following steps are required . －Push PB [EHC speed control 速度制御] on. －Push PB [EHC load control 負荷制御] on.	FD 23B[自動化進行] [automation-console 自動化コンソール].

STP-4 Startup of Main Turbine (2/3) BP 22 to BP 25

No.	Guide	Location
6	Select BP 22 [preparation for turbine startup タービン起動準備] □	[CRT 501]
7	Disengage CV chest warming on FD23B[Automation Progress 自動化進行] －Select [CV warming disengage 暖気除外] on. －Check control action at [FD21Pressure/Load control] □	FD 23B[自動化進行] FD21[圧力/負荷制御]
8	Set load limiter at initial position. －Select [Load Limiter initial set 負荷制限器初負荷] on FD 23B[Automation Progress 自動化進行] . －Check the load limiter set approx. 8.4%. □	FD 23B[自動化進行]
9	Put rub check monitor on. After contact it select [operator check 運転員確認] □	Back panel area CRT 501
10	Put the turbine vibration monitor switch in [engage 使用]. □	Main control panel
11	Select BP 23[turbine startup タービン起動] on CRT 501. □	CRT 501
12	Set the turbine acceleration and heat soak time by selecting [turbine startup calculation タービン起動計算] on FD 23 B[Automation Progress 自動化進行] □	FD 23B
13	Select [turbine startup タービン起動] at FD 23 B[Automation Progress 自動化進行]. －Check the acceleration specified by the high pressure turbine first stage inner wall temperature: < 93℃ low speed [低速 50 rpm/min.] 93 to 177℃ medium speed [中速 75 rpm/min.] >177℃ high speed [150 高速 rpm/min.] －Turbine speed increase to 100 rpm then close all valves. □	[FD 23 B] FD21 [turbine start タービン起動] CRT 703 FD23 [MSV/IV/ISV test MSV 弁テスト、IV/ISV 弁テスト]
14	Observe actuations of turbine valves and turbine speed increase. Also confirm that all turbine valves are closed at a speed of 100 rpm. □	FD23 [MSV/IV/ISV testMSV 弁テスト、IV/ISV 弁テスト]
15	Select BP 24 [turbine rub check ラブチェック] on CRT 501 □	CRT 501

STP-4 Startup of Main Turbine (3/3) BP 22 to BP 25

No.	Guide	Location
16	Direct the turbine local operator to check the turbine rub check. □	Local
17	Disengage the rub check monitor then select [confirmation on rubbing 運転員確認] after completion of rub check. □	CRT 501
18	Select BP25 [turbine speedup タービン昇速] □	
19	Let the turbine speed up to 1500 rpm by selecting [turbine speedup タービン昇速] on [FD 23 B Automation Progress 自動化進行] and monitor the following action on FD21[turbine startup タービン起動] －Selection of the turbine acceleration －Selection of speed set at 1500 rpm □	FD 23B[自動化進行] FD21[タービン起動]
20	Continuously monitor the turbine operating parameters during acceleration. Following CRTs are useful. [CRT parameters /turbine lube oil system パラメータ/タービン潤滑油系] [CRT turbine タービン] [FD 23A CV/TBV test CV/TBV 弁テスト] □	CRT 703
21	Stop the lift pumps at a speed of 1000 rpm. －Select [LOP lump select 一括選択] at [sequential 連動] and push on [stop 停止] PB of [LOP 3～10] . □	Main Panel
22	Confirm that the turbine has attained at the rated speed. □	
23	After confirming the bearing oil pressure, secure following oil pumps and put the control switches of these pumps in auto position. －TGOP [stop 停止] on for Turning oil pump. －MSOP[stop 停止] on for Turbine motor suction oil pump. □	Main Panel
24	Open MSH first stage extraction steam supply valve. －Select [sequential 連動] at [MSH first stage extraction steam supply valve MSH 第 1 段加熱抽気元弁] and Push [fully open 全開]PB on. －Confirm following actuations proceed. N36-MO-F0 49 A/B fully open. Steam check valve and drain valves fully open. □	Main Panel CRT [MSH] FD44B[MSH]
25	Implement turbine over speed test. □	

