

核四廠一號機安全釋壓閥洩放管路(SRVDL)
系統查證研究報告

楊慶威

核 能 研 究 所

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A Study of Safety Related System Inspection on SRVDL System of
Taipower's Fourth Nuclear Power Plant Unit 1

By

Ching-Wei Yang

ABSTRACT

The Safety Relief Valve Discharge Line (SRVDL) system is designed to direct RCPB (Reactor Coolant Pressure Boundary) abnormal high pressure steam into the suppression pool to maintain the integrity of RCPB. There are eighteen Safety Relief Valves (SRVs) on Main Steam Lines (MSLs) in Taipower's Fourth Nuclear Power Plant unit 1. It performs four functions (1) safety function (2) relief function (3) manual function (4) Automatic Depressurization System (only eight SRVs). There are two vacuum breaker check valves equipped on each discharge line in order to prevent partial vacuum occurred in the discharged line. Also, there is a quencher setting on the end of each discharged lines.

The referenced documents, such as ASME Code, material specifications, purchase specification and design report, drawings etc., were collected in advanced. The Quality Record Packages (QRPs) of the Safety Relief Valves, Piping, penetration, Vacuum Breaker Check Valves, Quenchers and also the system related documents were reviewed to conform the integrity of those safety related components and the SRVDL system as well.

Keywords: Safety Relief Valve Discharge Line (SRVDL) system, Safety Relief Valve (SRV)

Institute of Nuclear Energy Research

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摘 要

安全釋壓閥洩放管路主要設計功能為導引壓力邊界異常高壓蒸汽至抑壓池以維持壓力邊界完整性。核四廠主蒸汽系統(Main Steam Line)管路上，安裝 18 只安全釋壓閥(Safety Relief Valve)，安全釋壓閥具備安全功能、釋放功能、手動功能，其中八只並具有自動釋壓功能，每只安全釋壓閥出口銜接洩放管(Discharge Line)，將反應爐高壓蒸汽藉由深入抑壓池之冷管嘴噴灑入池水中，使蒸汽急速冷却以降低壓力。同時此系統為了防止洩放管因蒸汽冷凝形成局部真空，引起抑壓池水進入洩放管內，造成釋壓閥洩放管部份積水，再度釋放時將造成安全釋壓閥背壓過高，設計於上乾井部位的洩放管路上裝置兩只真空破壞止回閥，以破除安全釋壓閥釋放蒸汽冷卻後產生之局部真空。

安全釋壓閥洩放管路是為滿足上述設計需求之重要組件，查證作業執行方式為：收集研讀安全釋壓閥之法規規範、材料規範、設計報告、設計圖面、採購規範等參考文件，據以查證其品質文件之完整性與正確性。其次，系統相關文件亦為查證重點。上述系統查證研究結果彙整於本報告中。

關鍵字：安全釋壓閥洩放管路、安全釋壓閥

核能研究所

目 錄

頁次

1. 前言	1
2. SRVDL 系統介紹	3
3. 系統重要設備、管路品質文件查證	9
4. 系統重要設備、管路現場查證	49
5. SRVDL 系統文件查證	52
6. 結論與建議	59
誌謝	64
參考文獻	65

圖目錄

頁次

圖一：主蒸氣管上之安全釋壓閥配置示意圖 4

圖二：安全釋壓閥相關組件立體圖5

圖三：穿越器48

表目錄

	頁次
表一：安全釋壓閥洩放管品質文件查證表	20
表二：安全釋壓閥洩放管非破壞檢驗報告查證表	21
表三：SRVDL 不銹鋼管件對接銲道非破壞檢測執行狀況 統計表.....	22
表四：驟冷管嘴非破壞檢驗文件查證表.....	41

1. 前言

建立核能電廠建廠期間重要安全相關系統、組件視察技術能力，為「核設施安全審查與稽查技術精進」計畫之重點工作項目之一。核研所核四建廠安全管制支援專案計畫(以下簡稱核四專案)配合原能會核管處政策指示與規劃，先後完成「核四廠餘熱移除系統熱交換器(RHR Hx)品質文件查證報告」、「核四廠一號機主蒸氣隔離閥(MSIV)品質文件查證報告」及「核四廠一號機反應爐壓力容器品質文件查證報告」，藉由上述選定之重要安全設備之品質文件查證作業建立視察技術能力，深入查證該設備之製造品質是否符合相關法規規範，並將查證結果彙整為報告，陳報原能會核管處作為管制參考。

93 年度起，核四專案同仁藉由累積之重要安全設備之品質文件查證作業技術能力，研擬進一步精進視察技術能力，將查證範圍由設備類組件品質文件查證擴大至重要安全相關系統查證，查證範圍除持續執行系統重要安全設備之品質文件查證外，亦選定系統中部份管件、管閥類組件之品質文件作為查證標的。此外，將系統相關之設計文件列入查證範圍，深入研究其設計與運轉功能，以期能持續精進核能電廠建廠期間之視察技術能力。重要安全相關系統查證視察能力之建立，其目的不僅對於確保建廠期間系統設計及組件品質有正面效益，亦期望能提供原能會日後電廠商業運

轉後安全管制之參考。

接續前述主蒸氣隔離閥(MSIV)品質文件查證作業，本報告選定主蒸氣系統之安全釋壓閥洩放管路(SRVDL)為視察研究查證之系統，重要安全設備、組件之品質文件查證則選取兼具自動釋壓(Automatic Depressurization System，ADS)之安全釋壓閥及其洩放管路、管閥為標的。本報告亦將陳報原能會核管處參考。

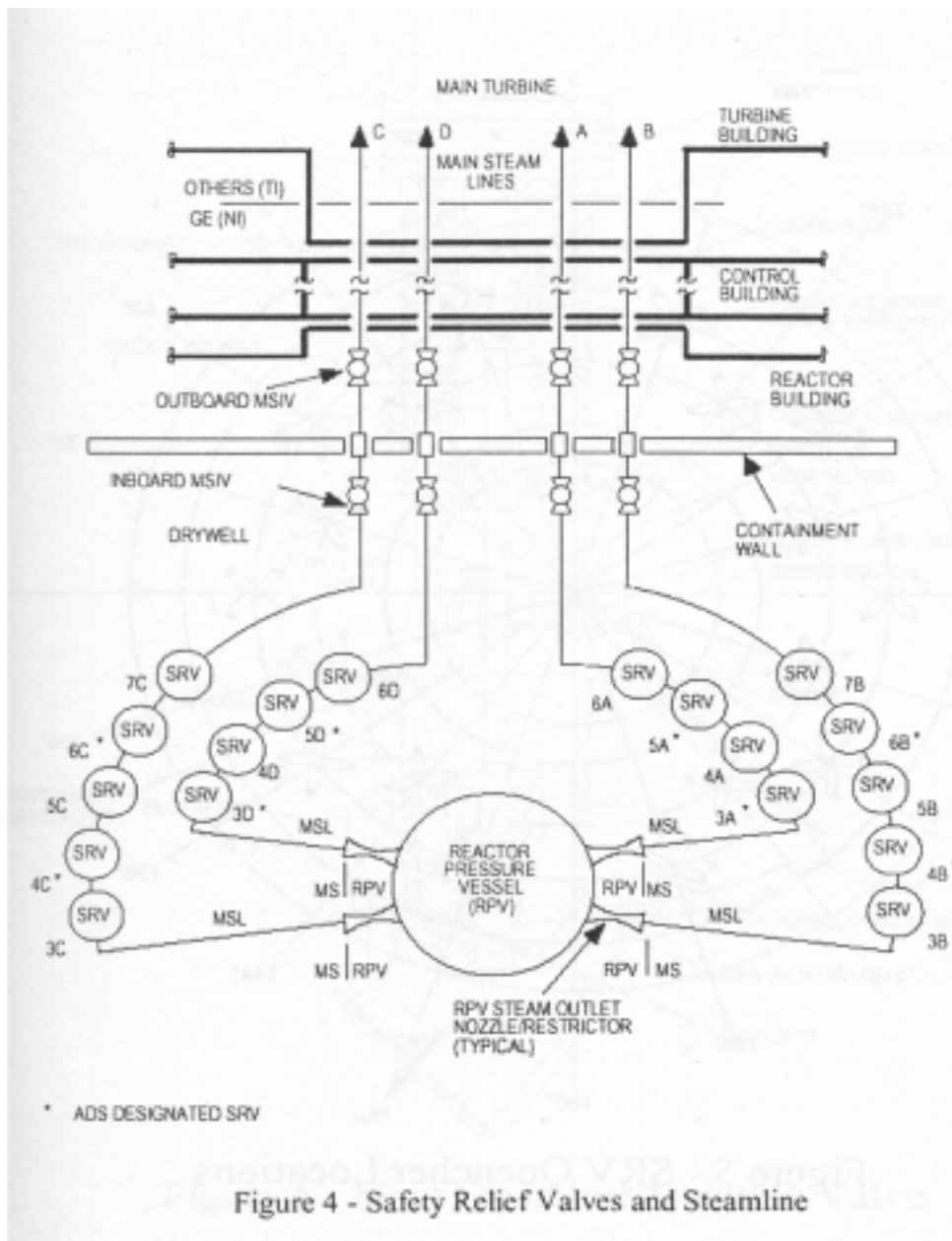
2. SRVDL 系統介紹

2.1 系統總論

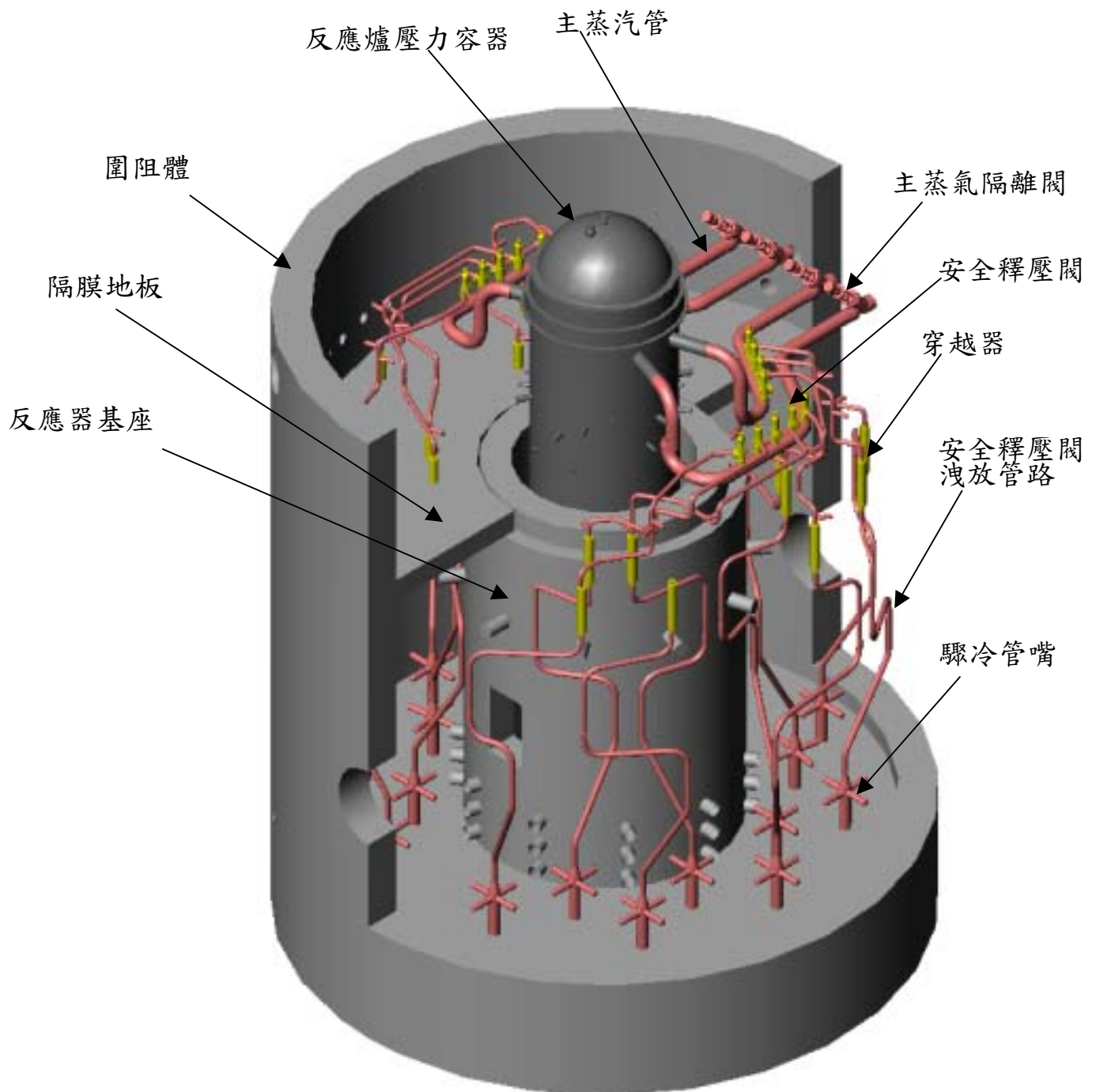
核四廠安裝兩部機組，每一部機組有一座反應爐，每一座反應爐有四條主蒸氣管路，圍阻體內之主蒸氣管路共配置 18 只安全釋壓閥 (Safety Relief Valve, SRV)及洩放管路(Discharge Line, DL)，其中 8 只具備自動釋壓 (Automatic Depressurization System, ADS)功能。圖一為主蒸氣管上之安全釋壓閥配置示意圖。圖二則是將反應爐壓力容器(RPV)、反應器基座 (Pedestal)、主蒸汽管(Main Steam Line)、安全釋壓閥洩放管路(SRVDL)、隔膜地板(Diaphragm Floor)、圍阻體內主蒸氣隔離閥(Inboard MSIV)、圍阻體(RCCV)等重要結構、系統、組件相關位置，以立體圖方式表現。

