出國報告（出國類別：開會）

赴捷克參加2018 ASME 壓力槽與管路國際研討會出國報告

服務機關：核能研究所
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派赴國家/地區：捷克/布拉格
出國期間：107 年 7 月 14 日~107 年 7 月 22 日
報告日期：107 年 8 月 15 日

摘 要

此次公差主要為配合核研所目前執行的中央計畫「原子能系統工程跨域整合發展」項下分項計畫「核電終期營運安全與用過核子燃料貯存技術發展」，前往捷克布拉格(Prague)參加由美國機械工程師學會(ASME)於 107 年 7 月 15 日至 7 月 20 日召開之「2018 年 ASME 壓力容器及管路國際研討會」(2018 ASME Pressure Vessels and Piping Conference)，於會議中發表 2 篇研究論文，並主持兩場論文發表場次。職配合相關研究專長與目前所執行的研發計畫需求，參與相關領域的論文發表議程與教育訓練，並與國外專家學者技術交流，蒐集相關技術資料，瞭解與目前核安議題需求、並建立交流管道，以精進核安議題之結構評估技術，特別是積極參與近年來於 ASME PVP 研討會漸受重視之核後端相關組件結構完整性議題。此外，職亦參與相關學術領域之委員會議，以討論未來技術領域的會議場次規劃與論文方向。透過專業領域論文發表、會議主持、教育訓練與學術委員會議的參與，對於國際發展方向與技術掌握，於國內的研究推動上，有實質上的助益。因此，建議應鼓勵同仁積極參與此類型之研討會，以發表研究成果並與國際學者專家技術交流，提升本所能見度並建立合作與交流學習的對象。另外，核後端相關組件的結構分析研究領域，亦建議應分配適當之研究資源，以維繫人才運用並確保非核家園後國內放射性放棄物的貯存安全。亦建議同仁在未來參加大型研討會時可嘗試參與相關學術委員會，以爭取主導性並增加本所曝光度。

關鍵字：結構完整性、壓力溫度運轉曲線、機率破裂力學、乾式貯存、老化管理

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摘　要

一、 目的

此次公差主要為配合核研所目前執行的中央計畫「原子能系統工程跨域整合發展」項下分項計畫「核電終期營運安全與用過核子燃料貯存技術發展」，前往捷克布拉格(Prague)參加由美國機械工程師學會(ASME)於 107 年 7 月 15 日至 7 月 20 日召開之「2018 年 ASME 壓力容器及管路國際研討會」(2018 ASME Pressure Vessels and Piping Conference)。本次會議職主要發表「Comparison of Pressure-Temperature Limits for a Pressurized Water Reactor Pressure Vessel Considering Beltline and Extended Beltline regions (考慮腹帶區與延伸腹帶區之壓水式反應器壓力槽壓力溫度運轉限度比較)」，並與國立清華大學核工所馮玉明教授與職共同指導，為本所補助國內大學博士班研究生研究獎助學生黃品鈞先生共同發表「Application of Flaw Updating Process on Probabilistic Structural Evaluation for a Reactor Pressure Vessel under Pressurized Thermal Shocks (裂紋更新程序應用於反應器壓力槽承受壓力熱震之機率性結構評估)」等兩篇研究論文。ASME 每年舉辦之「壓力容器及管路國際研討會」，為 ASME 於壓力容器及管路相關工程技術與應用的重要國際會議，會中主要聚集國際間機械工程、結構工程、能源工程等相關應用領域的研究學者及專家就各項研發技術議題發表專題演講與研究論文。本次會議議題技術論文發表主題涵蓋範圍，依不同專門領域主要區分為：(1)法規及標準(Codes & Standards)；(2)電腦模擬技術與螺栓接合(Computer Technology & Bolted Joints)；(3)設計及分析(Design & Analysis)；(4)流體結構交互作用(Fluid-Structure Interaction)；(5)高壓技術(High Pressure Technology)；(6)材料與製造(Materials & Fabrication)；(7)運轉，應用與組件(Operations, Applications, & Components)；(8)地震工程(Seismic Engineering)；(9)學生論文競賽(Student Paper Competition)以及(10) ASME 非破壞檢測、診斷與預測(Nondestructive Evaluation, Diagnosis and Prognosis)等議題，另外亦包含 EPRI Expert Workshop on Creep Continuum Damage Models for Structural Mechanics 以及 1st International Workshop on Risk & Resilience of Industrial Installations Against Natural Threats & Mitigation Strategies 等二領域專題討論會。各技術領域相關的論文，則於個別之技術議程中進行發表，並相互研討與技術經驗交流。

本次 ASME 舉辦之壓力容器及管路國際研討會，於捷克布拉格市之 Hilton Prague 飯店舉行，按照大會慣例，皆會於全體會議(Plenary session)中以兩場主題演講(Keynote speech)做為大會開場序幕。本次大會主題為促進全球壓力容器與管路產業的優越性(Promoting Excellence in the Global Pressure Vessel & Piping Industry)，並以兩篇專題演講：美國商業核電面臨挑戰的應對(Addressing the Challenges of Commercial Nuclear Power in the United States)，以及再生能源對化石燃料發電廠的影響-考慮疲勞和潛變疲勞的適應性挑戰(Impact of Renewable Energy Generation on Fossil Fuel Power Plants — Challenges of Flexibility Considering Fatigue and Creep-Fatigue)。各項技術論文發表場次則於 7/16(一)起至 7/19(四)舉行，至於 EPRI 與風險可靠度等相關專題討論會，則安排於 7/19(四)至 7/20(五)舉行。本次研討會總計約有接近 750 篇不同領域的論文，分別以約 200 場技術場次進行發表。參加的學者專家來自於約 40 多個國家，可謂規模盛大。職的論文分別於亞洲結構完整性計畫(Asian Programs in Structural Integrity) I 與 II 場次中發表，職亦擔任該二場次的議程主持(Session chair)。至於技術論文發表之聆聽，除了參加職的研究專長相關領域，如結構完整性評估、破壞力學應用或機率破裂力學風險分析等核能電廠組件運轉安全相

關場次外，因應國內未來非核家園政策發展趨勢，本次公差職亦著重參加核後端領域相關技術場次，包含用過核子燃料密封筒結構完整性(MF-32-1: Structural Integrity for Spent Fuel Canisters)、放射性物料貯存與運輸(OAC-4-1、OAC-4-2、OAC-4-3: Radioactive Materials (RAM) Storage and Transport – I, II & III)，以及安排於其他場次的個別核後端組件相關論文發表。另外，亦參加大會於 7/16(一)下午安排之 Aging Management for Spent Fuel Dry Storage and Subsequent Transportation 教育訓練，以逐步地了解國際間相關技術於核後端領域之應用。透過與來自不同國家相關領域的學者專家互相交流研討並蒐集相關資訊，對於爾後所內研發方向之規劃有實質上的助益。