STP-5 Generator Synchronization (1/3) BP 26 to BP 28

No.	Guide	Location
1	Confirm following reactor operating conditions: －reactor water level 1180mm －reactor pressure 6.58 MPa －APRM approx. 15% □	CRT 305
2	Confirm following turbine operating conditions: －load limiter setting －turbine speed －bypass valve opening －Control mode [Sequential 連動] mode selected for turbine speed control , load control and pressure control. □	CRT 704 FD23B[自動化進行]
3	Confirm following generator conditions before synchronization : －Field breaker switch position 52E [auto 自動] lamp on －AVR ready to use － main transformer and IPB(isolated phase bus) fan switches in [auto 自動] position NOTE: Operation Mode This guide is based on the semi-automatic operation. When the generator synchronization, load setting, and load limiter operation are implemented by the process computer, select following setting: －Select [Sequential 連動] at FD23B[Automation Progress 自動化進行] for turbine [speed control 速度制御] and [load control 負荷制御]. －Push PB[EHC speed control 速度制御] and PB[EHC load control 負荷制御]. －Push PB[Electrical control 電気制御] on. □	FD24B[IPB Tr] FD23B[自動化進行] [Automation consol 自動化コンソール].
4	Select BP26 [preparing generator synchronization 発電機並列準備]. □	CRT 501
5	Close the generator field breaker switch 52E. －Push PB[close 入]. □	Main Panel
6	Confirm the cooling fans on the IPB and the transformers have been started. □	CRT [main & house trans IPB/ 主変、所変]
7	Monitor the generator voltage has been increased up to 27.0 kV and voltages on each phase are balanced. □	CRT [generator 発電機]

STP-5 Generator Synchronization (2/3) BP 26 to BP 28

No.	Guide	Location
8	Close the line switch R26 －Push PB [on 入] at [500 kV Line Switch 発電機断路器] □	Main Panel
9	Match the turbine speed with the network frequency using load regulator (LR). －Select [speed matching 揃速] on FD 23B/[自動化進行] □	FD23B[自動化進行]
10	Select BP27 [generator synchronization & initial loading 並列初負荷] Note: This guide is based on the semi-automatic operation. If the generator is manually synchronized to the grid, take following steps: －Put the switch to [on 入] position of the [synchromonitor 同期検定器] . －Push PB [on 入] of [generator main breaker O-26 発電機遮断器] . －Return the synchromonitor switch to [off 切]position . □	CRT 501 Main Panel
11	Push PB [on 入] of [automatic synchronizing circuit 自動同期回路]. －Observe the synchromonitor action. □	Main Panel
12	Check the main breaker switch close automatically. □	Main Panel Large Panel
13	Increase load set up to a specified value for the initial synchronization. －Select [LR, initial loading selection 負荷設定器初負荷選択]. －Confirm the generator is running under load limiting condition on FD21[pressure/load control 圧力/負荷制御] －Load setting is at 10% deviation. □	FD 23B[自動化進行] FD21[圧力/負荷制御] CRT 704
14	Transfer generator hydrogen purity monitor to generator side circulation. □	Local Panel
15	Implement turbine heat soak for more than 20 minutes for cold starting. □	
16	Select BP 28[pressure control change 圧力制御切替] □	CRT 501

STP-5 Generator Synchronization (3/3) BP 26 to BP 28

No.	Guide	Location
17	Gradually increase the setting of the load limiter up to 109 % with the bypass valves fully closed. －Select [pressure control change 圧力制御切替] on FD 23B Automation Progress 自動化進行] －Check Gradually increase the load limiter setting. －Confirm that the indication lamp of [EHC load control limiting 負荷制御制限中] off. －Confirm that the all bypass valves are fully closed. －Increasing the load limiter setting up to 109 %. －Put the load regulator into [APR following mode 追従] □	FD 23B/[自動化進行] FD21[pressure load change 圧力負荷制御]
18	Check that the turbine and generator operating status including TG aux. systems. －CRT 305 －CRT 705 －CRT[generator seal oil system 発電機密封油系] －CRT[generator stator cooling system 発電機冷却系] －CRT[trend: stator winding temperatures トレンド /固定子巻線温度] －CRT[parameters/ turbine control system パラメータ/タービン制御系]	[CRT 305], [CRT 705]

STP-6 C-FW pumps in service (1/3) BP 31 to BP 33

No.	Guide	Location
1	Confirm that the generator power has been reached at 20% power (270 MWe) □	Large Panel
2	Select 31[starting second condensate pump 復水ポンプ2台目起動] □	CRT 501
3	Change over the house load from the starting transformer to the house transformer so as to receive house load power from the generator. －Select [sequential 連動] at [house load 所内電源]、and Push PB[starting transformer 起変→house transformer 所変] on. －Check the following bus breakers changing to the house load transformer - M/C 6A-1 - M/C 6B-1 - M/C 6C-1 - M/C 6D-1 □	Main Panel Large Panel
4	Increase the number of servicing condensate filter columns from 2 to 3 and condensate demineralizers from 4 to 6. －Push PB [in service 採水] at [CF]system master. －Push PB [in service 採水] at [CD] system master. □	Main Panel
5	Check out for starting second LPCP and HPCP on CRT[condensate system 復水系(1)][condensate system 復水系(2)] □	CRT[復水系(1)] [復水系(2)]
6	Start second LPCP (B). －Select PB[sequential 連動] and push PB [LPCP (B) start 起動]. －Observe following actuations automatically proceed: - Discharge valve (F003B) fully closes and then slightly opens. - LPCP (B) starts. - Discharge valve (F003B) fully opens. □	Main Panel CRT[復水系(1)] [復水系(2)]
7	Place LPCP (C) in standby. －Push PB[LPCP (C) standby 待機] on. －Confirm following actuations automatically proceed: - control switch position changes from [off lock 切保持] to [auto 自動]. - discharge valve (F003C) fully opens. □	Main Panel CRT[復水系(1)] [復水系(2)]