安全釋壓閥洩放管壓力邊界內主要組件由上而下分別是，安全釋壓閥(Safety Relief Valve, SRV)、真空破壞止回閥(Vacuum Breaker & Check Valve)、碳鋼洩放管路、穿越器(Penetration)、不銹鋼洩放管路、驟冷管嘴(Quencher)等安全相關設備、組件。SRVDL 系統主要功能為提供反應爐過壓保護，當核能系統運轉壓力過高，安全釋壓閥之安全(Safety)功能即自動開啟；或因主蒸氣隔離閥關閉導致瞬間過壓，安全釋壓閥之釋壓(Relief)功能將依預先設定先後開啟；安全釋壓閥亦可由控制室手動操作，當汽機主冷凝器因 MSIV 關閉而不能使用時，可手動開啟該閥以降低爐壓。

安全、釋壓及手動模式均將過壓蒸氣經釋放管路導引至抑壓池中，由驟冷管嘴將釋放蒸氣均勻噴出。SRVDL 系統中 8 條具備自動釋壓功能之 SRVDL 管路系統則另兼具持續洩放反應爐槽壓力，使低壓注水系統能發揮功能之目的。



圖一：主蒸汽管上之安全釋壓閥配置示意圖



註：真空破壞止回閥未在本圖中標示，其安裝位置位於上乾井之碳鋼管路歧管上。

圖二：安全釋壓閥相關組件立體圖

2.2 壓力邊界上主要組件簡介

2.2.1 安全釋壓閥(Safety/ Relief Valve, SRV)

核四廠的安全釋壓閥分類為 ASME Sec. III, Class 1，由 Target Rock Corporation 公司製造的碳鋼角球型閥，型號 8-1500 X 10-900，分為主體(Body)、閥座(Seat)、閥帽(Bonnet)、彈簧組(Spring Assemble)、致動氣缸組(Actuator Cylinder Assemble)等主要元件，為反應爐過壓保護設備之一，安裝於上乾井的主蒸汽管上，為了方便於電廠大修時之拆解，進出口均為法蘭接頭，進口和主蒸汽管用螺栓鎖住，其功能有：

(a)安全功能：

核能系統壓力過高，可能導致反應爐冷却水壓力邊界(Reactor Coolant Pressure Boundary, RCPB)損壞。當反應爐壓力上升，作用於閥盤之蒸汽推力大於彈簧之設定壓力時，閥盤被蒸汽向上推，反應爐蒸汽便經由閥盤與閥座間沖放，過壓蒸氣經洩放管路導引至驟冷管嘴，將蒸氣均勻噴入抑壓池中，由此可限制反應爐蒸汽壓力過高，使其不超過 ASME 設計規範。安全功能亦可作為釋放功能的後備。

(b)釋壓功能：

為防止核能系統於全功率運轉下因 MSIV 關閉導致瞬間過壓，反應爐壓力上升至釋壓沖放之壓力設定值時，壓力開關將產生訊號使安全釋壓閥所附之直流電磁激磁開啟，引導儀用氮氣進入致動氣缸藉由機械結構施力以克服 SRV 彈簧壓力使閥開啟。

(c)手動功能:

安全釋壓閥可由控制室手動操作，當汽機主冷凝器因 MSIV 關閉而不能使用時，可手動開啟該閥以降低爐壓。

(d)自動釋壓功能(ADS):

十八只安全釋壓閥，其中有八只具有自動釋壓功能。每只具有自動釋壓功能之安全釋壓閥均設有兩組電磁閥，接受邏輯電路控制信號，任何一組電磁閥動作均可供給氮氣至致動氣缸以開啟有 ADS 之安全釋壓閥，其設計目的在於洩放反應爐壓力使低壓注水(LPCF)系統能發揮其功能。

2.2.2 真空破壞止回閥(Vacuum Breaker Check Valve)

每一條安全釋壓閥洩放管路安裝有二只真空破壞止回閥，引導上乾井內空氣進入洩放管路，以防止沖放後蒸汽在管內冷凝而形成真空，致使抑壓池水倒灌入洩放管路，如果安全釋壓閥洩放管路積水，再次開啟時可能導致再度排放時之背壓增加。

2.2.3 碳鋼及不銹鋼洩放管路

安全釋壓閥出口和洩放管以法蘭銜接，方便電廠大修時拆解檢修之用，在上乾井為碳鋼管(SA106 GR B)，管路上銲接有二只真空破壞止回閥，碳鋼管銲接在隔膜地板的不銹鋼穿越器。不銹鋼穿越器下方為濕井，管路材質為不銹鋼(SA312 TP316L)，深入抑壓池之最低水面 3 公尺下，與驟冷管嘴漸縮管銲接。

2.2.4 穿越器(Penetration)

穿越器為不銹鋼製，預埋安裝在隔膜地板內。

2.2.5 驟冷管嘴(Quencher)

驟冷管嘴為不銹鋼材質，由主體(Body)、基座(Pedestal)、漸縮管(Reducer)和十字管臂(Arms)組成，每支管臂有 374 個 9.9mm 的小孔，四支共有 1496 個小孔，驟冷管嘴上方的漸縮管與不銹鋼管銲接，下方的基座(Pedestal)銲接於抑壓池的支撐墊板(Spacer Plate)上。安全釋壓閥釋放的過壓蒸汽經由碳鋼、穿越器、不銹鋼管、驟冷管嘴的十字管臂，將過壓蒸汽由小孔往各方向噴出，均勻分佈於整個抑壓池，驟冷管嘴四支管臂上 1496 個小孔之特殊設計，具有降低蒸汽沖放時可能產生之震動，並可充分提高其蒸汽冷凝效率。

3. 系統重要設備、管路品質文件查證

3.1 SRV 品質文件查證

原 SRVDL 系統查證計畫中預計將由 18 台安全釋壓閥(SRV)中，挑選具代表性之 5 台不同 Safety setting pressure 之 SRV 作為品質文件查證標的，經聯絡品質課請其準備相關組件品質文件時，品質課告知 SRV 尚未交貨，目前無法提供其品質文件。依據汽源課提供之相關資料顯示，Target Rock 承包設計製造之 SRV 原型閥(Prototype valves)於 Wyle Laboratories 執行環境(EQ)及地震(SQ)測試時發生相當多不符合項目，台電公司委託之石威公司見證人員 Gene S. Johnson 於 91 年間執行 3 次見證並簽發多份 NUC(Notice of Unsatisfactory Condition)要求 GE 公司追蹤處理。台電公司初步判定其肇因應與設計相關，正依相關程序處理中。建議正式交貨後，可將 SRV 品質查證列為重點視察項目，以確認其設計及製造品質符合要求。

3.2 Vacuum Breaker 品質文件查證

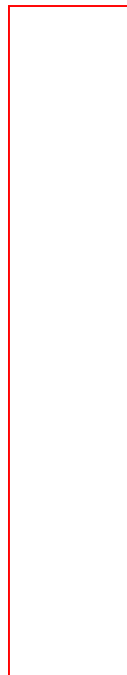
查證 1B21-AV-0015A 、 1B21-AV-0015B 、 1B21-AV-0015C 、 1B21-AV-0015D、1B21-AV-0016A、1B21-AV-0016B 等六台 Vacuum Breaker 品質文件資料，閥體(Valve Body)為其最主要之壓力承持組件，查證結果整理於下：

3.2.1 Valve Body 材料為 SA216-WCB，符合 Purchase Specification 2A.6.1 規定。查證材料測試報告(CMTR)，化學成分(Chemical Composition) 分析與機械性質(Mechanical Properties)測試結果符合 ASME Sec II SA-216/SA-216M 材料規範相關規定。

3.2.2 Vacuum Breaker 品質文件含 ASME NPV-1 Data Report，符合 ASME Sec III NCA-8000 要求，但視察發現依據 Valve Body 之 CMTR，其 Valve Body 之識別應包括其 Heat Serial 及 Body Serial 二個號碼(附件一)，但是 NPV-1 Data Report 中僅登錄 Body Serial No. (附件二)，文件查證過程中無法確認其相對關係，與品質文件具可追溯性之要求似有不符。

3.2.3 Valve Body 材料 SA216-WCB 為鑄造件，進口連接管徑為 10 英吋，依據 ASME Sec III Table ND-2571-1 規定：鑄造件之 Quality Factor 為 0.8 僅須執行目視檢驗(VT)；Quality Factor 為 0.85 則須執行液滲或磁粒檢驗(PT or MT)；Quality Factor 若為 1.00 則必須執行射線照相或超音波檢驗(RT or UT)，PT、MT 檢驗為可自行選擇(Optional)之檢驗項目。查證其品質文件發現，Valve Body 僅有執行 VT 之檢驗紀錄(附件三)，且無鑄造件之 Quality Factor 數據可供證明其已執行之檢測符合 ASME Sec III Table ND-2571-1 規定。

附件一 Heat Serial and Body Serial No in CMTR



附件二 Body serial No only in NPV-1 Data Report



QUAKER ALLOY, INC.

MYERSTOWN, PA 17067

CERTIFICATE OF ACCEPTANCE ON QUALITY EXAMINATION AND INSPECTION

CUSTOMER FLOWERVE PCD CORPORATION PURCHASE ORDER W2000 CONTRACT 10" 300M WE BODY
 PATTERN 1-100-558 DRAWING 8-110-055-5 R1- DESCRIPTION 10" 300M WE BODY
 MATERIAL SPECIFICATION ASME SA216 GR. WCB GRADE WCB Q DESIGNATION WCB
 HEAT E4775 CASTING SERIAL -1 R.T.U.T. SERIAL 44616 SHOP ORDER 44616 JOB FILE
 NO. PIECES 1 SOURCE INSPECTION QUALITY SYSTEM R/19 DATED 2/20/98 & NCA3800
 ASME B&PV SECT. III CODE, 19 89 EDITION, THRU 19 ADDENDA NUCLEAR CLASS NOT

VERIFICATION AND CERTIFICATION

REQUIRED	EXAM/INSPECT	APPROVED PROCEDURES	SIGNATURE*	LEVEL*	DATE
100% (Mac. Feasible Coverage) PARTIAL OTHER	☐ RADIOGRAPHY ☐ ULTRASONIC				
100% (Mac. Feasible Coverage) PARTIAL PARTIAL (REPAIRS ONLY)	☐ MAG. PARTICLE ☐ WET ☐ DRY ☐ PENETRANT**				
X	VISUAL	MS-SP-55 1980 ED. INR QAB-V-01-06 RS	J. Schuchert #	9-16-99	
X	DIMENSIONAL	8-110-055-5 R1- PARTIAL	J. Briguich	9-16-99	
RANGE	BRINELL HARDNESS	ITIN			

ALL VERIFICATION RECORDS MUST BE MAINTAINED ACCORDING TO SNT-TC-1A, NATA-2001-1, OR ME-STD-271, OR ME-STD-271 ARE MAINTAINED AND ON FILE FOR
 REQUEST. ALL ACCEPTED PROCEDURES AND MATERIALS USED MEET THE REQUIREMENTS OF APPLICABLE CODES. MATERIAL CERTIFICATIONS OF ANALYSIS ARE
 AND ON FILE FOR ME-STD-271 REQUEST.

THE CORRECTED COPY OF THIS CERTIFICATE OF ACCEPTANCE ON QUALITY EXAMINATION AND INSPECTION
 WILL BE FURNISHED TO THE MATERIAL USER UPON REQUEST.