此外，職亦參加大會於 7/18(三)中午之材料與製造(Materials & Fabrication, MF)技術領域委員會議(Committee meeting)，討論下一年度研討會技術論文發表領域與場次規劃。相關之公差行程，將於後文中摘要說明。

二、 過程

此次公差共計 9 天，由 107 年 7 月 14 日至 7 月 22 日。主要是參加在捷克布拉格市內之 Hilton Prague 飯店自 107 年 7 月 15 日至 7 月 20 日所舉辦「2018 年 ASME 壓力容器及管路國際研討會」(2018 ASME Pressure Vessels and Piping Conference)，為 ASME 一年一度辦理之壓力槽與管路領域的重要國際研討會，藉由參與該領域國際研討會，瞭解各國針對核能結構組件完整性、破壞力學與失效評估、核安管制議題，以及核後端組件延伸應用等之交流研討，以增進核能安全分析與評估等相關技術之發展。行程及工作日誌大要如下：

日期	行程	公差地點	工作內容
107.07.14(六) | 107.07.15(日)	台北→巴黎→布拉格	布拉格	去程
107.07.15(日)		布拉格	休息，準備，與資料整理
107.07.16 (一) | 107.07.20 (五)		布拉格	參與 2018 ASME PVP 研討會、主持會議並發表論文
107.07.21 (六) | 107.07.22 (日)	布拉格→巴黎→台北		返程

7 月 14 日至 15 日，星期六至星期日

7 月 14 日自桃園機場搭乘長榮航空出發，於隔日(7 月 15 日)上午 7 時許到達法國巴黎戴高樂國際機場，經大約 9 小時的等待，於下午 16 時轉機飛往捷克布拉格，並於當日下午 18 時 30 分飛抵布拉格市。飛抵捷克布拉格後便搭車前往下榻旅館 Alveo Suites 投宿，抵達旅館時已大約晚間 7 時許，先前往市區兌換公差期間所需之當地幣別(捷克克朗 CZK)，再返回下榻旅館梳洗用餐並準備 ASME 研討會報告資料，以及連繫熟識之國際學者以準備本次公差所需其他相關事項。

7 月 16 日至 20 日，星期一至星期五

7/16 (一)上午 8:00 赴召開大會的 Hilton Prague 飯店二樓報到處進行會議報到手續，並且領取相關資料(會議註冊費為論文作者早鳥優惠價 989 歐元，已於公差前預繳)；圖一為職於報到處前留影。大會期間於會場或論文發表場合與許

多來自世界各國的學者專家會晤，大致計有：美國沙瓦那河國家實驗室(Savannah River National Laboratory)資深研究員 Poh-Sang Lam (林寶生)博士與 Andrew Duncan 博士、SIA (Structural Integrity Associates, Inc.)的研發工程師 Do-Jun Shim 博士、EMC^2 公司(Engineering Mechanics Corporation of Columbus)的 Gery Wilkowski 博士與 Frederick Brust 博士、阿港國家實驗室(Argonne National Laboratory)的 Zenghu Han (韓增虎)博士、橡樹嶺國家實驗室(Oak Ridge National Laboratory)的 Xiang Chen 博士、GE Power 的 Haiyang Qian (錢海洋)博士；英國 Amec Foster Wheeler 的 Jinhua Shi (師金華)博士；日本東京大學 Naoto Kasahara 教授、大阪大學 Masahito Mochizuki 教授、電力中央研究所(Central Research Institute of Electric Power Industry, CRIEPI)的 Naoki Miura 博士、JAEA (Japan Atomic Energy Agency)的 Kai Lu (盧凱)博士、Institute of Nuclear Safety System, Inc.的 Masayuki Kamaya 博士；韓國 Korea University 的 Yun-Jae Kim 教授、Kyung Hee University 的 Yoon-Suk Chang 教授，以及 KEPCO E&C(Korea Electric Power Corporation, Engineering and Construction Company, Inc.)的 Senior vice president Kye Kwang Jee；中國北京清華大學的 Yinghua Liu (劉應華)教授、哈爾濱工程大學 Gongmin Liu (柳貢民)教授、上海核工程研究設計院的 Yupeng Cao (曹昱澎)博士與高級工程師 YongJian Gao (高永建)、中國特種設備檢測研究院的 Lele Gui (桂樂樂)博士，以及中國核動力研究設計院的 Kai Sun (孫凱)等人。其中職與部分學者已有學術上的往來，於電廠結構完整性、機率破裂力學分析及結構可靠度評估上已有許多技術與意見之交流。圖二為職於開幕演講後與盧凱博士、曹昱澎博士及高永建先生的合影，其餘學者專家交流討論之摘要，則於後文擇要說明。

圖一　職於 2018 ASME PVP 研討會報到處前留影。

圖二 本所周雄偉副研究員與 JAEA 盧凱博士(右二)、上海核工程研究設計院曹昱澎博士(右一)與高永建先生(左)於 2018 ASME PVP 研討會會場合影。

本次研討會的技術論文發表與教育訓練一連四天分依不同議程展開，7 月 20 日(五)則以專題討論會為主。經統計大致有 750 篇技術論文發表，依所屬專業領域共分為 200 多個技術場次舉行，堪稱規模盛大。相關之議程與發表之論文場次與論文資訊如附件一。此次會議主要涵蓋 10 項不同議題，由個別之學術委會主辦，包含(1)法規及標準(Codes & Standards, CS)；(2)電腦模擬技術與螺栓接合(Computer Technology & Bolted Joints, CT)；(3)設計及分析(Design & Analysis, DA)；(4)流體結構交互作用(Fluid- Structure Interaction, FSI)；(5)高壓技術(High Pressure Technology, HPT)；(6)材料與製造(Materials & Fabrication, MF)；(7)運轉，應用與組件(Operations, Applications, & Components, OAC)；(8)地震工程(Seismic Engineering, SE)；(9)學生論文競賽(Student Paper Competition, SPC)以及(10) ASME 非破壞檢測、診斷與預測(Nondestructive Evaluation, Diagnosis and Prognosis, NDPD)等。依不同技術領域安排 4 場次教育訓練(Technical Tutorials & Workshops, TW)，包含：(1) Aging Management for Spent Fuel Dry Storage and Subsequent Transportation、(2) Fracture Mechanics Application to Piping、(3) Advanced Fatigue Analysis，以及(4) Auto-Refrigeration & Brittle Fracture Prevention 等。另外，亦包含 EPRI Expert Workshop on Creep Continuum Damage Models for Structural Mechanics 以及 1st International Workshop on Risk & Resilience of Industrial Installations Against Natural Threats & Mitigation Strategies 等二領域專題討論會。