STP-6 C-FW pumps in service (2/3) BP 31 to BP 33

No.	Guide	Location
8	Start second HPCP (B). －Select PB[sequential 連動] at [HPCP] and push [HPCP (B) start 起動] on. －Observe following actuations automatically proceed: - discharge valve (F009B) fully closes - minimum flow valve(F020B) fully opens - HPCP (B) starts. - discharge valve (F009B) fully opens. □	Main Panel
9	Place HPCP (C) in standby. －Push PB[HPCP (C) standby 待機]. －Observe following actuations automatically proceed: - control switch position changes from [off lock 切保持] to [auto 自動]. - discharge valve (F009C) fully opens. □	Main Panel
10	Start CV chest warming of RFPT(A) (1) push PB [reset リセット] to reset RFPT(A) trip condition. (2) When the high pressure and low pressure control valve fully open, then trip the RFPT(A) turbine. (3) Repeat step (1) and (2) until the HPSV inner wall temperature equalizes the main steam temperature. (4) After CV warming completion, reset RFPT(A). Note: Chest warming will take 30 to 60 min. □	[RFPT Panel パネル] at Main Panel FD 22A[RFP-T/parameter パラメータ(2/4)]
11	Check out for starting T/D RFP(A) －system status －system lineup □	CRT 602, CRT[main-steam 主蒸気系]
12	Select BP 32 [first T/D RFP starting1 台目起動]. □	CRT 501
13	Increase RFP-T (A) －Push PB[speed increase 昇速] at [RFPT パネル pane]. －Observe following actuations automatically proceed: - minimum flow valve fully opens. - oil temp. setting changes from 32℃ to 46℃. - the turning gear motor automatically stops - pump speed is maintained at 1,000 rpm - after heat soaking, the pump will start to increase its speed again. - Pump speed is again maintained at 2,000 rpm for 5 min. □	[RFPT パネル] FD 22/RFP-T(A) Lamp [maintain 保持] on Lamp[increasing 昇速] on

STP-6 C-FW pumps in service (3/3) BP 31 to BP 33

No.	Guide	Location
14	Completion of RFPT speed increase is indicated by window [feed water control in service 給水制御中] lights on. □	FD14/T/D+M/D [給水制御中]
15	Confirm the RFPT operating status on CRT 602. □	CRT 602
16	Verify feed water control system status as follows: －master controller [auto 自動] & [single element 単要素]() －M/D RFP(A) controller [auto 自動] －T/D RPF(A) controller [manual 手動]&[in control 給水制御中] －Select [sequential 連動] at FD14 [T/D+M/D] Note: In case of full automatic transfer from M/D RFP to T/D RFP by process computer, implement following steps. －Push PB [feedwater control 給水制御系]. □	FD14 [T/D+M/D] [Automation console 自動化コンソール
17	Select BP 33 [M/T transferring 切替]. □	CRT 501
18	Change over from M/D RFP(A) to T/D RFP(A) on FD 14 [T/D+M/D] －Select [M/T transferring 切替] on FD14 . －Observe following actuations automatically proceed: - T/D RFP(A) discharge valve (F0302A) fully opens. - T/D RFP(A) controller slowly increases flow setting. - at "0"deviation, T/D RFP(A) is in automatic control mode - M/D RFP controller is put into manual control mode. - M/D controller setting is gradually decreased almost 0 %. □	FD14 [T/D+M/D] CRT604[給水ポンプ切替]
19	Put M/D RFP(A) out of service. －Select M/D RFP [sequential 連動] and push PB [trip 停止]. －Observe following actuations automatically proceed: - M/D RFP(A) large discharge valve (F0305A) closes. - M/D RFP(A) small discharge valve (F0307A) closes. - M/D RFP trips. □	Main Panel CRT[feed water system 給水系]
20	Put M/D RFP (A) in standby. －Push PB [standby 待機] on. －Observe following actuations automatically proceed: - M/D RFP(A) large discharge valve (F0305A) opens. - M/D RFP(A) small discharge valve (F0307A) opens. - M/D RFP(A) controller out put setting increases. - M/D RFP(A) controller puts into "auto" at 0% deviation. □	Main Panel CRT[feed water system 給水系]() FD14 [T/D+M/D]