FORM 113 REV. 5/89

DATE
9-24-99

SIGNATURE
Paul Klein

DATE
9-16-99

SIGNATURE
J. Schuchert



3.3 洩放管路品質文件查證：

3.3.1 不銹鋼管材質查證

位在濕井及抑壓池內的安全釋壓閥排放管為不銹鋼管，其材質規範為 SA312 Type 316L，管徑有 12”及 10”Sch 60 無縫鋼管兩種，該管路係依據 ASME Sec III Subsection ND, Class 3 設計。

不銹鋼管材料測試證明(Certified Material Test Report, CMTR)的查證係依據 ASME Section II Material Specification Part A---Ferrous、採購規範(Purchase Specification for Shop Fabricated Piping – ASME III Class 2 and 3)，製造及檢驗依照 ASME Section III Subsection ND 以及 Piping Isometric 的規定。

安全釋壓閥排放管共有 18 條，選擇具有 ADS 功能，較有代表性之一條作為查證之重點，檢查項目有不銹鋼管材的化學分析、機械性質、水壓測試、熱處理、肘節管(Elbow)以機械彎曲製成，其圓度公差依照 ND-4223.2 Ovality Tolerance 規定檢驗，查證結果如安全釋壓閥洩放管品質文件查證表(表一)，其查證結果及依據文字簡述如下：

- (a) 品質文件 D-7-C-1 (PSP-0254)Page 2 – 9/36 頁的 Customer Po # 誤繕寫為 7739-008 unit2 (附件四)。
- (b) 依照 Material and Process Requirements for ASME Sec. III, Class 1, 2, 3

Piping Standard Equipment Requirements 的 3.8.6 節 Welding of Austenitic Stainless Steel 不銹鋼材可用 Type 308L 或 316L 等銲材，但 SRVDL 的材質為 SA312 TYPE 316L，從合金元素的匹配性應以 316L 較為合理。雖然銲材之 CMTR 未附於品質文件中，然而製造商之工程傳票(Traveler) (附件五) 中記載之銲接程序書 (附件五-1)顯示，SRVDL 不銹鋼管對接銲道使用 Type 308L 銲材，母材與銲材之匹配性與一般銲接工程實務並不吻合，建議請製造廠家提出選用 308L 銲材之考量。

3.3.2 洩放管非破壞檢驗文件查證:

安全釋壓閥洩放管是由安全釋壓閥出口至驟冷管嘴間的連接管，位於上乾井的洩放管為碳鋼管銲接組裝而成，藉不銹鋼穿越器與濕井的不銹鋼管銲接而成，所有的銲道應依照 ND-5222 執行非破壞檢驗。肘節管 (Elbow) 以機械彎曲製成，其最小壁厚依照 ND-4223.1 Minimum Wall Thickness 之規定檢驗，查證結果如安全釋壓閥洩放管非破壞檢驗報告查證表(表二)，其查證結果及依據文字簡述如下:

- (a) 1B21-PSP-004 超音波檢測報告中彎管有些管壁厚度低於規定最小值 (附件六)，BF Shaw 公司自行開立 NCR-1453 (附件七)，並通知 GE 公司要求解釋，GE 回覆文件 DDR-62.2213.1-8 (附件八) 中認為 BF

公司所量測之彎管厚度值仍然符合 B&V 公司 31113-0A10-2102 Rev.1 中之厚度需求 (0.475")。故該管件仍符合規定要求。

- (b) 由安全釋壓閥洩放管非破壞檢驗報告查證表(表二)中可以歸納出，製造廠家對於表面檢測方式之選擇原則為，碳鋼材質選擇靈敏度較高之 MT 檢驗方法，對於非鐵磁性之 316L 不銹鋼管件，因限於磁粒檢驗無法檢測非鐵磁性材料，因而選擇以 PT 作為表面檢測之方式。碳鋼管件 1B21-PSP-004 製造圖面上 NDE 的記錄為 PT (附件九)，但實際之檢測報告為 MT (附件十)，雖並不影響設備品質，建議仍應修正以符合現狀。且製造圖面為制式格式，其餘碳鋼管件應存在相同問題，建議應一併修正。
- (c) 管件對接銲道之 NDE 的記錄有 PT、MT 及 VT，符合 Class 3 管件非破壞檢驗要求。

上述管件之非破壞檢驗作業基本上以符合 ASME Sec III Subsection NC 相關規定，滿足 Code minimum requirement 為安全相關系統設備組件之最低要求，而 PSAR Commitment 屬於 Licensing requirement，滿足 PSAR 承諾事項亦為台電公司之責任與義務。查閱 PSAR 對於 SRVDL 系統之特殊規定，發現 PSAR 3.9.3.1.13 Safety Relief Valve Piping and Quencher 章節中明確記載：「SRVDL 管路製造規範需遵循

ASME Class 3，但是濕井內抑壓池上之不銹鋼管路銲道非破壞檢測則須依 Class 2 之要求執行」(附件十一)，此項規定將其 NDE 檢測需求由 Class 3 升級(Upgrade)至 Class 2，已超過 Code requirement 之規定。Class 3、Class 2 管路銲道非破壞檢測分別是：依據 ASME Sec III ND-5222，管徑公稱大於 2 英吋之 Class 3 管件銲道需執行之非破壞檢測至少必須執行液滲(PT)、磁粒(MT)或射線照相(RT)三種檢測方式之任一種(附件十二)；依據 ASME Sec III NC-5222(a)，所有 Class 2 管件對接銲道(butt weld)必需執行 RT 檢測(附件十三)。另查證 GE 公司之 ASME Code Section III Class 2 and 3 Piping Design Specification，發現上述 PSAR 3.9.3.1.13 之特別規定並未明示於該採購規範中，因 SRVDL 系統濕井內之不銹鋼管路銲道均屬於對接銲道，且依據表二之查證結果，對接銲道並未執行 RT 檢測，核四專案遂全面清查濕井內 72 支 SRVDL 不銹鋼管件品質文件，將廠製部分對接銲道非破壞檢測執行狀況作成統計表(表三)，發現 PSAR 3.9.3.1.13 之 Class 2 非破壞檢測承諾並未落實，72 支 SRVDL 不銹鋼管件對接銲道非破壞檢測作業為 VT 及 PT，品質文件中未發現對接銲道之 RT 紀錄或報告。

GE 公司曾於去年(2003)主動提出一、二號機 RHR 熱交換器 Shell Weld Intersections 未執行 PSAR 要求之 RT 檢測，並以 AUT(自動超音波

檢測)取代 RT 檢測，以留下符合法規規定之永久保存資料。原能會對於此一案件相當重視，要求台電公司全面清查 PSAR 超過法規之檢驗要求是否均已落實，而台電公司於今年(2004)六月份之龍門核管會議中答覆指出：「對於奇異公司的清查結果，經本公司審慎評估後，確定奇異公司對於 ASME 法規以外 PSAR 之特殊要求事項皆已做適當處理以符合 PSAR 要求。」。PSAR 中對於 SRVDL 之 Class 3 不銹鋼管路要求須符合 Class 2 管路非破壞檢測承諾並未落實，已於本次查證研究中證實，因該批管件均已移入濕井內，待 RPV Setting 及 EL 12300 隔膜地板完工後，恐有增加檢測困難之可能性，此項發現有其一定之時效性，核四專案立即於 93 年 8 月 16 日填報「核研所核四支援小組視察發現缺失通報表」，INER-LM-93-009(附件十四)，依程序向原能會核管處通報。

全面清查濕井內 72 支 SRVDL 不銹鋼管件品質文件過程中，另亦發現部分 ISO 圖中有標示銲接記號之管件，其製造圖(shop drawing)中顯示該段管件廠製作業中並無管件對接之銲接作業，係由單一管件材料依設計圖彎製而成，SRVDL 不銹鋼管件對接銲道非破壞檢測執行狀況統計表(表三)中備註欄位中標示為 NBW-1 之管件均屬此類，此類管件均屬各條 SRVDL 洩放管路中隔膜地板下方的第一支不銹鋼管件為其另一共同點。以工程角度而言，單一管件只要其長度符合設計要求，取代原須由

二段以上管件銲接而成之管件，應屬較佳之設計，清查過程中發現部分單一管件長度超過 20 英尺，然而一般實務上單一管件合理長度應在 6 公尺(約 20 英尺)以下(附件十五)，建議此部分應請製造商先行確認澄清，如果該類 NBW-1 管件事實上確由單一管件材料依設計圖彎製而成，則建議 ISO 圖中相關管件之銲接標示應予以修正，以符合現況及品質文件正確性之品保需求。其次，製造商之工程傳票(Traveler)中顯示部分管件端口位置有 Build up 銲接作業(附件十六)，一般而言，Build up 銲接之目的為彌補工件尺寸之不足，此部分 Build up 銲接作業之目的為增加管件長度？或是修正管件端口內徑呎吋？或另一種可能是管件端口開槽部位發現瑕疵後之補銲作業？建議請廠家說明澄清。

表一：安全釋壓閥洩放管品質文件查證表

JOB No:7738-42

SYSTEM: 1B21

Class: 3

SA312 TYPE 316L

Piece Mark No.	Sketch No.	.MATERIAL CERTIFICATION.												Bend PT	Bend. Report	Weld metal CMTR (Note 1)	Remark
		Mill Heat No.	Chem. Comp.	Tensile >70000	Yield >25000	Elong 35Min	Flatten	Sensiti. 5%Max	Grain Size >=3	Hard. Rb92 Max	IGA 0.001” Max	Hydo.	Heat Trea.				
PSP-0139	893	31509	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	缺	
PSP-0138	892	31638	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	缺	Reducer
		31509	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	缺	
		J9524	✓	✓	✓	✓	N/A	✓	N/A	N/A	✓	N/A	✓	N/A	N/A	N/A	
PSP-0254	894	31654	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	N/A	
PSP-0137	891	31638	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	缺	
		31638	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	缺	

說明： 1. Note (1) 參考 3.3.1(b)

表二：安全釋壓閥洩放管非破壞檢驗報告查證表

項目	BEND			Thickness Before & After Bend	Butt Weld			100%	備註
檢測方法	PT	MT	RT	UT	PT	MT	RT	VT	
1B21-PSP-0137	V			V	V			V	SS
1B21-PSP-0138	V			V	V			V	SS
1B21-PSP-0139	V			V				V	SS(無銲道)
1B21-PSP-0254	V			V				V	SS(無銲道)
1B21-PSP-0004				V		V		V	CS(No Bending)
1B21-PSP-0005		V		V		V		V	CS
1B21-PSP-0316									CS (Flange Fitting) (無銲道)

表三：SRVDL 不銹鋼管件對接銲道非破壞檢測執行狀況統計表(1/3)

ISO 圖號	管件編號	銲道檢測方法			備註
		VT	PT	RT	
1B21-M4103	PSP-0213				NBW-1
	PSP-0214	Y	Y	N	REDUCER
	PSP-0215				NBW
	PSP-0216	Y	Y	N	UWS
1B21-M4104	PSP-0209				NBW-1
	PSP-0210	Y	Y	N	REDUCER
	PSP-0211				NBW
	PSP-0212	Y	Y	N	UWS
1B21-M4105	PSP-0195	Y	Y	N	
	PSP-0194	Y	Y	N	REDUCER
	PSP-0284				NBW
	PSP-0193	Y	Y	N	UWS
1B21-M4106	PSP-0192	Y	Y	N	
	PSP-0190	Y	Y	N	REDUCER
	PSP-0268				NBW
	PSP-0189	Y	Y	N	UWS
1B21-M4107	PSP-0188	Y	Y	N	
	PSP-0187	Y	Y	N	REDUCER
	PSP-0267				NBW
	PSP-0185	Y	Y	N	UWS
1B21-M4108	PSP-0253	Y	Y	N	
	PSP-0184	Y	Y	N	REDUCER
	PSP-0266				NBW
	PSP-0183	Y	Y	N	UWS

Y : Record Available

N : No Record

NBW-1 : weld mark in the ISO drawing, but no piping butt welds in its shop drawing

NBW : No Butt Weld

REDUCER : 10" x 12" Reducer in this piping, 2 butt welds on Reducer's both ends

UWS : Under Water Surface, butt weld RT is not required per PSAR

表三：SRVDL 不銹鋼管件對接銲道非破壞檢測執行狀況統計表(2/3)

ISO 圖號	管件編號	銲道檢測方法			備註
		VT	PT	RT	
1B21-M4109	PSP-0182	Y	Y	N	
	PSP-0180	Y	Y	N	REDUCER
	PSP-0265				NBW
	PSP-0178	Y	Y	N	UWS
1B21-M4110	PSP-0177	Y	Y	N	
	PSP-0176	Y	Y	N”	REDUCER
	PSP-0264				NBW
	PSP-0175	Y	Y	N	UWS
1B21-M4111	PSP-0174	Y	Y	N	
	PSP-0172	Y	Y	N	REDUCER
	PSP-0263				NBW
	PSP-0171	Y	Y	N	UWS
1B21-M4112	PSP-0170	Y	Y	N	
	PSP-0168	Y	Y	N	REDUCER
	PSP-0262				NBW
	PSP-0167	Y	Y	N	UWS
1B21-M4113	PSP-0166				NBW-1
	PSP-0164	Y	Y	N	REDUCER
	PSP-0261				NBW
	PSP-0163	Y	Y	N	UWS
1B21-M4114	PSP-0162				NBW-1
	PSP-0160	Y	Y	N	REDUCER
	PSP-0260				NBW
	PSP-0159	Y	Y	N	UWS