7 月 16 日星期一上午抵達會場報到後，職便參加第一時段場次 Session 1.1B (MF-1-1)的技術論文發表，其議程主題為破壞力學在失效評估的應用-I

(Application of Fracture Mechanics in Failure Assessment-I)。該場次之發表論文主要為材料參考溫度之評估與破壞力學實驗之相關研究，亦包含疲勞與潛變對裂紋成長行為的分析等。隨後，便是大會於 10:15 隆重舉行之開幕儀式(Opening Ceremony)及主題演講，如圖三所示，現場與會人士相當踴躍。首先，由擔任本次 2018 ASME PVP Conference Chair 的 Pierre Mertiny 博士進行歡迎致辭與開幕演說、然而由於擔任 Technical Program Chair 的 Hakim A. Bouzid 與擔任 Conference Advisor 的 Sam Zamrik 未克出席，便由今年大會主席 Pierre Mertiny 於歡迎致辭後，改邀請由去年之主席 Douglas Scarth 博士就今年主題：促進全球壓力容器與管路產業的優越性(Promoting Excellence in the Global Pressure Vessel & Piping Industry)進行演說(如圖四)。至於本次大會的主題演講，則由美國 Nuclear Division Structural Integrity Associates, Inc.的副總裁兼首席核能部長 Christine King 女士(如圖五)，以及捷克 Doosan Škoda Power 的渦輪發電機產品總監 Luboš Prchlík 博士，分別進行兩場專題演講：(1) Addressing the Challenges of Commercial Nuclear Power in the United States (美國商業核電面臨挑戰的應對)；(2) Impact of Renewble Energy Generation on Fossil Fuel Power Plants — Challenges of Flexibility Considering Fatigue and Creep-Fatigue (再生能源對化石燃料發電廠的影響-考慮疲勞和潛變疲勞的適應性挑戰)。以下摘要概述之：

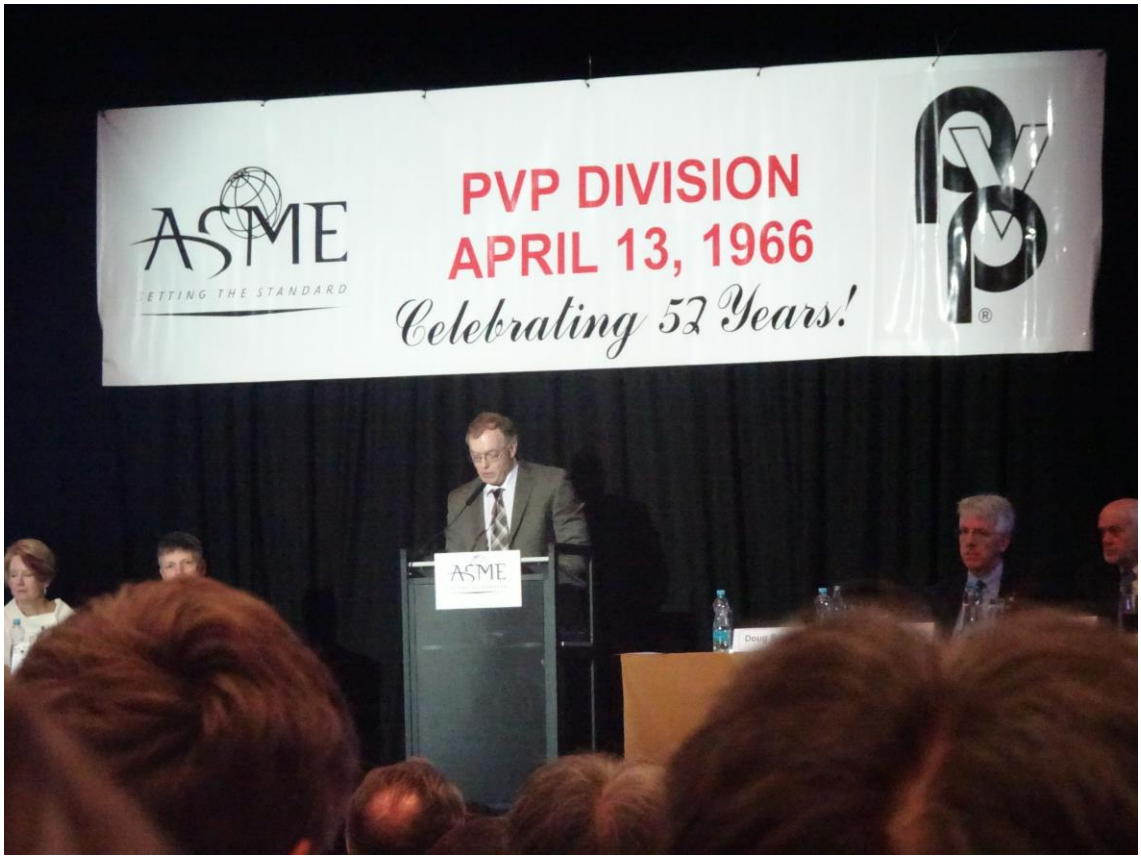
(1) Addressing the Challenges of Commercial Nuclear Power in the United States

此專題演講主要表達目前美國商業核電所面臨的挑戰，包含應如何更安全與更可靠地運轉老舊形式的核能電廠，以及如何適應市場對於廉價的天然氣與受補貼的再生能源對核能發電之衝擊。此外，如何吸引新的工程師、科學家或其他專業人員持續投入核能產業，並有效率地轉變數十年來核電得知識與觀念，研發更有效率、更高可靠度與更低汙染之核反應器，更是在人才資源上面臨的重大挑戰。本專題演講以量化數據分析，配合資深從業人員的觀點，理性地探討美國發電市場的趨勢與需求，並勉勵大家於遵守紀律的前提下，大膽地發揮創造力與多元化設計能力，並發揮毅力與執行力，追求卓越，以面對市場多變化的挑戰。圖六與圖七為翻攝錄於此專題演講的簡報投影片內容。

(2) Impact of Renewble Energy Generation on Fossil Fuel Power Plants — Challenges of Flexibility Considering Fatigue and Creep-Fatigue