STP-7 Power ascension using core flow (1/2) BP 39

No.	Guide	Location
1	Confirm that following systems are functioning normally: RFC, APR, NMS, MRBM, ATLM, EHC, RRS, and process computer. □	
2	Verify that following system control modes are as follows: －RFC: [Power control auto 出力制御自動] [gang auto ギャング自動] [automatic flow control 流量制御自動] －RC&IS: [full-auto 自動] is not selected. －APR: [flow control 炉心流量] is selected at [generator power control 発電機出力制御]. －Process computer: [power control 出力制御] are selected. Note: These conditions are full automatic mode. If computer control is not used, then [power control 出力制御] should be disengaged and manipulation data will be put on FD 12[APR [manipulation 操作]. □	FD11[RFC master マスタ] FD12[manipulation 操作] FD13[mode-selection モード選択] [automation-console 自動化コンソール]
3	Confirm that BP 39[power ascension 出力上昇V] is permissible. □	CRT 501
4	Operator will input following data on CRT 501 then select [confirmation by operator 運転員確認] －target generator power 1356 MWe －rate of generator power change 270 MWe/h Note: above values are maximum ones. □	CRT 501
5	Select BP 39 [power ascension V負荷上昇V], then push PB[automation progress 自動化進行] 0n. －window[core flow 炉心流量] at [generator power control 発電機出力制御] lights on. □	[automation-console 自動化コンソール] FD 13 [モード選択]
6	Observe generator power increases with a predetermined rate with core flow increase on CRT 705 □	CRT 705
7	Request P1 calculation and verify core thermal limits. －CMFLCP≦1.0 －CMFLPD≦1.0 □	Process Computer
8	Confirm that the unit has attained at the rated power then notify plant personnel by the paging phone. □	

STP-7 Power ascension using core flow (2/2) BP 39

No.	Guide	Location
9	Implement plant operating status check after attaining the rated power according to the prescribed checklist. □	

SDP-1 Power Descent from the rated power (1/2) BP 51 to 52

No.	Guide	Location
1	Confirm that following systems are functioning properly: －RFC, APR, NMS, MRBM, ATLM, EHC, RRS, and Process Computer. □	
2	Verify that following system control modes are as follows: －RFC: [Power control auto 出力制御自動] [gang auto ギャング自動] [automatic flow control 流量制御自動] －RC&IS: [full-auto 自動] is not selected. －APR: [flow control 炉心流量] is selected at [generator power control 発電機出力制御]. －Process computer: [power control 出力制御] are selected. □ Note: These conditions are full automatic mode. If computer control is not used, then [power control 出力制御] should be disengaged and manipulation data will be put on FD 12[APR [manipulation 操作].	FD11[RFC master マスタ] FD12[manipulation 操作] FD13[mode-selection モード選択] [automation-console 自動化コンソール]
3	Confirm that BP [power descent 負荷下降Ⅰ] can be selected on CRT 501. □	CRT 501
4	On CRT 501 input following parameters then select [operator confirm 運転員確認]. －target power level 950 MWe －rate of change of the generator power －270 MWe/h □ Note: above values are maximum ones.	CRT 501
5	Select BP39 [power descent 負荷下降Ⅰ] on CRT 501, then push PB [automation progress 自動化進行]. －Confirm that [core flow 炉心流量] window of [generator power control 発電機出力制御] lights on at FD 13. □	[automation-console 自動化コンソール] FD 13[APR モード選択]
6	Observe that core flow decreases and generator power follows to decrease at a specified rate of change. □	CRT 705
7	Confirm that the reactor power change is executed within permissible operating area on the Power-Flow map. □	CRT 705
8	Confirm that automatic power down process halts at 75 % power on FD 13. －[core flow 炉心流量] window of [generator power control 発電機出力制御] lights off. □	FD 13 [APR モード選択]

SDP-1 Power Descent from the rated power (2/2) BP 51 to 52

No.	Guide	Location
9	Verify that following system control modes are as follows: －RFC: [Power control auto 出力制御自動] lights off. －RC&IS: [full-auto 自動] lights on. －APR: [control rod 制御棒] is selected at [generator power control 発電機出力制御]. －Process computer: [power control 出力制御] are selected. □ Note: These conditions are full automatic mode. If computer control is not used, then [power control 出力制御] should be disengaged and manipulation data will be put on FD 12[APR [manipulation 操作].	FD11[RFC master マスタ] FD12[manipulation 操作] FD13[mode-selection モード選択] [automation-console 自動化コンソール]
10	Select BP52 [power descent 負荷下降Ⅱ] then push PB [automation progress 自動化進行. －[control rod 制御棒] window of [generator power control 発電機出力制御] lights on at FD 13. □	FD 13[APRモード選択]
11	Observe that the generator power decreases with a specified rate of change as the control rods are automatically inserted. □	CRT 705
12	Confirm that automatic power down process halts at 50 % power on FD 13. －[control rod 制御棒] window of [generator power control 発電機出力制御] lights off. □	FD 13 [APR モード選択]