Y : Record Available

N : No Record

NBW-1 : weld mark in the ISO drawing, but no piping butt welds in its shop drawing

NBW : No Butt Weld

REDUCER : 10” x 12” Reducer in this piping, 2 butt welds on Reducer’s both ends

UWS : Under Water Surface, butt weld RT is not required per PSAR

表三：SRVDL 不銹鋼管件對接銲道非破壞檢測執行狀況統計表(3/3)

ISO 圖號	管件編號	銲道檢測方法			備註
		VT	PT	RT	
1B21-M4115	PSP-0158				NBW-1
	PSP-0157	Y	Y	N	REDUCER
	PSP-0259				NBW
	PSP-0155	Y	Y	N	UWS
1B21-M4116	PSP-0154				NBW-1
	PSP-0153	Y	Y	N	REDUCER
	PSP-0258				NBW
	PSP-0152	Y	Y	N	UWS
1B21-M4117	PSP-0151				NBW-1
	PSP-0150	Y	Y	N	REDUCER
	PSP-0257				NBW
	PSP-0149	Y	Y	N	UWS
1B21-M4118	PSP-0148	Y	Y	N	
	PSP-0146	Y	Y	N	REDUCER
	PSP-0256				NBW
	PSP-0145	Y	Y	N	UWS
1B21-M4119	PSP-0144	Y	Y	N	
	PSP-0142	Y	Y	N	REDUCER
	PSP-0255				NBW
	PSP-0140	Y	Y	N	UWS
1B21-M4120	PSP-0139				NBW-1
	PSP-0138	Y	Y	N	REDUCER
	PSP-0254				NBW
	PSP-0137	Y	Y	N	UWS

Y : Record Available

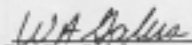
N : No Record

NBW-1 : weld mark in the ISO drawing, but no piping butt welds in its shop drawing

NBW : No Butt Weld

REDUCER : 10" x 12" Reducer in this piping, 2 butt welds on Reducer's both ends

UWS : Under Water Surface, butt weld RT is not required per PSAR

		IXP - BUFFALO 40 GUNDER ST. BUFFALO, N.Y. 14216 Phone: (716) 884-7770 FAX: (716) 884-7887 e-mail: bscorbell@ixpmetcon.com	
MATERIAL CERTIFICATION			
Revised & Reissued June 9, 2000		IXP Sales Order # 7280	
Date December 8, 1999		Customer PO # 7739-008 Unit 2	
Customer B.F. Shaw		Part Name Seamless Stainless Steel Pipe	
Part # 12.750" OD Sch 60 (0.562" AW)		Part Name Seamless Stainless Steel Pipe	
Specifications: ASME SA312 (1989 Ed.), TP 316L, ASME Code Section III Subsection ND, Class 3, 1989 Edition, No Addenda 10CFR50 Appendix B, 10CFR21 BFS-PI-1 Rev.2			
CHEMICAL COMPOSITION		Mill Heat No. 31654 Heat Treat Lot: 23016 IXP Serial # 7280-16-2	
REQUIRED %		B.F. Shaw, Inc. QA REVIEW Initials Date MTR# 505K Page 1 of 5	
		This material was manufactured, supplied and tested in accordance with WC-IXP Quality Program Rev.0 dated 3/19/99 Second Edition which has been audited and approved by, WF Shaw as conforming to ASME Code Section III - WCA-3800.	
		Material is in the pickled and passivated condition. Material is free from Mercury & low melting point alloy contamination. No weld repair was performed on this material.	
		Black & Veatch AUG 2 1999 K L B	
CARBON 0.020 Max. MANGANESE 2.00 Max. PHOSPHORUS 0.040 Max. SULFUR 0.030 Max. SILICON 0.75 Max. NICKEL 10.0 - 15.0 CHROMIUM 16.0 - 18.0 MOLYBDENUM 2.00 - 3.00		Mill Product 0.012 0.012 1.85 1.82 0.024 0.025 0.015 0.013 0.47 0.49 11.20 11.21 16.32 16.29 2.10 2.14	
TEST LONGITUDINAL		MECHANICAL PROPERTIES	
TENSILE PSI 70,000 Min.		86,300	
0.2% Offset YIELD PSI 25,000 Min.		41,800	
ELONG. % IN 4D 35 Min.		48.6	
FLATTENING		ACCEPTABLE	
SENSITIZATION 5% max ditching		0% ditching	
TEST- A10			
GRAIN SIZE ASTM #5 OR FINER		G.S #5.5	
HARDNESS Rb 92 Max.		Rb 78	
IGA-A20 0.001" Max Depth		None Observed	
Parts were hydrostatically tested at 1300 PSI for a minimum of 8 seconds. No defects noted.			
Parts were annealed at 2000°F + or - 100°F for one-half hour minimum at temperature and water quenched to below 400°F.			
We hereby certify that the material was manufactured, sampled, tested and inspected to the above listed specification and purchase order requirements, and the results met these requirements.			
Quality Control		 D. F. Sahlem - W. A. Galus	
72801654.016a			
Form QP-10-23 Rev. 2 8/5/98			

B. F. Shaw, Inc.
SHOP TRAVELER
LUNEMER NUCLEAR PROJECT

Job No./Sketch No. 9738-42-861

Page 1 of 1

OPERATIONS		SIGN OFFS		END DATE		JOB NO.	
Order	Description	Shop	Field	Initials	Date	Initials	Date
1	UT Thickness Bend Area						
2	Bend						
3	Visual Insp. Bend						
4	UT Thickness Bend						
5	UT Insp. Bend						
6	Nondestructive						
7	Temper						
8	Drawl, Shop End Mach.						
9	PS Up						
10	Post Weld, MT/PT						
11	Intermitt. Heat, MT/PT						
12	Visual Insp. Standard						
13	Visual Insp. Standard						
14	Visual Insp. Standard						
15	Visual Insp. Standard						
16	Visual Insp. Standard						
17	Visual Insp. Standard						
18	Visual Insp. Standard						
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99	Visual Insp. Standard						
100	Visual Insp. Standard						

6/5053

附件五-1 Type 308L Filler metal

Review
ANL JMD 9-10-99
Page 1 of 3

The Shaw Group, Inc.

Approved TR Smith WPS No. N80341 Rev. 1
 Date April 22, 1999 Revision Date August 16, 1999
 Support PQR No. (s) 12,361 (PRN066), L5853 (PRN067), L7492 (PRN072), L5768 (PRN076)

Welding Process GTAW-MA SMAW, GTAW-ME Type (s) Manual/Machine

JOINTS (QW-402) The specific joint preparation for production welds shall be as specified in the design on the Shop Sketch Drawing. This WPS may be used with the typical joint designs as shown on sheet 1 of 3. GTAW shall be used for the Root Pass at a minimum. Standard Root Openings for this WPS shall be: GTAW-MA (Manual) 0" to 1/32" GTAW-ME (Machine) 1" to 1/32" This WPS may be used for Weld Repair and as a procedure for Weld Metal deposits for base metal build-up or repair. Joint preparation shall be by machining, grinding or filing. See Job Instructions for control of grinding and filing tools. Air Carbon Arc or Plasma Arc may be used for shaping. For the thermal cutting processes above, preheat and interpass temperature requirements shall be the same as for welding. Surfaces shall be ground to bright metal following the cutting operation. The SMAW process shall only be used with backing. Backing shall be either the weld metal deposited or the base metal of the shop process being welded. Backing Rings shall not be used. The GTAW portion of this procedure may be used with or without backing. Non metallic liners and non fusing metal liners shall not be used.

Base Metals (QW-403)
 P-No. 8 Group No. To P-No. 8 Group No.
 Base Metal Thickness Range Groove SMAW - 1/16" thru 2.250" Files ALL
 Maximum Deposit Thickness per pass shall not exceed 1/4" inches

Filler Metals (QW-404)	GTAW-MA	SMAW	GTAW-ME
Spec No. (SFA)	5.9	5.4	5.9
AWS No. (class)	ER308L	E308L-16	ER308L
P-No.	8	5	6
A-No.	8	8	8
Size of Filler Metals	1/16", 3/32", 1/8", 5/32"	3/32", 1/8", 5/32", 3/16"	.035", .045", 1/16"
Weld Metal	See Notes 3 and 6	See Notes 3 and 6	See Notes 3 and 6
Thickness Range	1.5" Max. in Mat'l upto 1.5"	2.250" Max.	1.5" Max. in Mat'l upto 1.5"
Groove	1/2" Max. in Mat'l over 1.5"		1/2" Max. in Mat'l over 1.5"
Files	All	All	All
Filler Metal	solid core		solid core
Consumable Insert	Not Permitted	Not Permitted	Not Permitted

Positions (QW-420)
 Position (s) of Groove All
 Welding Progression: Up XXX Down
 Position(s) of Fillet All

Preheat (QW-406) Pre-heat temperature: the maximum temp. in the weld preparation immediately prior to the deposition of weld metal. See Notes
 Preheat Temperature Minimum 50 degrees F. for all thicknesses of Mat'l
 Interpass Temperature Maximum 180 degrees F. Maximum
 Preheat Maintenance None Required
 Interpass Temperature: the maximum allowable temp. of the previously deposited weld metal before the next pass is deposited within 1" of bead

Gas (QW-408)
 GTAW Gas(es) Shielding Argon GTAW
 Protective Back Purge: See Notes 3 and 4
 Purge Argon 99.9% Minimum
 Trailing shield Shall Not Be Used

Postweld Heat Treatment (QW-427) Not Permitted
 Temperature Range As Welded
 Time Range N/A

Lungmen Nuclear Units 1 and 2
 Taiwan Power Company
 Contract No. 8748611M001-1
 B & V Spec. 31113.62.2211 & 31113.62.2213.1
 Shop Fabricated Piping - ASME III Class 1
 Shop Fabricated Piping - ASME III Class 2 & 3

28/30 53

附件六 Minimum wall thickness

100

1204

B. F. Shaw, Inc.

QUALITY CONTROL BENDING REPORT

Lungmen Nuclear Project

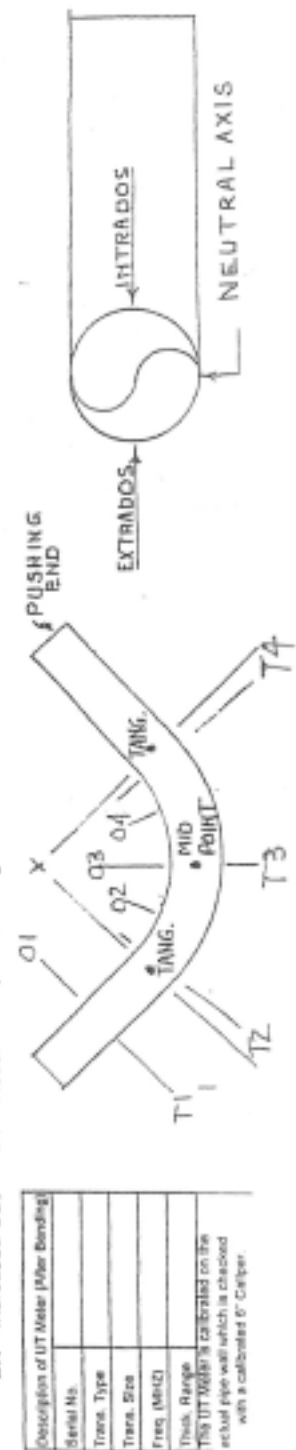
Job No. 7738-00	Spool No. 2073	Piece Mark No. 1821-PS-P-0004
Material Spec./Grade SA106B	Manufacturer	Heat Number A26495
Nominal Diameter 10.75	Nom. Thickness .594	Min. Thickness .520

Bend No.	Bend (1) Temperature		Ovality (8% Max) (2)				Thickness (3)										Disposition
							Before Bending					After Bending					
			(101) Base Metal	(102) 1/4	(103) Mid Pt	(104) 3/4	Max % Ovality	(T1) Base Metal	(T2B) 1" - 6"	(T3B) Mid Pt	(T4B) 1" - 6"	(T2A) 1" - 6"	(T3A) Mid Pt	(T4A) 1" - 6"	Max % Thinning		
3	In	1879	1879	N	12.75	10.937	10.937	10.937	2.3	In	587	582	590	1.016	1.028	1.036	NCR 1453
	Ex	1528	1711	IE	10.75	10.687	10.687	10.687	2.3	Ex	601	599	603	1.016	1.028	1.036	
2	In	1872	1877	N	10.75	11.062	11.0	10.575	3.4	In	594	594	599	1.006	1.060	1.013	NCR 1453
	Ex	1486	1463	IE	10.75	10.687	10.687	10.687	3.4	Ex	599	606	601	1.016	1.028	1.036	
	In			N						In							
	Ex			IE						Ex							
	In			N						In							
	Ex			IE						Ex							