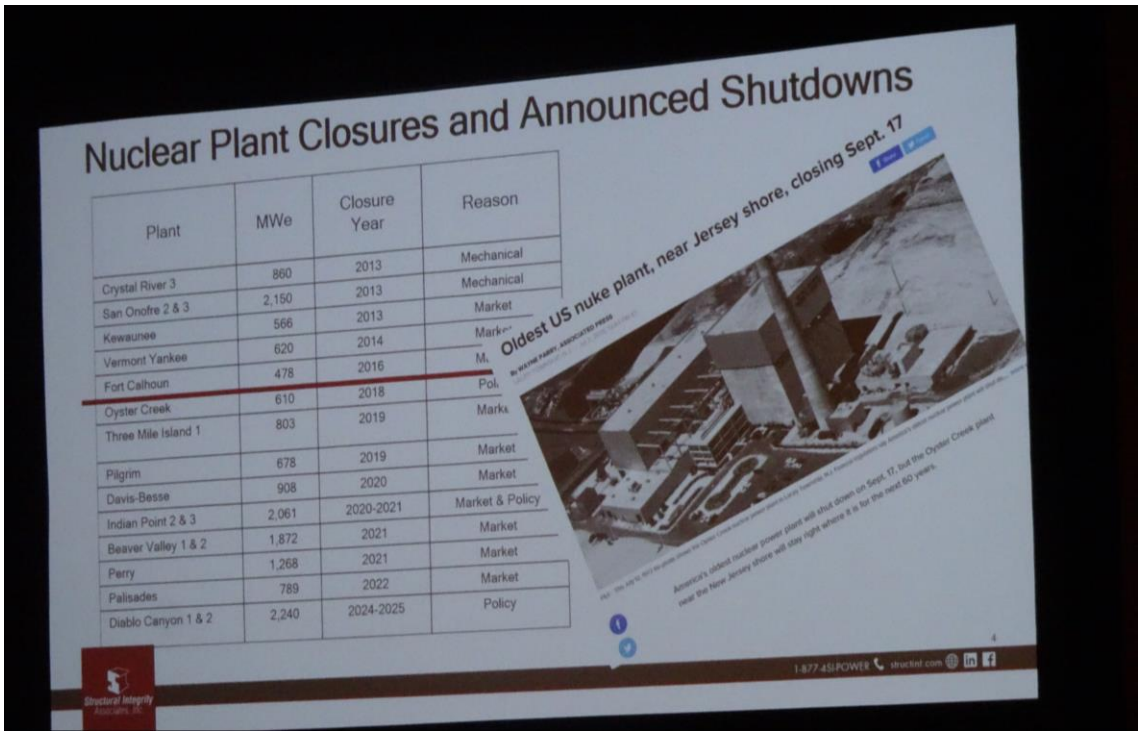
此專題演講探討主題主要針對世界趨勢中將大規模部署的再生能源，因其性質不穩定性，故須配合化石燃料發電加以互補。然而能源生產匯集到現有電網中有三大挑戰需加以解決，分別是穩定性、效率與靈活性，特別是靈活性，為再生能源面臨最重要需克服的議題。因此，為克服能源調度靈活性的問題，化石燃料發電(尤其是燃氣發電)需更加有彈性地運轉。如此將對現代蒸汽和燃氣渦輪機運行產生新的挑戰，包括增加渦輪機啟動和負載的變化，縮短啟動時間或需於低負載狀態下長期運轉，同時保持高效率和可靠性。然而，如此操作模式變化將會導致疲勞、熱負載和潛變疲勞負載增加。因此，開發適用於未來靈活操作模式下的設計分析技術與精進疲勞-潛變壽命評估模式，為目前因應電網中再生能源占比逐漸增加下之關鍵技術。此演講內容中亦以多張圖片說明渦輪機於靈活操作模式下面臨之劣化機制，本報告則不再一一說明。圖八與圖九為翻攝錄於此專題演講的簡報投影片內容。