SDP-2 Generator off line (1/2) BP 60 to 61

No.	Guide	Location
1	Confirm that the generator power has reached 10% power (136 MWe). □	[automation-consol e 自動化コンソール]
2	Note: This procedure is based on manual mode. In case of the load regulator and load limiter regulation from the process computer, following setting are required: －Select [sequential連動] at [load control負荷制御] and [speed control 速度制御]. －Push PB[EHC load control 負荷制御] on. Push PB[EHC speed control 速度制御](EHC) on. □ In case of automatic generator off line: －Push PB[generator control 電気制御]. □	FD23B[automation -progress 自動化進行] [automation-consol e 自動化コンソール]
3	Select BP60[preparation for generator off line 発電機解列準備]. □	CRT 501
4	Decrease the generator power using the load limiter set point change down to 3% power (approx. 41 MWe) . －Select [▽] of [load limiter 負荷制限] on FD 21 then push action PB of FD. □	FD21[EHC control panel コントロールパネル]
5	Select BP 61[generator off-line, turbine trip 発電機解列、タービントリップ]. □	CRT 501
6	Take the generator out of service by opening the generator breaker. －Push PB[off 切] of 500 kV generator breaker O-26 □	Main Panel
7	Observe that an increase of the turbine bypass valve opening and the reactor pressure is controlled by the TBV on FD 23A [CV/TBV valve test 弁テスト]. □	FD 23A [CV/TBV弁テスト]
8	Confirm that the turbine drain valves are fully opened on CRT [turbine main steam system タービン主蒸気系]. □	CRT [タービン主蒸気系]
9	Disconnect the line switch. －Push PB[off 切] of [500kV Generator line switch 500kv 発電機断路器]. □	Main Panel

SDP-2 Generator off line (2/2) BP 60 to 61

No.	Guide	Location
10	Open the generator field breaker. －Push PB[off 切] of [generator field breaker 発電機界磁遮断器 52E] □	Main Panel
11	Check that following control switches are on [auto 自動] position. －[turbine lift pumps リフトポンプ] No.3 – No.10 －[turbine turning gear 主タービンターニング装置] －[turbine emergency oil pumps 主タービン非常用油ポンプ] □	FD 22[LO] FD22[turbine タービン] Large Panel
12	Start the turbine gear oil pump (TGOP) and motor suction oil pump (MSOP). －Push PB [start 起動] of [TGOP 主ﾀｰﾋﾞﾝｷﾞｱｵｲﾙﾎﾟﾝﾌﾟ]. －Push PB [start 起動] of [MSOP 主ﾀｰﾋﾞﾝﾓｰﾀｻｸｼｮﾝｵｲﾙﾎﾟﾝﾌﾟ] □	Main Panel
13	Trip the main turbine －Push PB[main turbine trip 主タービントリップ]. □	Main Panel
14	Check that following turbine valves are fully closed on FD 23B[MSV/IV/ISVvalve test 弁テスト]: －MSV No.1 – No.4 －IV No.1 – No.6 －ISV No.1 – No.6 －CV No.1 – No.4 □	FD 23B[MSV/IV/ISV 弁テスト]
15	Confirm that Moisture Separator Heater (MSH) has been out of service on CRT □	CRT[MSH]
16	Check that the temperature setting of the turbine lube. oil control has been automatically altered from 46℃ to 32 ℃. □	Back panel
17	Set the maximum [flow limiter 最大流量制限] at 90 % on FD21[EHC control panel ｺﾝﾄﾛｰﾙﾊﾟﾈﾙ]. □	FD21[EHC ｺﾝﾄﾛｰﾙﾊﾟﾈﾙ]
18	Confirm that IPB fans has been stopped on FD [24B/IPB Tr] □	FD [24B/IPB Tr]
19	Transfer generator hydrogen purity monitor into circulation mode. (Local panel) □	Local panel

SDP-3 Reactor depressurization and sub-criticality (1/3) BP 63 to 66

No.	Guide	Location
1	Confirm that the reactor power has been decreased below 7 % power on APRM. □	CRT305
2	Conform the Operation mode. －Select RC&IS Selection Mode Gang-mode [ギャングモード] －Select RC&IS Operation Mode Semi-automation [半自動] Note: Procedures of this guide are based on Semi-automatic mode operation. For full-automatic operation of control rod withdrawal by kick signal from process computer, following steps are required. －Select RC&IS Operation Mode Automation [自動] －Push PB [Power Control 出力制御] □	FD13[mode-selection モード選択] [automation-control 自動化ｺﾝﾄﾛｰﾙ]
3	Select BP 63[reactor mode: startup 原子炉モード起動] on CRT 501 □	CRT 501
4	Check that no scram signals exist. □	ANN
5	After announcement by the paging phone, change over the mode switch from [run 運転] to [startup 起動]. Check that alarm[mode switch out of "run" mode モードスイッチ運転以外] is activated. □	Main Panel ANN
6	Select BP 64[descent of the reactor power 原子炉出力減少 II] . □	CRT 501
7	Insert control rods according to the specified rod sequence. －Push PB [Insert 挿入] □	Main Panel CRT401[control rod position 制御棒位置]
8	Confirm that all control rods have been fully inserted by the window [all control rods full-in 全制御棒全挿入] turning "green" on the mimic display. □	Large panel