() Pre-Bend Visual Inspection Satisfactory Date: _____
 () Post Bend Visual Inspection Satisfactory Date: _____

Notes:

- Carbon Steel bends completed at a temperature less than 1850 deg. F require Post Bend Heat Treatment. Stamp the Shop Sketch "PBHT Req'd"
- % Ovality = $\frac{DX-DY}{D} \times 100$ (3) % Thinning = $\frac{T2B-T2A}{T2A} \times 100$
- Use values for T2, T3, & T4: T2B* = T2A* - T2A* x 100
- DX = Increased OD, DY = Reduced OD, D = Original OD
- In = Intrados, Ex = Extrados
- N = Neutral Axis, IE = Intrados/Extrados Axis
- All Stainless Steel bends shall be PT examined after solution annealing
- All Carbon Steel bends shall be MT examined after bending
- PT & MT shall be signed-off on the Shop Traveler. Complete a PT or MT Report



Attachment 1 page 2 of 2 DDR-62.2213.1-80

附件七 NCR

Attachment 7: page 1 of 2 DDR-62.2213.1-80
B.F. Shaw, Inc. ORIGINAL

8/01

Job/Sketch No. 7738 - 00 - 2073 NCR Serial No. 1453

Applicable Code: ☐ Sec. I ☐ Sec. VIII, Div. 1 ☐ B31.1 ☐ B31.1B.E.P. ☐ (Other) _____
☒ Sec. III, Class ☐ 1 ☐ 2 ☒ 3

Job/P.O. No. _____ Receiving Report No. _____ Vendor _____

Description of Non Conforming Item 10" 3/80 SA106B BENDS

Description of Non Conformance BENDS 2+3 ARE BELOW REQUIRED MIN. WALL OF .520 - ACTUAL IS .490 AND .484

☐ Sketch or additional description of non-conformance attached. ONLY TO S. HAWK
☒ NCR label(s) attached to Non-Conforming item(s). (Number of Labels 1)

NCR Initiated by RBL (Signature) QC INSP. (Title) 11-13-02 (Date)

Prescribed Corrective Action _____

QC Hold Points _____ *AI/ANI Hold Points _____
Customer Hold Points _____ ☐ Sketch attached

Prescribed Corrective Action approved: ☐ Detailed repair procedure attached - Procedure No. _____
If Sec III is checked is 10 CFR 21 Applicable? ☐ Yes ☐ No If yes, refer to separate 10 CFR 21 Report.

QA/QC Manager _____ (Signature) (Date) Department Manager _____ (Signature) (Date)
☐ Projects ☐ Engineering ☐ Purchasing

Prescribed Corrective Action accepted: Customer Approval: ☐ Obtained ☐ Not Required

*AI/ANI _____ (Signature) (Date) _____ (Signature) (Title) (Date)

☐ Rework Tag(s) attached to Non-Conforming item(s). (Number of Tags _____)
Signature _____ Date _____

Completed Corrective Action

The prescribed corrective action has been completed in accordance with the instructions provided.
Supplemental information _____

Title _____ Signature _____ Date _____

Verification of Corrective Action
Method of verification _____
☐ NCR label(s) removed from item(s). (No. of Labels _____) ☐ Rework Tag(s) removed from item(s). (No. of Tags _____)

Q. C. Inspector _____ (Signature) (Date) *AI/ANI _____ (Signature) (Date)

*Applies only to Sec. I; Sec. III; Sec. VIII, Div. 1; or B31.1 Boiler External Piping

COMMITTED TO THE QUALITY PROCESS

附件八 DDR

000K 5.0 LUK

Appendix A: LGAR-1 Revision 3

GENERAL ELECTRIC		DEVIATION DISPOSITION REQUEST	
1. SUPPLIER AND LOCATION GE MANUFACTURING 100 OLD AIRPORT ROAD, LAWRENCE, SC 29555		2. PART NAME SHOP FABRICATED PIPING	
3. PRODUCT SHOP FABRICATED PIPING ASME B CLASS 2 AND 3		4. PART NUMBER 7739-08-0003 1821-PSP-0804	5. DATE INSPECTED 1/13/2002
6. IDENTIFY DEVIATING ITEM: SEE ATTACHED 7739-NCR-1453 AND ATTACHED QC BENDING REPORT.		7. PROJECT LUNDAEN NUCLEAR UNITS 1 AND 2	8. SUPPLIER JOB NUMBER 1738
10. DESCRIBE NONCONFORMANCE, PROPOSED DISPOSITION, AND ENGINEERING BASIS: BEND #2 & #3 IS UNDER MANUFACTURES MIN. WALL OF .520" DURING BENDING ACTUAL WALL IS INDICATED ON BEND REPORT. REQUESTING BV TO ACCEPT AS IS.			
11. CAUSE OF DEVIATION, ACTION TAKEN TO PRECLUDE RECURRENCE, AND TIME AND POINT OF IMPLEMENTATION: EXCESSIVE THINNING ON HEEL OF BEND DURING BENDING. NCR WRITTEN, NCR WILL BE EVALUATED PER SECTION 16 OF QA MANUAL AT TIME OF NCR DISPOSITION.			
12. NO. OF SUPPLIER ATTACHMENTS: 2		13. GE QC REPRESENTATIVE (GCR) SIGNATURE, OR HOW NOTIFIED: <i>[Signature]</i>	
APPROVED AS PROPOSED DISAPPROVED OTHER: NO. OF GE ATTACHMENTS		14. SUBMITTAL APPROVAL <i>[Signature]</i> DATE 1/13/2002	
15. DESIGN VERIFICATION STATEMENT AND WHERE FILED: The identified bends are acceptable as manufactured. Per B&V calculation 3111Z-0A10-2102 Rev.1, the min. req'd wall for 250 mm, Sch 80 LB21-L-M piping is 12.070mm (0.475in). All attached bend reports, show an actual minimum wall thickness greater than this.			
16. DISTRIBUTION STATEMENT VERIFIED BY: <i>[Signature]</i> 12/4/02		17. FINAL DISTRIBUTION FOR MASTER FILE	
17. SIGNATURES RESPONSIBLE ENGINEER (RE) <i>[Signature]</i> 1/14/02 RESPONSIBLE ENGINEER (RE) <i>[Signature]</i> 1/14/02 LEAD SYSTEM ENGINEER (LSE) <i>[Signature]</i> 12/6/02 MATERIALS APPL. ENGINEER (MAE) N/A PROJECT MANAGER <i>[Signature]</i> 1/14/02 QC ENGINEER (QCE) <i>[Signature]</i> 1/14/02 BUYER <i>[Signature]</i> 1/14/02		18. OWNER APPROVAL REQUIRED YES NO OBTAINED ☐ ☒ ☒ 20. CHANGE CONTROL DOCUMENTS ECCN/CA NO. N/A FBI NO. N/A OTHER N/A 21. PO NUMBER/VERSION 01113.42.2213.1-086 DDR NUMBER DDR-12-2213.1-80 1/13/02	
22. SUPPLIER QC N/A		23. SUPPLIER DATE N/A	

1821-NF (REV.06) FOR J.F. McCormick (See following sheet for instructions) A-2

EPRI NO. 02N-173876-11117-02 1213.1-06 Rev. 3
LUNDAEN NUCLEAR UNITS 1 AND 2
TANDEM POWER COMPANY
P.O. NO. 31113.42.2213.1-002
CONTRACT NO. 0745E1-0001-1

附件九 Shop drawing PT operation

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附件十 MT Report

301



B.F. Shaw, Inc.
**MAGNETIC PARTICLE
EXAMINATION REPORT**



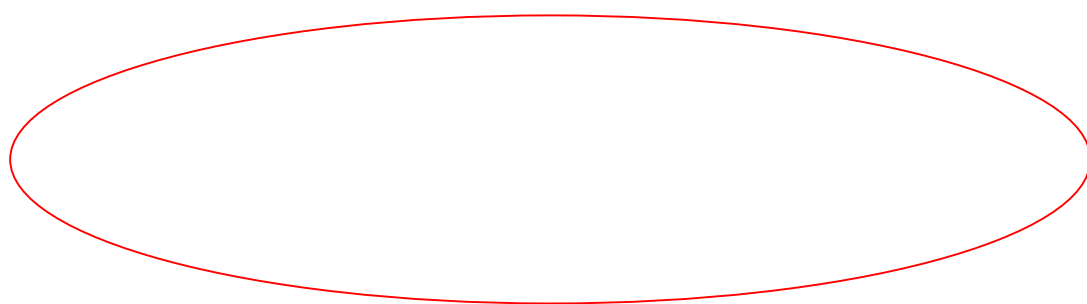
Job/Sketch No. 7738 - 00 - 2073 Lungmen Project
 Procedure (and Contract Addendum if applicable) BFS-MT-1 Rev. 0, Add. Rev. 0
 Unit Type CONTAIN. PROBE Model DA-400 Serial No. 8392
 Current ☒ AC ☐ DC Amperage 4amps Prod Spacing 2-4"
 Technique Yoke
 Type Powder - Color Yellow ☐ Wet ☐ Dry ☐ Fluorescent ☒ Non-Fluorescent
 Acceptance Criteria (Governing Code) ASME SECTION III CL 3
☒ Root Pass ☐ Intermediate Pass ☒ Final Pass ☒ As Welded ☒ After PWHT

Weld I.D.	Acc.	Rej.	Conditions/Remarks (Part Description if not a weld)	Examiner's Signature	Level	Date
C	✓		ROOT	ST-	II	4-11-03
C	✓		Final	L.M.J.	II	6-5-03
H	✓		ROOT	Samuel Davis	II	4-16-03
H	✓		Final	L.M.J.	II	6-5-03
B	✓		ROOT	Samuel Davis	II	4-16-03
B	✓		Final	L.M.J.	II	6-5-03
G	✓		ROOT	Samuel Davis	II	4-16-03
G	✓		Final	L.M.J.	II	6-5-03
Beard 1	✓		360°	L.M.J.	II	6-5-03
Beard 2	✓		360°	L.M.J.	II	6-5-03
Beard 3	✓		360°	L.M.J.	II	6-5-03
TC1	✓		Removal Area	L.M.J.	II	6-5-03
T1	✓		Removal Area	L.M.J.	II	6-6-03

Witnessed by: _____
 Customer _____ AI/ANI _____

COMMITTED TO THE QUALITY PROCESS

23



ND-5211.3

required to be radiographed shall be examined by the liquid penetrant method.

ND-5212 Piping, Pumps, and Valves

Longitudinal welded joints in piping greater than 2 in. nominal pipe size shall be examined by the requirements of ND-2500. Longitudinal welded joints in pressure retaining parts of pumps and valves greater than 2 in. nominal pipe size shall be examined in accordance with the requirements of ND-2500 for the applicable product form. Butt welds made by the electroslag welding process shall be radiographed for their entire length.

ND-5220 CATEGORY B VESSEL WELDED JOINTS AND CIRCUMFERENTIAL WELDED JOINTS IN PIPING, PUMPS, AND VALVES

ND-5221 Vessels

(a) Category B welded joints (ND-3351.2) shall be fully radiographed when:

(1) the thickness exceeds the limits of ND-5211.2 or ND-5211.3, except as permitted in (b) below;

(2) the welds are based on a joint efficiency permitted by ND-3352.1(a), except as permitted in (b) below;

(3) they are butt welds in nozzles or communicating chambers attached to vessel sections or heads that are required to be radiographed and exceed 10 in. nominal pipe size or 1½ in. wall thickness;

(4) the welds are made by the electroslag welding process.

(b) In accordance with (a)(2) above, any Category B and similar type welds not required to be fully radiographed by thickness or location as in (a) above shall as a minimum be partially radiographed. This shall consist of a radiographic examination at least 6 in. long of any section of the weld picked at random plus a similar examination of any intersection of the weld with all Category A and similar welds in either of the sections being connected. Acceptance standards for partially examined welds shall be as set forth in ND-5321.

(c) The welds not required to be radiographed by (a) or (b) above shall be examined by spot radiography except as permitted by (d) below. Spot radiography is required when a joint efficiency described in ND-3352.1(b) is used.

ND-5000 — EXAMINATION

ND-5232

(d) No radiography is required when a vessel or part is designed for external pressure only or when a design complies with ND-3352.1(c).

(e) The requirements of ND-5211.2 and ND-5211.3 shall be met.

ND-5222 Piping, Pumps, and Valves

Circumferential welded joints in piping, pumps, and valves greater than 2 in. nominal pipe size shall be examined by either the magnetic particle, liquid penetrant, or radiographic methods. Acceptance standards shall be those stated in ND-5300.