圖三　大會開幕儀式現場

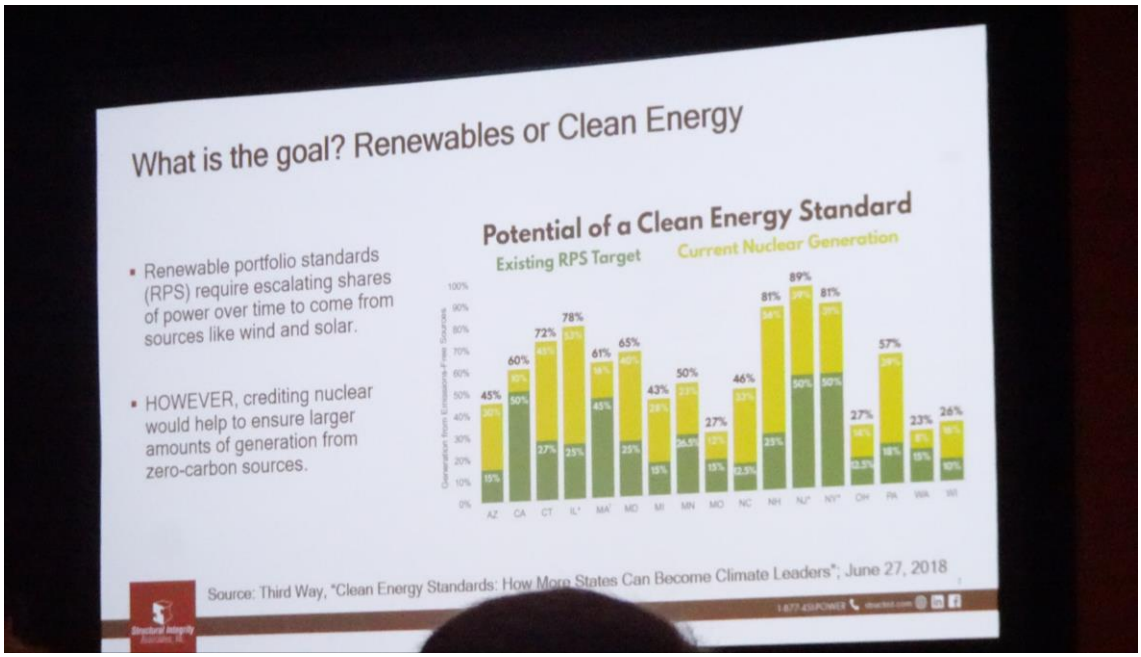


圖四　去年主席 Douglas Scarth 博士就今年會議主題進行演說

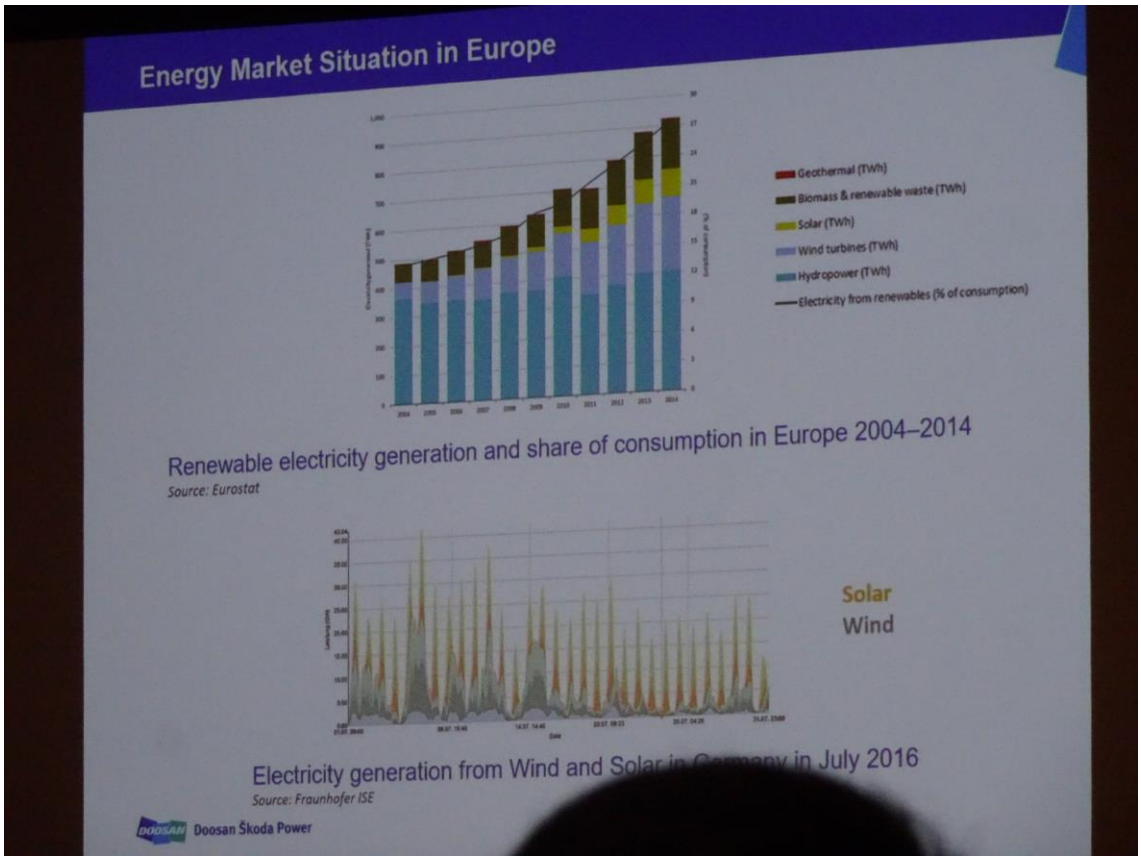
圖五　Christine King 女士進行第一場專題演講



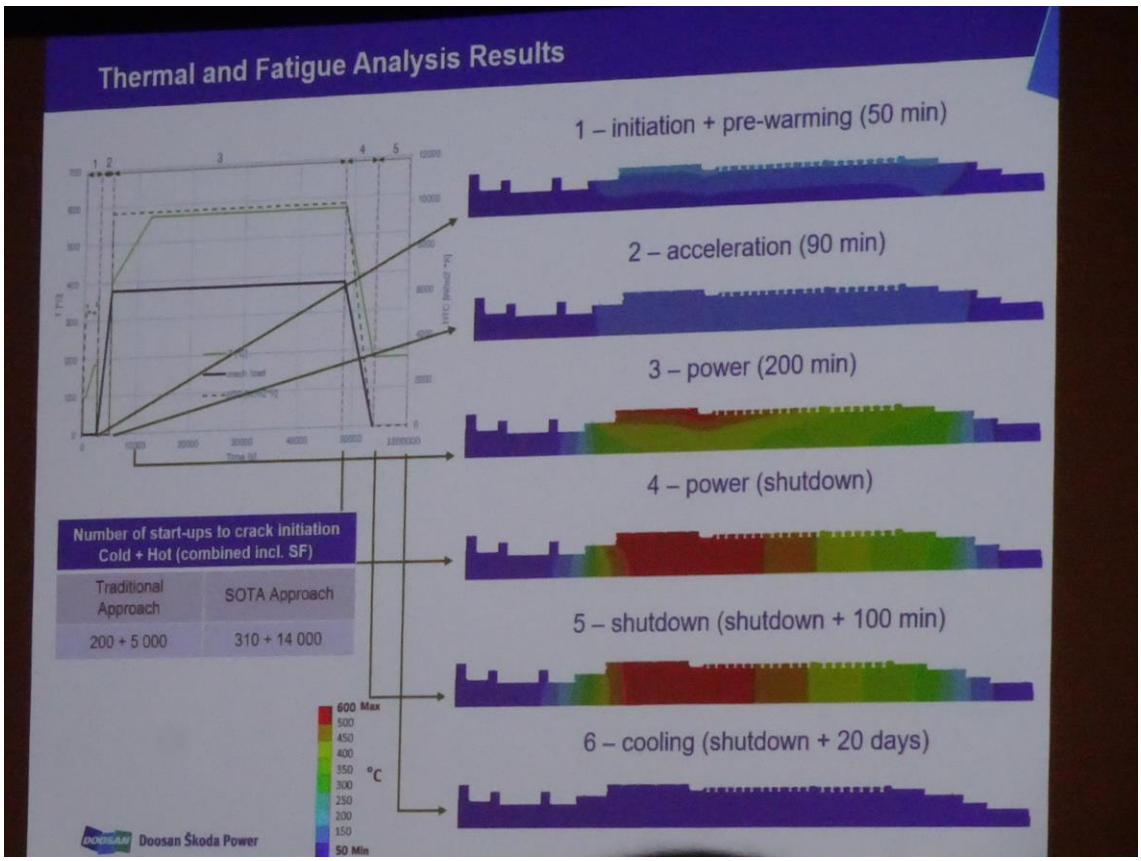
圖六　專題演講 Addressing the Challenges of Commercial Nuclear Power in the United States 簡報節錄



圖七　專題演講 Addressing the Challenges of Commercial Nuclear Power in the United States 簡報節錄



圖八　專題演講 Impact of Renewble Energy Generation on Fossil Fuel Power Plants — Challenges of Flexibility Considering Fatigue and Creep-Fatigue 簡報節錄



圖九　專題演講 Impact of Renewble Energy Generation on Fossil Fuel Power Plants — Challenges of Flexibility Considering Fatigue and Creep-Fatigue 簡報節錄