SDP-3 Reactor depressurization and sub-criticality (2/3) BP 63 to 66

No.	Guide	Location
9	Start reactor water level control by dumping reactor water through the CUW system. －Select [starting CUW dump CUW ダンプ開始] after select [sequential 連動] on FD14. ·CUW blow down valve(F023) opens. ·CUW controller adjuster output increases ·at deviation "0", CUW controller is in "auto" □	FD14 [CUW+M/D]
10	Verify that the reactor level is maintained at the normal level (1180 mm) by CUW dump valve control during depressurization process. □	CRT 303
11	Select BP 65[reactor mode: refueling 燃料交換] □	CRT 501
12	After announcement by the paging phone, change over the mode switch from "startup 起動" to "refueling 燃交". □	Mode switch
13	Check out before reactor depressurization －Select [sequential 連動] of [pressure control 圧力制御]. －Select PB [Pressure control 圧力制御] on [automation console 自動化コンソール] －Input a target pressure and rate of the temperature change. Note Pressure setting range: 3.2～6.52 MPa Rate of water temp. change setting range: －5～－55℃/hr □	FD 23 B [自動化進行] [Automation consol 自動化コンール] CRT 501
14	Select BP 66[starting reactor depressurization 原子炉減圧開始] □	CRT 501
15	Conform depressurization the reactor by TBV which is controlled by pressure setting following mode. －Window [Reactor depressurization 原子炉減圧] lights on. －Window [Pressure Set 圧力設定] lights on. □	FD23B[automation progress 自動化進行] FD21[EHC-control panel ｺﾝﾄﾛｰﾙﾊﾟﾈﾙ]
16	Check that at a pressure of 6.4 MPa CUW blow line orifice bypass valve (G31-MO-F024) fully opens. □	CRT[CUW]

SDP-3 Reactor depressurization and sub-criticality(3/3) BP 63 to 66

No.	Guide	Location
17	Confirm that at a pressure of 4.14 MPa alarm [MSIVclosure bypass 閉バイパス] is activated. □	[Important alarm]
18	Confirm that at a pressure of 3.9 MPa following drain valves fully open on CRT [NB&MSIV]: －first drain bypass valve(B21-MO-F007) －second drain bypass valve(B21-MO-F010) －main steam line warming valve(B21-M0-F012) □	CRT [NB&MSIV]
19	Confirm that the reactor has been depressurized down to 3.9 MPa. □	Large Panel

SDP-4 Starting reactor shutdown cooling

BP 71

No.	Guide	Location
1	Confirm that the reactor has been depressurized down to 0.98 MPa. □	
2	Select BP 7 1 [reactor shutdown 原子炉停止] on CRT 501. □	CRT 501
3	Start RHR piping flushing at a pressure of 0.93 MPa as per RHR system operating procedure. □	Refer to RHR system operating procedure
4	Start RHR piping warming at a pressure of 0.76 MPa as per RHR system operating procedure. In case of skipping flushing and warming process at this training, then take following steps shown below: －additionally start one more pump for RSW and RCW respectively (two pumps in service for each system) －let cooling water through RHR heat exchanger at a flow rate of 1,200 m3/hr by opening RHR heat exchanger outlet valve (F013) －close RHR suppression pool suction side isolation valve (MO-001) －close RHR minimum flow valve (MO-F021A) □	Refer to RHR system operating procedure FD 03[RCW,RSW] FD 03 [RHR (A)]
5	At a pressure of 0.69 MPa line up RHR (A) system for shutdown mode as follows: －reactor side suction valve(MO-F012A): open －SHC mode outboard isolation valve (MO-F011A) : open －SHC mode inboard isolation valve (MO-F010A) : open □	 FD 03 [RHR (A)] FD 02 [LDS (B)] FD 03 [RHR (A)]
6	Start RHR (A) system for shutdown cooling mode (SHC) －Select PB [sequential 連動] at [RHR(A) master マスタ] －Push PB [SHC starting 起動] □	Main Panel
6a	Observe that following actuations occur: －RHR Hx bypass valve(MO-F013A) fully closes －RHR Hx outlet valve(MO-F004A) fully closes －RHR injection valve (MO-F005A) fully opens －RHR pump (A) starts and the fill system pump trips. －RHR Hx bypass valve(MO-F013A) gradually opens. (hold for 10 minutes at a flow of 400m3/hr then open the valve to take more than 650 m3/hr) □	CRT [RHR(A)]
7	Adjust flow rate so as to keep a specified cooling rate using Hx outlet valve (MO-F004A) and Hx bypass valve (MO-F013A) while the flow rate should be maintained below the rated flow rate (954 m3/hr). □	FD 03/ RHR(A)
8	Repeat same steps for RHR(B) and (C) system if required.	