ND-5230 CATEGORY C VESSEL WELDED JOINTS AND SIMILAR WELDED JOINTS IN PIPING, PUMPS, AND VALVES

ND-5231 Vessels

(a) Category C full penetration welds shall be fully radiographed when:

(1) the thickness exceeds the requirements of ND-5211.2 or ND-5211.3;

(2) they are butt welds in nozzles or communicating chambers attached to vessel sections or heads that are required to be radiographed and exceed 10 in. nominal pipe size or 1½ in. wall thickness;

(3) the welds are made by the electroslag process.

(b) Any Category C butt weld not required to be fully radiographed by thickness or location using the joint efficiency of ND-3352.1(a) shall meet the requirements of ND-5221(b).

(c) The welds not required to be fully radiographed by (a) above shall be examined by spot radiography, except as permitted by (d) below. Spot radiography is required when the butt welds are designed with a joint efficiency as described in ND-3352.1(b).

(d) No radiography is required when the vessel or part is designed for external pressure only, when the design complies with ND-3352.1(c), or when the joint is not a butt welded joint.

ND-5232 Piping, Pumps, and Valves

The requirements for welded joints similar to Category C shall be the same as given in ND-5222.

NC-5130

NC-5000 — EXAMINATION

NC-5230

(c) Indications of nonlaminar imperfections of (1) through (3) below are unacceptable:

(1) any linear indications greater than $\frac{1}{16}$ in. long;

(2) rounded indications with dimensions greater than $\frac{1}{16}$ in.;

(3) four or more indications, in a line separated by $\frac{1}{16}$ in. or less, edge to edge.

(d) Weld repairs made to weld edge preparations for Category A, B, C, D, and similar type welds shall be examined by the magnetic particle or liquid penetrant method before the surfaces become inaccessible. The examination may be performed before or after postweld heat treatment.

NC-5140 EXAMINATION OF OPENINGS CUT IN VESSELS DESIGNED TO NC-3200

For nozzle connections with necks abutting the vessel wall [Fig. NC-4266(b)-1 sketches (a) and (b)], the radially disposed surfaces of the openings cut in the vessel walls shall be examined by either magnetic particle method or a liquid penetrant method in accordance with the requirements of this Article. Defects thus discovered shall be removed and repaired as required by the applicable Article.

NC-5200 EXAMINATION OF WELDS²

NC-5210 CATEGORY A VESSEL WELDED JOINTS AND LONGITUDINAL WELDED JOINTS IN PIPING, PUMPS, AND VALVES

NC-5211 Vessel Welded Joints

(a) Category A welded joints shall be fully radiographed when either of the members being joined exceeds $\frac{1}{16}$ in. thickness.

(b) Category A welded joint surfaces may be examined by either the magnetic particle or liquid penetrant method as an alternative to the radiographic examination when the thickness of each member being joined is $\frac{1}{16}$ in. or less.

NC-5212 Pipe, Pump, and Valve Welded Joints

Longitudinal butt welded joints, as defined in NC-3351.1, shall be radiographed.

²See NC-5250 for vessels designed to NC-3200. See NC-5280 for requirements for storage tank welds.

NC-5220 CATEGORY B VESSEL WELDED JOINTS AND CIRCUMFERENTIAL WELDED JOINTS IN PIPING, PUMPS, AND VALVES

NC-5221 Vessel Welded Joints

(a) Category B welded joints shall be fully radiographed when either of the members being joined exceeds $\frac{1}{16}$ in. thickness.

(b) Category B welded joint surfaces may be examined by either the magnetic particle or liquid penetrant method as an alternative to the radiographic examination when the thickness of each member being joined is $\frac{1}{16}$ inch or less.

NC-5222 Piping, Pump, and Valve Welded Joints

(a) Butt-welded joints shall be radiographed.

(b) Fillet and partial penetration welded joints shall be examined by either the magnetic particle or liquid penetrant method.

NC-5230 CATEGORY C VESSEL WELDED JOINTS AND SIMILAR WELDED JOINTS IN OTHER COMPONENTS

(a) Category C full penetration butt welded joints and similar welded joints in other components shall be fully radiographed when either of the members being joined exceeds $\frac{1}{16}$ in. of thickness.

(b) Category C full penetration corner welded joints and similar welded joints in other components shall be ultrasonically or radiographically examined when either of the members being joined exceeds $\frac{1}{16}$ in. of thickness.

(c) Category C welded joint surfaces and similar welded joints in other components may be examined by either the magnetic particle or liquid penetrant method as an alternative to the radiographic or ultrasonic examination when the thickness of each member being joined is $\frac{1}{16}$ in. or less.

(d) Category C partial penetration and fillet welded joints and similar welded joints in other components shall be examined by the magnetic particle or liquid penetrant method on all accessible surfaces.

18. AUG. 2004 14:21

NO. 7215 P. 1

核研所核四支援小組視察發現缺失通報表

通報日期	93 年 8 月 16 日	通報表編號	INER-LM-93-009
視察項目	SRVDL 不銹鋼管件非破壞檢測缺失		
視察發現摘要	核四專案全面清查濕井內 72 支 SRVDL 不銹鋼管件品質文件，將廠製部分對接銲道非破壞檢測執行狀況作成統計表(附件一)，發現 PSAR 3.9.3.1.13 之 Class 2 非破壞檢測承諾並未落實，72 支 SRVDL 不銹鋼管件對接銲道非破壞檢測作業為 VT 及 PT，品質文件中未發現對接銲道之 RT 紀錄或報告。視察發現依據簡述如下： 1. 依據 PSAR 3.9.3.1.13 Safety Relief Valve Piping and Quencher，SRVDL 管路製造規範需遵循 ASME Class 3，此外濕井內水面上之不銹鋼管路銲道非破壞檢測則須依 Class 2 之要求執行(附件二)。 2. 依據 ASME Sec III ND-5222，管徑公稱大於 2 英吋之 Class 3 管件銲道需執行之非破壞檢測可選擇 PT、MT 或 RT 檢驗(附件三)，Class 2 管件銲道非破壞檢測依據 ASME Sec III NC-5222(a)，其對接銲道非破壞檢測作業則規定為需執行 RT 檢驗(附件四)。另查證 GE 公司之 ASME Code Section III Class 2 and 3 Piping Design Specification，發現上述 PSAR 3.9.3.1.13 之特別規定並未明示於該採購規範中。		
建議事項	1. 濕井內水面上之 SRVDL 不銹鋼管件廠製部分對接銲道非破壞檢測作業現況不符合 PSAR 3.9.3.1.13 之承諾，建議要求台電公司督促 GE 公司盡速改善。 2. 鑒於 RHR Hx Shell weld intersections 之非破壞檢測作業亦出現 GE 公司未將 PSAR 承諾落實於採購規範之類似案件，合理懷疑 PSAR 承諾未落實應非僅是個案，建議要求台電公司督促 GE 公司全面清查。 3. 日後管件工地安裝銲接之非破壞檢測作業亦需符合 PSAR 3.9.3.1.13 之承諾，建議要求台電公司以正式紀錄列入品保體系追蹤管控。		

查證者：楊慶庭

核管處視察員：張國榮

1. d

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2004 Aug 16

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12/95

O P E R A T I O N S

Opert Record	Operation Description	SIGN OFFS				Shop Initials Date	QC Initials Date	AM-Cont. Initials Date	End Shift Initials Date
		Init	Init	Date	Date				
X	UT Thickness Meas Area								
X	Band								
X	Visual Insp. Band								
X	UT Thickness Meas								
X	MT/PT Band								
X	Solution Annual								
	Normalize								
	Complete								
	Sever. Shop End Mach								
X	Fit Up								
X	Final Weld, MT/PT								
	Intermitt. Weld, MT/PT								
	Good Welds, Standard								
	Visual Welds, Pre-Service								
X	Final Weld, VT								
X	Final Weld, RT								
	Final Weld, MT/PT								
	Final Weld, UT P/S								
	Direct. Check Prior to PWHT								
	Post Weld-Hold HE. Treat								
	End								
	Check, Field End								
X	Final Direct. Check								
X	Visual Inspection								
X	Documentation Check								
X	API Inspection								
X	Code Name Plate								

Welding Process Code				MCR No.	
Process	Manual	Autoclave	MCR No.	MCR No.	
Gas Tungsten Arc	GTAW	GTAW	MAN		
Shielded Metal Arc	SMAW	SMAW	MAN		
Gas Metal Arc	GMAW	GMAW	MAN		
Flame Arc	FCAW	FCAW	MAN		
Submerged Arc	SAW	SAW	MAN		

* Includes Material Verification
** H=Hotel Point, W=Witness Point
or M = Monitor Point

B. F. Shaw, Inc.

SHOP TRAVELER

LUNGMEIN NUCLEAR PROJECT

End Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.		Init		Date		Date		Date		Date	
Shift No.											

3.3 驟冷管嘴非破壞檢驗文件查證:

驟冷管嘴為 SA-182 Grade 316L 不銹鋼材質，由主體、基座、漸縮管和十字管臂銲接而組成，所有的銲道完成後依檢測程序書(QC-2584-60)執行 VT 檢測和依檢測程序書(QC-2584-10)執行 PT 檢測，所有與主體的對接銲道增加 RT 檢測，檢測依(QC-2584-10) RT 程序書，RT 接受標準依照 ND-5320 規定，查證結果如驟冷管嘴非破壞檢驗文件查證表(表四)，其查證結果及依據文字簡述如下:

3.3.1. 驟冷管嘴 RT 檢測報告的管材厚度應為 5/8”，但誤植為 3/4”的銲道如下

所示:

(a) 2584-H1 銲道編號 202(Page 605)(附件十七)。

(b) 2584-H1 銲道編號 203(Page 606)(附件十八)。

(c) 2584-F2 銲道編號 202(Page 635)(附件十九)。

3.3.2 驟冷管嘴 RT 檢測報告的接受標準誤植或未填寫的銲道如下列所示:

(a) 2584-C1 銲道編號 200 接受標準誤植為 NB-5320。

(b) 2584-C2 銲道編號 201 (Page 656) (附件二十)、200 接受標準誤植為 NB-5320。

(c) 2584-D1 銲道編號 203 (Page 764) (附件二十一)、200、202 接受標準誤植為 NC-5320。

(d) 2584-D2 銲道編號 201、203、202 接受標準誤植為 NC-5320。

(e) 2584-E1 銲道編號 201 接受標準誤植為 NC-5320。

(f) 2584-F1 銲道編號 201、203 接受標準誤植為 NC-5320。

(g) 2584-G1 鐸道編號 203 接受標準誤植為 NC-5320。

(h) 2584-G2 鐸道編號 200、202 接受標準誤植為 NC-5320。

(i) 2584-B2 鐸道編號 141(Page 750) (附件二十二)未填寫接受標準。

(j) 2584-E1 鐸道編號 200 未填寫接受標準。

3.3.3 2584-D1 鐸道編號 203(Page 764) (附件二十一)未填寫幾何模糊度

(Geometric Unsharpness; Ug)。

表四：驟冷管嘴非破壞檢驗文件查證表

編號	NDE 檢測方法			銲道編號及管材厚度 5/8"										檢測需求	
	PT	VT	RT	120	121	140	141	142	143	200	201	202	203	Ug<0.020	接受標準 ND5322
2584-B1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
2584-B2	v	v	v	v	v	v	v	v	v	v	v	v	v	v	未填/141
2584-C1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NB5320/200
2584-C2	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NB5320/200,201
2584-D1	v	v	v	v	v	v	v	v	v	v	v	v	v	未填	NC5320/200,202,203
2584-D2	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NC5320/201,203,202
2584-E1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NC5320/201, 未填/200
2584-E2	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
2584-F1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NC5320/201,203
2584-F2	v	v	v	v	v	v	v	v	v	v	v	3/4"	v	v	v
2584-G1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NC5320/203
2584-G2	v	v	v	v	v	v	v	v	v	v	v	v	v	v	NC5320/200,202
2584-H1	v	v	v	v	v	v	v	v	v	v	v	3/4"	3/4"	v	v
2584-H2	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
2584-J1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
2584-K1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
2584-L1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v
2584-M1	v	v	v	v	v	v	v	v	v	v	v	v	v	v	v

附件十九 Wrong Weld thickness

[illegible]