職於本研討會所發表的兩篇論文，分別安排於 7 月 19 日(四)上午之 Session 4.2I (MF-24-1) Asian Programs in Structural Integrity – I，以及下午之 Session 4.3I (MF-24-2) Asian Programs in Structural Integrity – II 中進行演說。本技術議程(亞洲結構完整性計畫 Asian Programs in Structural Integrity)，為美國南卡大學(University of South Carolina)的 Yuh Jin Chao (趙玉津)教授、沙瓦那河國家實驗室(Savannah River National Laboratory)的 Poh-Sang Lam (林寶生)博士，以及瑞士 Paul Scherrer Institut (PSI)的 Guian Qian (錢貴安)博士等於 2015 年所發起(Develop)，期望藉由 ASME PVP 研討會的機會，發表屬於亞洲國家於結構完整性相關的研究成果。職雖於 2016 年開始加入此計畫，但因本所出國公差員額不定，無法每年固定參加該研討會，故主要以 Co-developer 的身份、擔任議程主持(Session chair)與審查投稿論文的方式，協助此議程進行。本次大會，便安排由職擔任 Asian Programs in Structural Integrity – II 之議程主持。然而，因趙玉津教授與錢貴安博士今年另有要務不克參加本研討會，故臨時亦委由職代替錢博士，主持 Asian Programs in Structural Integrity – I 之議程。

職所演說的論文：Comparison of Pressure-Temperature Limits for a Pressurized Water Reactor Pressure Vessel Considering Beltline and Extended Beltline Regions，安排於 Asian Programs in Structural Integrity – I 中發表，如圖十，為職與本所機械及系統工程專案沈祐宇助理研究員與專案主持人黃金城博士共同撰寫，主要為應用 ASME 法規與有限元素法，探討壓水式反應器(Pressurized Water Reactor, PWR)壓力槽在建立壓力-溫度運轉限度(P-T curve)時，同時考慮受輻射脆化影響最嚴重之腹帶區，以及輻射脆化較輕微，但因其

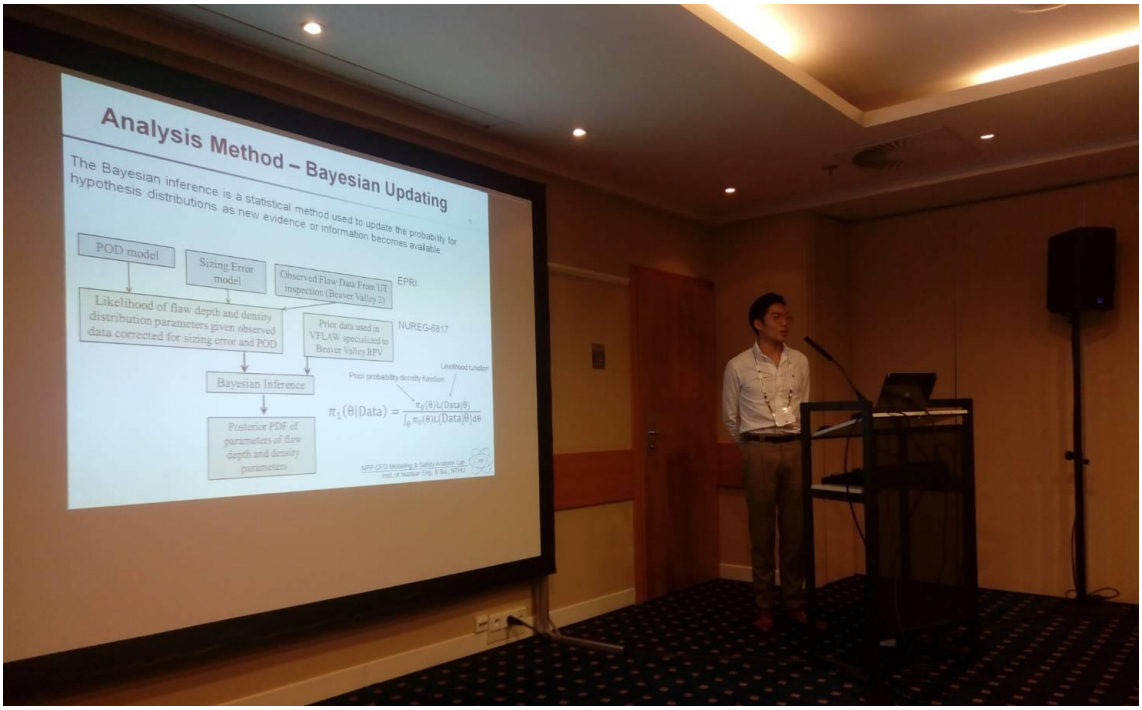
結構不連續會有應力集中現象之管嘴結構，兩者之間的比較。本論文相關內容詳如附件二，職亦為該議程之主持人(如圖十一)，共同主持人(Session co-chair)則為中國特種設備檢測研究院的 Lele Gui (桂樂樂)博士擔任，並於職演說時由桂博士為職進行介紹。議程一開始由職首先進行本議程之開場介紹後，便開始相關論文演說。除職的論文演說外，本場次另有三篇論文發表，分別由中國核動力研究設計院的 Kai Sun (孫凱)發表：The Fracture Toughness Properties of China Manufactured Reactor Pressure Vessel Steels in Transition Temperature Range；桂樂樂博士發表：Toughness Requirement of Chinese Pressure Vessel Steel 07MnNiMoDR Based on Fracture Mechanics Assessment Method；以及英國 Amec Foster Wheeler 的 Jinhua Shi (師金華)博士發表：A Study on the Fracture Toughness at Different Locations of SMAW Welded Joint of Primary Coolant Piping。該場會議結束後，職與相關論文發表人員與部分參與會議人員的合影如圖十二所示。

職發表的另一篇論文，為職與本所補助國內大學博士班研究生研究獎助學生黃品鈞先生(清華大學核工所)及馮玉明教授共同撰寫之論文：Application of Flaw Updating Process on Probabilistic Structural Evaluation for A Reactor Pressure Vessel Under Pressurized Thermal Shocks，安排於 7 月 19 日(四)下午之 Asian Programs in Structural Integrity – II 議程中發表，並由黃品鈞先生進行論文簡報，如圖十三。本研究主要應用貝氏更新(Bayesian updating)方法，修正模擬經檢測後之反應器壓力槽爐壁裂紋分布，再經由機率破裂力學分析，比較裂紋修正前後的模擬對反應器壓力槽承受壓力熱震(Pressurized thermal shock)暫態之破裂機率，並探討個別形式暫態的影響，本論文相關內容詳如附件三。本場次同樣由職擔任主持人，並由上海核工程研究設計院的 Yupeng Cao (曹昱澎)博士擔任共同主持人。本場次其餘之論文發表，則分別由曹昱澎博士發表：Constraint Assessment for Cruciform Specimens with a Semi-Elliptical Crack；中國北京清華大學的 Yinghua Liu (劉應華)教授發表：Material Constraint Effect for the Mode II Crack in Power-Law Creeping Solids；以及哈爾濱工程大學的 Gongmin Liu (柳貢民)教授發表：Analysis of Fluid Structure Interaction Behavior of Straight Pipe With Non-Penetrating Circumferential Crack 等論文。最後，隨者論文發表的完成，由職進行最後總結後，便圓滿地結束 Asian Programs in Structural Integrity 的相關議程。