附件三：

Performance Evaluation Sheet for Start up Operations

Examiner:_____

Examinee: (Electric Power Company)

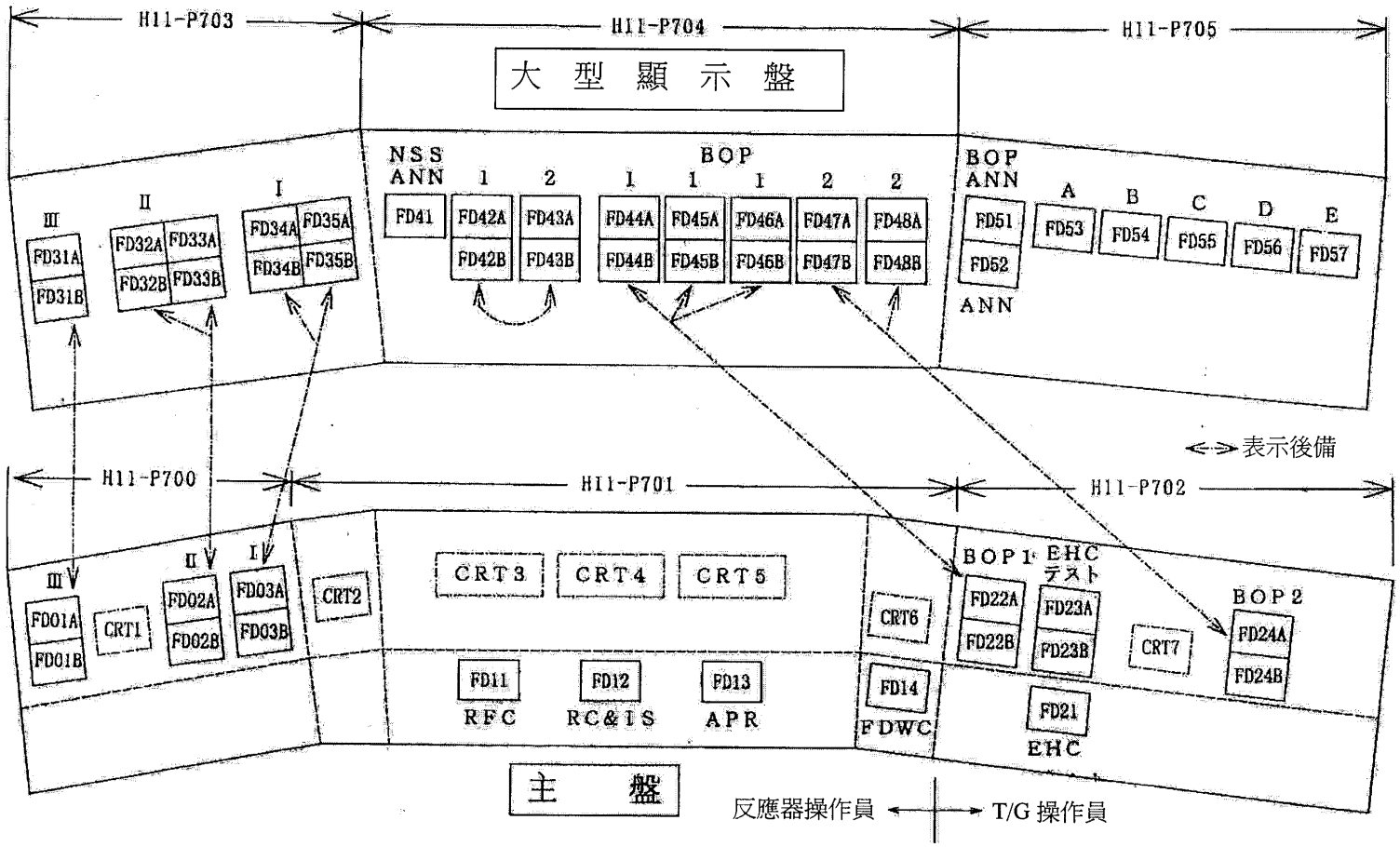
Date of Examination:Month:_____Date:_____,2003 Time:___:___～___:___

Standard	Points	Deduction	Checking Points	Remarks
Ability to Operate To reach To critical Condition and Control adequately	5	1	Selection of appropriate CRT and FD for reactor startup to attain criticality.(302,306, 401 and 402)	
		2	Confirmation of SRNM count rate exceeding 103 cps	
		2	CR withdrawals without recognition of the reactor period being in stable condition	
		3	Continuous CR withdrawals or withdrawals out of sequence	
		2	CR withdrawals without checking SRNM indications	
Ability to Operate Without Unnecessary Alarms	5	1	Causing Rod blocks	
		1	Causing SRNM "Short period" or "Short-Short Period"	
		1	Causing SRNM Automatically CR withdrawal Block	
		1	Causing reactor water level "High/Low"	
		3	Causing reactor scram	
Ability to Judge the Reactor Condition as Critical or not Adequately	5	1	Confirmation of the reactor period meter indicating a positive period	
		1	Confirmation of continuous increases of the SRNM trend and count rate on the indicators	
		5	Unable to judge criticality while the reactor being in critical condition	
		2	No time available for criticality judgment or unable to calculate for criticality judgment	
		5	Miss-judging criticality while the reactor not being in critical condition.	
Abitity to Record Necessary Data at Reactor Critical condtition	5	1	Time of attaining criticality	
		1	CR positions(CR group & CR number)	
		1	Data on period measurement	
		1	SRNM indications(count rate)	
		1	Printing CR position(OD-7)	
		1	Reactor coolant temperature(on the large display pane panel)	