附件二十一 Wrong acceptance standard and no Ug data

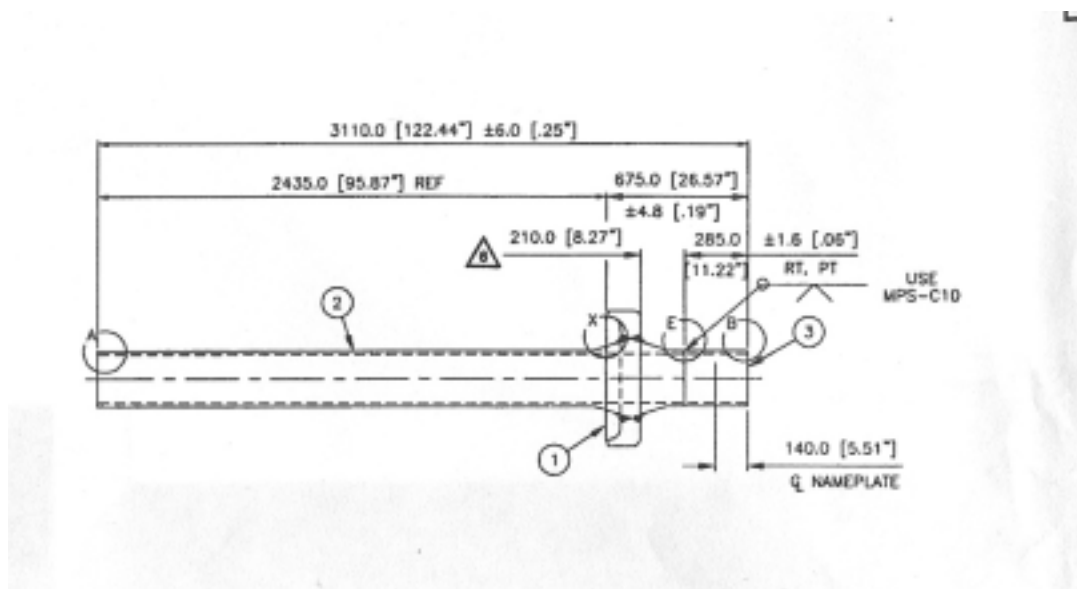
[illegible]

附件二十二 No acceptance standard

JOSEPH OAT CORPORATION		RADIOGRAPHIC FILM		
WELD NO.	TECHNIQUE NO.	MATERIAL	SOURCE	
2584-B2-1	B & V	3/5	1R192	
THICKNESS 5/8"	PENETRATOR 17F	SHIM THK 1/8"	CURIES 98ci	
FILM TYPE D-5	FILM SIZE 4 1/2 X 17"	SINGLE ☐ DOUBLE ☒	RADIOGRAPHIC LAB <u>CONFIRM</u>	
SENSITIVITY 2-T	LEAD SCREENS 205" 2.010"	UG .008"	ACCEPTANCE STD.	
SOURCE TO FILM DISTANCE 13"				
FILM ID	LAB	OAT	A.I.	CUST.
1-2	ACCEPT	REJECT	ACCEPT	REJECT
2-3	ACCEPT	REJECT	ACCEPT	REJECT
3-4	ACCEPT	REJECT	ACCEPT	REJECT
4-1	ACCEPT	REJECT	ACCEPT	REJECT
21	ACCEPT	REJECT	ACCEPT	REJECT
1-2	ACCEPT	REJECT	ACCEPT	REJECT
2-3	ACCEPT	REJECT	ACCEPT	REJECT
OAT INTERPRETER/DATE		A.I./DATE		CUSTOMER/DATE
WJC 3-13-00		3-15-00 T. H. H.		

3.4 穿越器文件查證:

穿越器(如圖三)為 TAYLOR FORGE ENGINEERED SYSTEMS. INC. 製造，管材 SA182 Grade 316L 符合規範要求，並執行 PT 檢測，安裝在隔膜地板混凝土，為了與上游的碳鋼管銲接，穿越器於工廠製造時已事先銲接一截 SA-333 Gr6 碳鋼管，查證 1B21-MPEN-0008A 文件，材質符合規範要求，SA-333 Gr6 依規定執行水壓測試。依照 Purchase Specification for Containment Mechanical Penetration Assemblies 的 7.2.1 節規定穿越器要執行水壓測試(Hydraulic Tests)，但在 QRP 缺此項測試文件。



圖三：穿越器

4. 系統重要設備、管路現場查證

現場查證 SRVDL 系統重要組件倉儲現況，其中 Vacuum Breaker、Diaphragm floor 以上之碳鋼管、Mechanic Penetration 均置放於庫房或管路存放處，倉儲狀況符合規定。Diaphragm floor 以下之管件及 Quencher 等不銹鋼組件則已由汽源課領出，置放於濕井預計安裝處。視察發現，部分管路上存有銲渣痕跡(照片一)，且部分 Quencher 之保護膠套有灼傷焦黑之狀況(照片二)，已將此現象向主辦課反應，請其儘速妥善處理，以期提供設備品質更多保障。施工處已利用塑膠帆布覆蓋(照片三)，Quencher 設備保養維護已有改善。另依據 Quencher 上之組件說明(照片四)，原廠家要求之儲存等級為 B(室內儲存，室溫維持在 5°C 至 48°C 之間)，Quencher 放置現場為戶外且地面處於長期積水狀況，設備雖然已利用枕木架高，然而長期而言 Quencher 置放於濕井現場，其儲存條件應無法滿足原廠家之儲存等級要求。



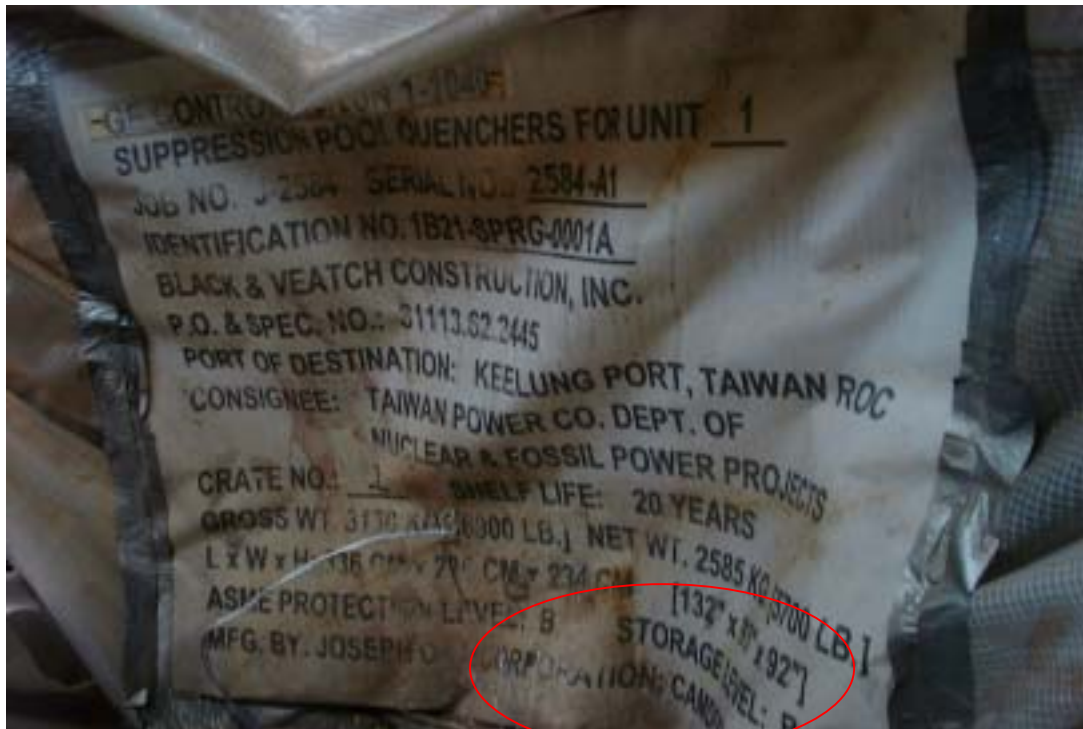
照片一、現場部分 SRVDL 不銹鋼管路上存有銲渣痕跡



照片二、現場部分 Quencher 之保護膠套有灼傷焦黑之狀況



照片三、Quencher 已利用塑膠帆布覆蓋，設備保養維護已有改善



照片四、原廠家要求之儲存等級為 B

5. SRVDL 系統文件查證

SRVDL 系統相關文件查證為此次視察研究重點項目之一，選定之重要查證文件有，ABWR 訓練教材第三篇第一章主蒸氣系統、第二篇第四章自動釋壓系統、Main Steam System (MS) System Design Description(文件編號：31113-0B21-2010)、Lungmen Regular Training Main Steam Student Text、Main Steam System(MS) Overpressure Protection Report(文件編號：31113-0B21 -2501)、Main Steam SRV Vent line Pressure Analysis(文件編號：31113 -0B21 -2136)，查證結果整理於下：

5.1 依據 ABWR 訓練教材第三篇第一章主蒸氣系統(B21-Main Steam System MS)敘述，肆、重要設備中第三、安全釋壓閥之 9. 釋放閥之排洩管之(2)各閥排洩管設有膨脹伸縮箱(Expansion Bellow)，供作閥動作時熱漲冷縮緩衝之用。但是查閱施工處之 P&ID 及 ISO 相關圖面資料，均未發現有膨脹伸縮箱或類似設備存在，特向核四廠原作者請教，但原作者表示因時間已久不復記憶，經其協助查閱 GE 之英文訓練教材及其原始文件 Main Steam System (MS) System Design Description 亦未發現類似敘述。再查閱核二廠相同系統設計狀況，根據核四廠提供之核二廠圖面，未發現類似設計。上述發現復請施工處汽源課確認後，證實訓練教材相關敘述應為錯誤，已建議台電公司予

以修訂。另外，訓練教材第二篇第四章 自動釋壓系統(Automatic Depressurization System ADS)圖八：SRV 與 MSIV 之相關參數設定中將 Non-ADS 之 SRV 歸類為 Non-Safety-Related，與 PSAR 之規定不符，亦建議台電公司一併修正。

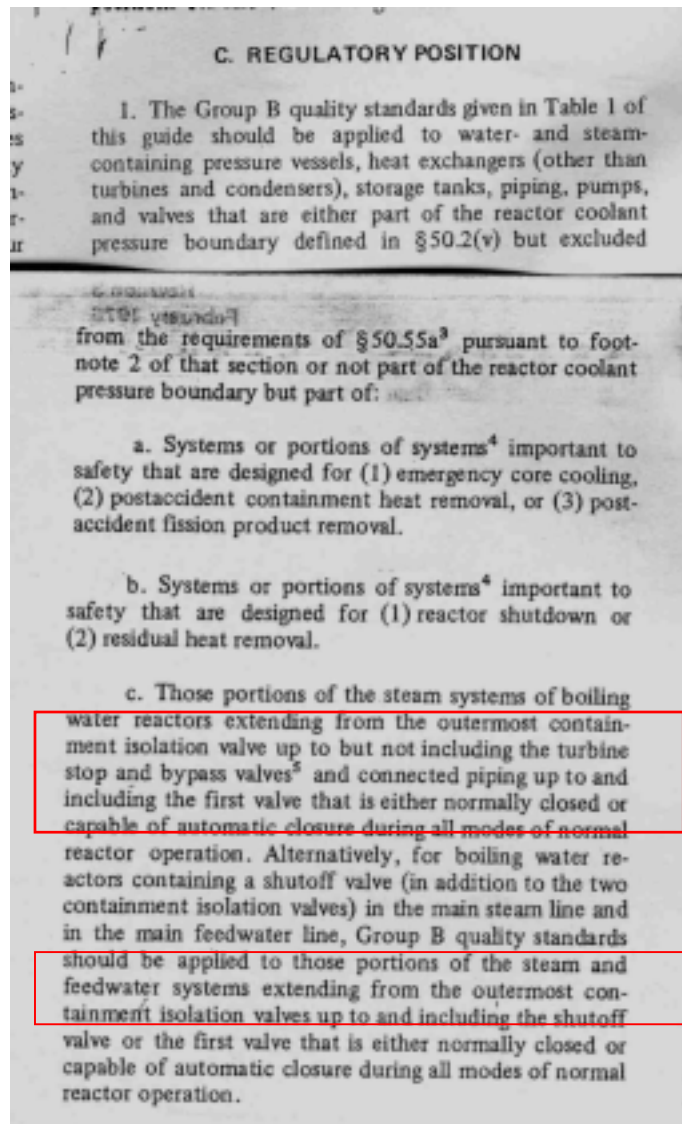
5.2 依據 ASME B&PV Code Section III NB-7000 OVERPRESSURE PROTECTION 規定，核能系統必須適當保護，以因應可能因溫度或壓力造成使用條件超過設計規範之限值(NB-7110)，且業主(Owner)或其指定代理人(Owner's Designee)必須製備過壓保護報告並須滿足 NB-7000 之相關規定(NB-7210)，過壓保護報告必須經由一位以上專業工程師(RPE, Registered Professional Engineer)簽證(NB-7230)。安全釋壓閥洩放管路系統最主要功能即為提供反應爐過壓保護，專案小組成員搜尋核四廠 IMS 資料庫後，找到由 GE 公司製備之「主蒸氣系統過壓保護報告」(Main Steam System Overpressure Protection Report)，報告編號為 31113-0B21-2501，及「主蒸氣系統安全釋壓閥洩放管路壓力分析」(Main Steam SRV Vent line Pressure Analysis)，報告編號為 31113-0B21-2136，等二份與安全釋壓閥洩放管路系統相關之文件。初步查證，「主蒸氣系統過壓保護報告」包含之範圍相當廣泛，安全釋壓閥洩放管路系統亦包含於該報告中，GE 公司為台電公司委託之設計