圖十　本所周雄偉副研究員進行之論文演說

圖十一　本所周雄偉副研究員主持 Asian Programs in Structural Integrity – I

圖十二　本所周雄偉副研究員(右三)與美國橡樹嶺國家實驗室 Xiang Chen 博士(右起)、中國核動力研究設計院孫凱、英國 Amec Foster Wheeler 師金華博士、上海核工程研究設計院曹昱澎博士、JAEA 盧凱博士，以及中國特種設備檢測研究院桂樂樂博士，於 Asian Programs in Structural Integrity - I 會後合影



圖十三　清華大學核工所博士班研究生黃品鈞先生進行之論文演說

除了職的論文發表與參加職本身研究專長領域，如結構完整性評估、機率破裂力學，與破壞力學應用等核能電廠組件運轉安全相關場次外，為因應國內未來非核家園政策發展趨勢以及所內研發方向拓展，本次公差職亦著重參加核後端領域相關技術場次與教育訓練，重點說明如下：

(一)核電運轉與核安議題相關：

(1)壓力組件之結構完整性(Structural Integrity of Pressure Components – I & II)：此議程主要探討核能電廠反應器冷卻劑壓力邊界(Reactor coolant pressure boundary, RCPB)組件於運轉與長期劣化下之結構完整性評估。較重要的論文為由西屋公司 J. Brian Hall 所發表的：Demonstrate ASME Section XI Appendix G Margins for Pressurized Water Reactor Inlet and Outlet Nozzle Corner Regions，因與職發表的論文探討議題相似，故非常具參考性，惟該論文中比較延伸腹帶區管嘴與腹帶區的 P-T curve 時，為考慮 10 CFR 50, App. G 修正後之腹帶區 P-T curve，故結果和職的論文不盡相同。另外，長期與本所有合作往來的美國橡樹嶺國家實驗室 Terry Dickson 先生與 Richard Bass 博士，亦撰寫一篇有關機率破裂力學 FAVOR 程式應用的論文：Application of the FAVOR-OCI Fracture Mechanics Computer Program to ASME Code Section XI, IWB-3610 Flaw Acceptance Criteria Evaluations，並由 EPRI 之 Jonathan Parker 代為演說

(2)環境疲勞議題(Environment Fatigue Issues)：本場次主要探討核能電廠組件金屬材料，特別是奧斯田鐵(Austenitic)不鏽鋼，於 PWR 水環境條件下之疲勞行為或裂紋成長壽命研究，主要係因由於 ASME 第三章第 1 部附錄 I 所規定的疲勞設計曲線(Fatigue design curve)並未考慮到金屬組件在爐水高溫高壓環境下因材料腐蝕所造成的疲勞加劇問題，導致無法反映組件在實際運轉環境下的疲勞破壞情形，因此，近年來相當多研究關於金屬組件在環境效應下的疲勞評估方法與研究陸續被提出討論。例如日本 Institute of Nuclear Safety System, Inc.的 Masayuki Kamaya 博士所發表之 Influence of Mean Strain on Fatigue Life of Stainless Steel in PWR Water Environment，以及英國 Amec Foster Wheeler 的 Norman Platts 發表的 Effect of Surface Condition on the Fatigue Life of Austenitic Stainless Steels in High Temperature Water Environments 等，皆分別針對運轉載重特性與 PWR 水環境等因子，探討組件裂紋成長機制與行為。

(二)核後端議題相關：

(1) Aging Management for Spent Fuel Dry Storage and Subsequent Transportation 教育訓練：安排於 7/16(一)下午，課程內容為四個小時。鑒於用過核子燃料未來中期貯存的期程，可能因最終處置場址難覓而將大幅延長，因此乾式貯存相關設施之老化管理議題便開始受到重視。此教育訓練的 Developer 為來自美國阿港國家實驗室的 Yung Liu 博士與 Zenghu Han(韓增虎)博士。然而由於 Yung Liu 博士無法出席本研討會，因此由韓增虎博士進行講說。課程內容包含美國用過核子燃料乾式貯存(即放射性材料)的適用法規和安全標準(Regulations and Safety Standards)介紹、核子燃料循環基礎知識背景說明，以及時限老化分析(Time-limited Aging Analyses, TLAAs)與老化管理方案(Aging Management Programs, AMPs)的準則、美國發展現況、評估架構與實施方法等，並以實際案例簡單地說明相關定義與範圍，使參加者能更容易地了解其應用之區分。經全程參與的人員，大會則頒發參訓證書以茲證明，如圖十四。由於本次教育訓練大會並無販售相關教材，會後職以電子郵件與韓博士聯繫取得教材簡報檔，如附件四，可作為國內相關研究人員的參考：