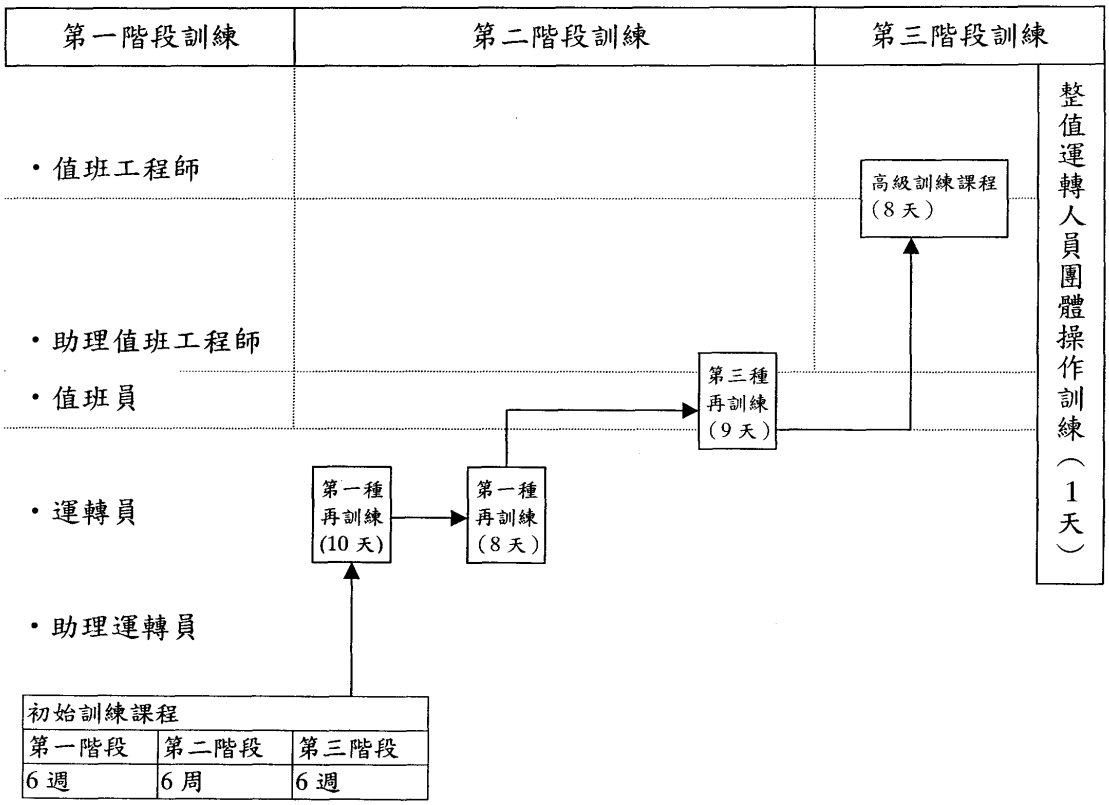
Performance Evaluation Sheet for Start up Operations

Standard	Points	Deduction	Checking Points	Remarks
Ability to Check related Plant Parameters And report them adequately	5	0.5 for each item	—No confirmation on the followings before CR withdrawal: - Alarm status - Existence of the channel bypasses on SRNM, APRM, MRBM and RWM - SRNM indications more than 3 cps CRD flow - Reactor coolant temperature - HCU accumulator abnormal indication lamp off - Mode switch position	
		1 for each item	Incomplete confirmation of the related parameters during CR withdrawals: - Filtered Period - SRNM count rate - SRNM trend indications - Reactor water level - Reactor pressure - Reactor water water temperature	
		1	Incomplete identification on the CR position and lack of pointing at/calling out manner before and after CR withdrawals	
		1	Incomplete or lack of pointing at/calling out on the SRNM indicatons and trend after CR withdrawals.	
		1	No recognition on the scale differences between odd and even ranges, and no pointing at/calling out on it.	
		1	No reporting on the SRNM indications after SRNM range alterations.	
		1 for each	No paging before starting CR withdrawals and attaining criticality	
		1 for each	No reporting to the shift foreman before starting CR withdrawals and attaining criticality	

圖一：主控制室圖



圖二：主控制室盤面佈置圖



圖三 ABWR 運轉人員訓練架構