者，此份報告由該公司負責，報告並經於美國加州註冊之專業工程師 Albe. TC. Tsang(P.E. Number 17048)簽證，就程序上而言，符合 ASME B&PV Code Section III NB-7000 OVERPRESSURE PROTECTION 相關規定，該報告之結論中明確表示，過壓保護系統之設計經分析後，確認 ASME Sec III NB、NC、ND-7000 相關規定均可符合。

5.3 Main Steam System Overpressure Protection Report 文件中其 5.1.4.a 小段之原文為：「MS piping from seismic restraint to the turbine stop valve is non-safety related. However, piping is designed per ASME Code Section III, NC-3000 (Class 2).」，此段文字敘述與個人認知似有差距，特查閱其他相關法規規範之規定並加以比對，結果整理於下：

5.3.1 依據 PSAR 3.2.2 Quality Group Classifications 章節敘述，系統及組件之 Quality Group 分類係依據 NRC Regulatory Guide 1.26 相關規定。但是查閱 NRC Regulatory Guide 1.26，「Quality Group Classifications and Standards for Water-, Steam-, and Radioactive-Waste-Containing Components of Nuclear Power Plants.」，後發現，從圍阻體外 MSIV 開始至 Turbine Stop Valve 之間之主蒸汽管路，應歸類為 Quality Group B(附件二十三)，依據 ASME SEC III 規定，其設計、製造、檢驗及品保系統均須符合 Division 1 – Subsection NC Class 2 Components 相關法規要求，而

在 Main Steam System Overpressure Protection Report 中則指出從 Seismic restraint 後至 Turbine stop valve 之間之主蒸汽管路僅須依據 NC-3000 設計，兩者之間明顯並不一致。



附件二十三 NRC RG1.26

5.3.2 依據 PSAR 3.2.3 Safety Classifications 章節敘述，系統及組件之 Safety Class 之定義係依據 ANS Standard 52.1 「Nuclear Safety

Criteria for the Design of Stationary Boiling Water Reactor Plants」相關規定。查閱該文件 Table A-1 Equipment Classification(附件二十四)，此部分主蒸汽管路為 Quality Group B，且其 Safety Class 分類為 Safety Class 2，Main Steam System Overpressure Protection Report 中對於此部分主蒸汽管路之安全等級分類與 ANS Standard 52.1 規定並不相符。

Table A-1 (Continued) Equipment Classification					
Principal Equipment	Safety Class ^(a)	Quality Assurance Requirement ^(b)	Principal Construction Code ^(c)	Seismic Requirement ^(d)	Safety Class Definition Reference
Reactor Coolant System					
a. Reactor vessel	1	B	III-1	SSE	3.3.1.1
b. Piping, main steam lines within outermost isolation valve	1	B	III-1	SSE	3.3.1.1
c. Piping, main steam lines between outermost isolation valve and shutoff valve	2	B	III-2	SSE	3.3.1.2a.
d. Safety/relief valves	1	B	III-1	SSE	3.3.1.1
e. Piping, feedwater lines within outermost isolation	1	B	III-1	SSE	3.3.1.1

附件二十四 ANS Standard 52.1 Table A-1

5.3.3 另再行查閱 PSAR Table 3.2-1c Classification Summary – Balance of Plant，上述主蒸汽管路之分類為 non-safety、Quality Group B（附件二十五）。NRC Regulatory Guide 1.26、ANS Standard 52.1「Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants」及 PSAR Table 3.2-1c Classification Summary – Balance of Plant 三份文件中之規定並不完全一致。

Table 3.2-1c Classification Summary — Balance of Plant						
Principal Component ^a	Safety Class ^b	Location ^c	Quality Group Classification ^d	Quality Assurance Requirement ^e	Seismic Category ^f	Notes
B21 Main Steam System (MS)						
1. Piping including supports—MSL (including branch lines to first valve) from the seismic guide up to but not including the turbine stop valve and turbine bypass valve	N	M,T	B	R	II	(r)

附件二十五 PSAR Table 3.2-1c

5.4 後記：

前述 5.3 節中從 seismic restraint 以後至 turbine stop valve 間之主蒸汽管路定義為 non-safety related 非安全相關之管路，僅須依據 NC-3000 設計，與 NRC Regulatory Guide 1.26 及 ANS Standard 52.1 「Nuclear Safety Criteria for the Design of Stationary Boiling Water Reactor Plants」相關規定似有不符之視察意見，經與計畫主持人廖俐毅博士討論後，廖博士指出，印象中當年原能會審查核四 PSAR 時已有審查委員提出類似質疑，相關處理過程須找到當年文件方可確認。本報告完成前，廖博士已將上述議題相關文件(PSAR 審查意見 Track Number 03-016)傳送作者參考。依據 GE 公司解釋，該文件闡述上述設計符合相關法規規範之重點簡述如下。

(a) PSAR 將此段管路歸類為 Seismic category II A，不屬於 Seismic

category I，安全等級分類即為 non-safety related，但 PSAR 要求須執行動態分析(Dynamic Analysis)。

(b)雖然核二廠之設計將此段管路歸類為 Seismic category I、Safety related component、quality group B，但是核二廠為 BWR 6，核四廠依據 ABWR 設計，此段管路並未 Downgrade。

(c)此段管路之設計、分析方法與結果分別載明於 SECY-93-087 (Dated April 2, 1993, “Policy, Technical, and Licensing Issues Pertaining to Evolutionary and Advanced Light-Water Reactor (ALWR) Designs.”、NUREG-1503 (Final Safety Evaluation Report Related to the Certification of the Advanced Boiling Water Reactor Design) 及 NUREG-1503, Supplement 1 等三份 USNRC 發行之文件中，USNRC 已審查並核准 GE 公司 ABWR 之 SSAR(Standard Safety Analysis Report)與 FSER (Final Safety Evaluation Report)。

基於上述理由，原能會已同意 GE 公司之答覆，此項 PSAR 審查意見已經結案。

6. 結論與建議

本次整體而言，安全釋壓閥洩放管路系統查證研究經驗，應可符合「建立核能電廠建廠期間重要安全相關系統、組件視察技術能力」之研究計畫目的，日後核四專案計畫將持續選取重要安全相關系統作為查證標的，精進視察技術能力之提升。

負責安全釋壓閥洩放管路系統的公司有 B&F Shaw、Joseph Oat 等設計製造公司為 ASME 認證合格廠商，品質文件大致上均足以證明其製造測試過程符合法規規範要求，查證作業中發現之缺失及相關管制建議分類列舉於下。核四專案計畫另將依規定填報視察發現通報表，呈報原能會核管處依程序執行管制措施。

6.1 品質文件查證部分

(a) 建議 SRV 正式交貨後，將品質查證列為重點視察項目，以確認其設計及製造品質符合要求。

(b) Vacuum Breaker 品質文件查證，發現依據 Valve Body 之 CMTR，其 Valve Body 之識別應包括其 Heat Serial 及 Body Serial 二個號碼，但是 NPV-1 Form 中僅登錄 Body Serial No，無法確認其相對關係，建議採取適當作為（例如以附註方式補正），以符合品質文件具可追溯性之要求。

- (c) Vacuum Breaker 之 Valve Body 僅有執行 VT 之檢驗紀錄，且無鑄造件之 Quality Factor 數據可供證明其已執行之檢測符合 ASME Sec III Table ND-2571-1 規定，建議應予以澄清或改善以符合法規要求。
- (d) 不銹鋼管材料品質文件 D-7-C-1 (PSP-0254)Page 2 – 9/36 頁的 Customer Po # 誤繕寫為 7739-008 unit 2，應予以更正為 unit 1。
- (e) SRVDL 不銹鋼管對接銲道使用 Type 308L 銲材，母材與銲材之匹配性與一般銲接工程實務並不吻合，建議請製造廠家提出選用 308L 銲材之考量。
- (f) 碳鋼管件 1B21-PSP-004 製造圖面上 NDE 的記錄為 PT，但實際之檢測報告為 MT，建議製造圖面上 NDE 的記錄為應予以更正，且製造圖面為制式格式，其餘碳鋼管件應存在相同問題，建議應一併修正。
- (g) 全面清查濕井內 72 支 SRVDL 不銹鋼管件品質文件，發現 PSAR 3.9.3.1.13 之 Class 2 非破壞檢測承諾並未落實，建議要求台電公司督促 GE 公司盡速改善，日後管件工地安裝銲接之非破壞檢測作業亦需符合 PSAR 3.9.3.1.13 之承諾，建議要求台電公司以正式紀錄列入品保體系追蹤管控，此外，台電公司與 GE 公司對於 PSAR

超過法規要求部分之清查作業顯然有缺失，建議應再提出更全面性清查作業之方式與其清查結果，以確認 PSAR 特殊要求均已符合並落實至相關設備組件製造與安裝實際作業中。此外，二號機部份之 SRVDL 不銹鋼管件廠製部分對接銲道非破壞檢測作業現況，建議要求台電公司應立即著手清查，並比照一號機採取相同處理作業。

- (h) 部分 SRVDL 不銹鋼管件 ISO 圖中有標示銲接記號之管件，其製造圖(shop drawing)中顯示該段管件廠製作業中並無管件對接之銲接作業，建議應予以澄清或是修正 ISO 圖，以符合現況。其次部分管件製造商之工程傳票(Traveler)中顯示部分管件端口位置有 Build up 銲接作業，建議請廠家說明澄清以確認 Build up 銲接之目的。
- (i) 驟冷管嘴 RT 檢測報告的管材厚度應為 5/8”，但 2584-H1 銲道編號 202、2584-H1 銲道編號 203、2584-F2 銲道編號 202 等三處均誤植為 3/4”，建議應予以更正。
- (j) 驟冷管嘴 RT 檢測報告的接受標準應為 ND-5320，部分檢驗報告誤植或未填寫，建議應予以更正。
- (k) 驟冷管嘴 2584-D1 銲道編號 203 未填寫幾何模糊度，建議應予以

補正。

- (l) 穿越器 1B21-MPEN-0008A 品質文件中缺執行水壓測試(Hydraulic Tests)之測試報告，建議廠家改善或澄清。

6.2 現場查證部分

- (a) Quencher 原廠家要求之儲存等級為 B，放置現場為戶外且地面處於長期積水狀況，設備雖然已利用枕木架高且經要求後以塑膠帆布覆蓋，設備保養維護已有改善，然而長期而言 Quencher 置放於濕井現場，其儲存條件應無法滿足原廠家之儲存等級要求。
- (b) 基於工程現實，重要設備提前移送至現場可能無法完全避免，但是一般而言，放置於庫房中之設備組件，其倉儲條件均能符合相關法規規範及廠家建議，然而移入工地後，因受限於核四廠採取之 Open Top 工法，除非該設備安裝之樓層完成封頂作業，設備儲存環境與條件往往遠不如庫房中，只要是儲存等級為 C 級（室內無溫度控制）以上之設備，其儲存環境條件必定無法符合廠家建議或規範要求。建議施工處應配合實際工程進度，整體妥善規劃設備移入工地之時程，以使設備存放於較差條件之時間盡量合理縮短，避免設備長期處於不符廠家規範之儲存條件。

6.3 系統文件查證部分

- (a) ABWR 訓練教材第三篇 第一章主蒸氣系統有關膨脹伸縮箱之敘述應為錯誤，另外訓練教材第二篇 第四章自動釋壓系統中將 Non-ADS 之 SRV 定位為 Non-Safety-Related，與 PSAR 之規定不符，建議台電公司一併修正。
- (b) GE 公司製備之「主蒸氣系統過壓保護報告」(Main Steam System Overpressure Protection Report) 經專業工程師簽證，且該報告之結論中明確表示，過壓保護系統之設計經分析後，確認 ASME Sec III NB、NC、ND-7000 相關規定均可符合，就程序上而言，應可符合 ASME 法規要求。
- (c) Seismic restraint 之後至 Turbine stop valve 之間之主蒸汽管路之 Safety class 及 Seismic category 等級分類議題，當年原能會審查核四 PSAR 時已有審查委員提出相同質疑，經 GE 公司提出解釋後，原能會已同意 GE 公司之答覆，此項 PSAR 審查意見已經結案。

誌謝

核四廠一號機安全釋壓閥洩放管路系統查證研究報告為核四建廠安全管制支援專案計畫團隊合作之成果，計畫主持人廖俐毅博士督導協助之功當居首位，團隊成員中吳毓秀先生負責壓力承持材料之材料測試証明及銲接作業查證，張瑞金先生專責非破壞檢測作業查證作業，劉 驥先生、史美嘉先生於資料搜尋、聯繫作業及行政支援等各方面之協助，謝謝他們。

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