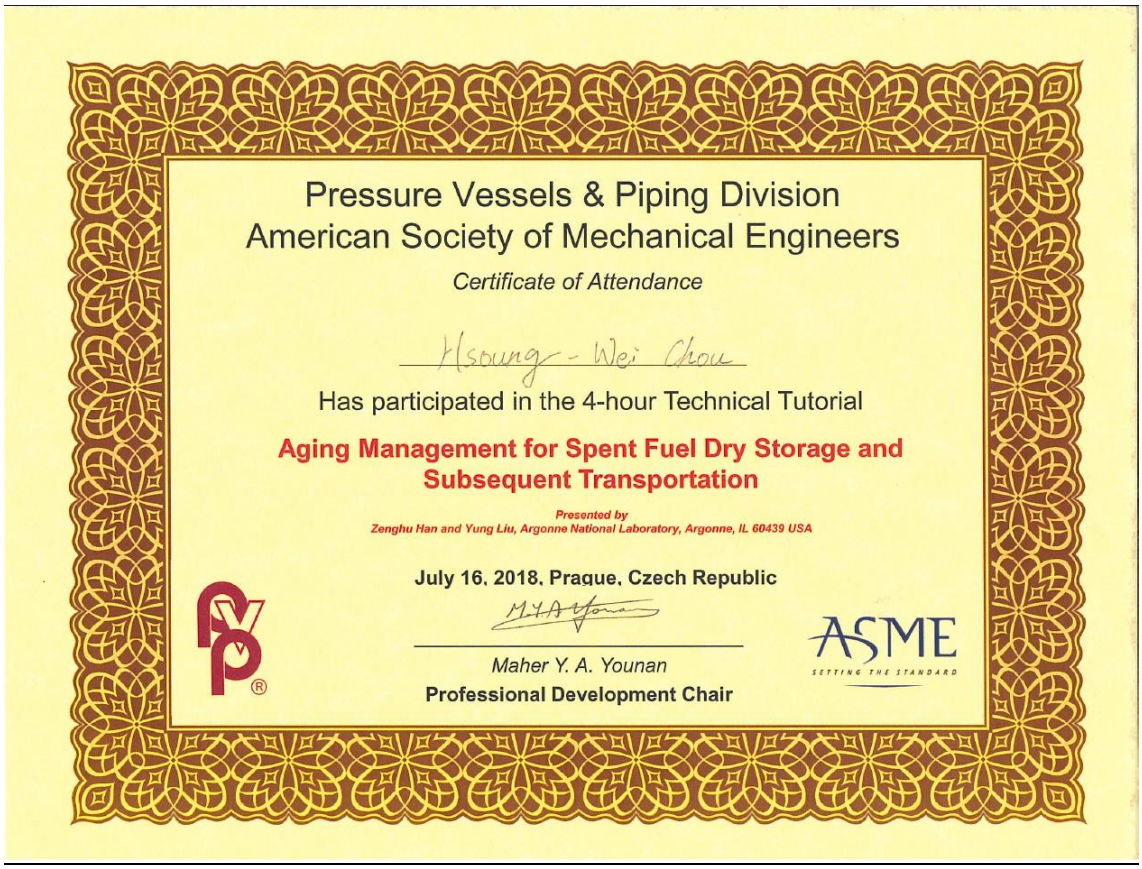
(2)放射性物料貯存與運輸(Radioactive Materials (RAM) Storage and Transport – I, II & III)：此議題安排於 7/18(三)，以 Session 3.1K (OAC-4-1)、Session 3.2K (OAC-4-2)，以及 Session 3.3K (OAC-4-3)等三場次舉行。此議題共計 11 篇論文發表，發表主題範圍相當廣泛，但皆為核後端組件相關之應用。大致包含放射性物料貯存容器掉落測試及分析、用過核子燃料運送護箱與運輸測試(Transportation test)、密封 O 形環設計與測試、容器外包件設計與熱分析、高分子密封材料老化試驗，以及運送包件(或護箱)的撞擊限制器(Impact limiter)設計、分析與材料等…。其中因職所屬機械及系統專案將執行用過核子燃料自乾貯場運送至最終處置場的運輸規劃與安全評估工作，故對美國桑迪亞國家實驗室(Sandia National Laboratories)的 Sylvia Saltzstein 與 Elena Kalinina 兩位女士(分別為該實驗室用過核子燃料儲存、運輸與安全研發的 manager 與 project leader)所共同簡報的論文：Results and Correlations from Analyses of the ENSA ENUN 32P Cask Transport Tests，深感興趣。該論文介紹用過核子燃料運送護箱與運輸現地測試規劃、執行與數據量測，以及後續的數據分析與結構安全評估的工作規劃等，特別是對其中所播放有關運輸測試的影片，更是印象深刻。職目前已以電子郵件與 Sylvia Saltzstein 女士聯繫，希望能提供簡報檔、影片檔及相關報告作為未來本所研發的參考，Sylvia Saltzstein 女士亦已回應非常高興本所對於該團隊的研究工作感到關注，並表達待相關計畫的 Final report 完成後，非常樂意提供相關檔案給本所參考。待職收到相關檔案後便提供本所同仁參考。

(3)用過核子燃料密封筒結構完整性(Structural Integrity for Spent Fuel Canisters)：此議程安排於 7/19(四)上午之 Session 4.1I (MF-32-1)，由美國沙瓦那河國家實驗室資深研究員 Poh-Sang Lam (林寶生)博士與 Andrew Duncan 博士，以及韓國 Korea University 的 Yun-Jae Kim 教授共同發起，並由 Kim 教授擔任主持人，林博士擔任共同主持人。此議題主要鑒於用過核子燃料之最終處置可能因最終處置場址難覓，以致乾式貯存運轉年限可能因而延長。因此環境劣化議題，特別是乾貯密封鋼筒可能因海風吹拂環境下發生氯化物導致應力腐蝕龜裂(Chloride Induce Stress Corrosion Cracking, CISCC)情形，近年來逐漸受到重視，故針對乾貯系統應建立相應之老化管理與潛在之裂紋評估。目前國際間正發展相關裂紋評估導則技術，部分研究成果則於此議程中發表。首先，先由已研究此課題多年的林寶生博士為此議程進行開場介紹，簡介此議題的緣由與發展歷程，如圖十五。隨後，由 Yun-Jae Kim 教授的兩位博士班學生，進行三篇研究論文發表，分別為：FE Welding Residual Stress Analysis and Validation for Spent Nuclear Fuel Canisiters、Progress Report on Stress Intensity Factor and J-integral Estimation for Spent Nuclear Fuel Canisters under Mechanical Loading、Engineering J Estimation Equations for Spent Fuel Canisters Under Combined Mechanical and Welding Residual Stresses，主要為應用有限元素法分析密封鋼筒焊道之焊接殘留應力，計算運轉條件下含裂紋密封鋼筒之破裂行為，以及與法規(API-579 與 R6 方法)評估之驗證比對等。第四篇論文則由 Andrew Duncan 博士發表 Crack Growth Rate Testing of Bolt-Load Compact Tension Specimens Under Chloride-Induced Stress Corrosion Cracking Conditions in Spent Nuclear Fuel Canisters，詳盡地介紹目前沙瓦那河國家實驗室進行之模擬氯離子環境腐蝕試驗，以及應力腐蝕裂紋成長量測，以配合後續之裂紋評估模式發展。會後職與三位專家進行交流請益，簡述國內目前發展情況，並與林寶生博士提及希望明年能邀請他至本所進行專題研討，介紹美國相關議題發展過程、分享研發經驗並與國內相關領域研發人員進行技術交流，林博士亦表達樂觀其成之意。

另外，職亦於 7/18(三)中午，代表瑞士 PSI 錢博士參加材料與製造(MF)領域之學術委員會議(Committee meeting)，如圖十六。MF 技術領域之委員會主席

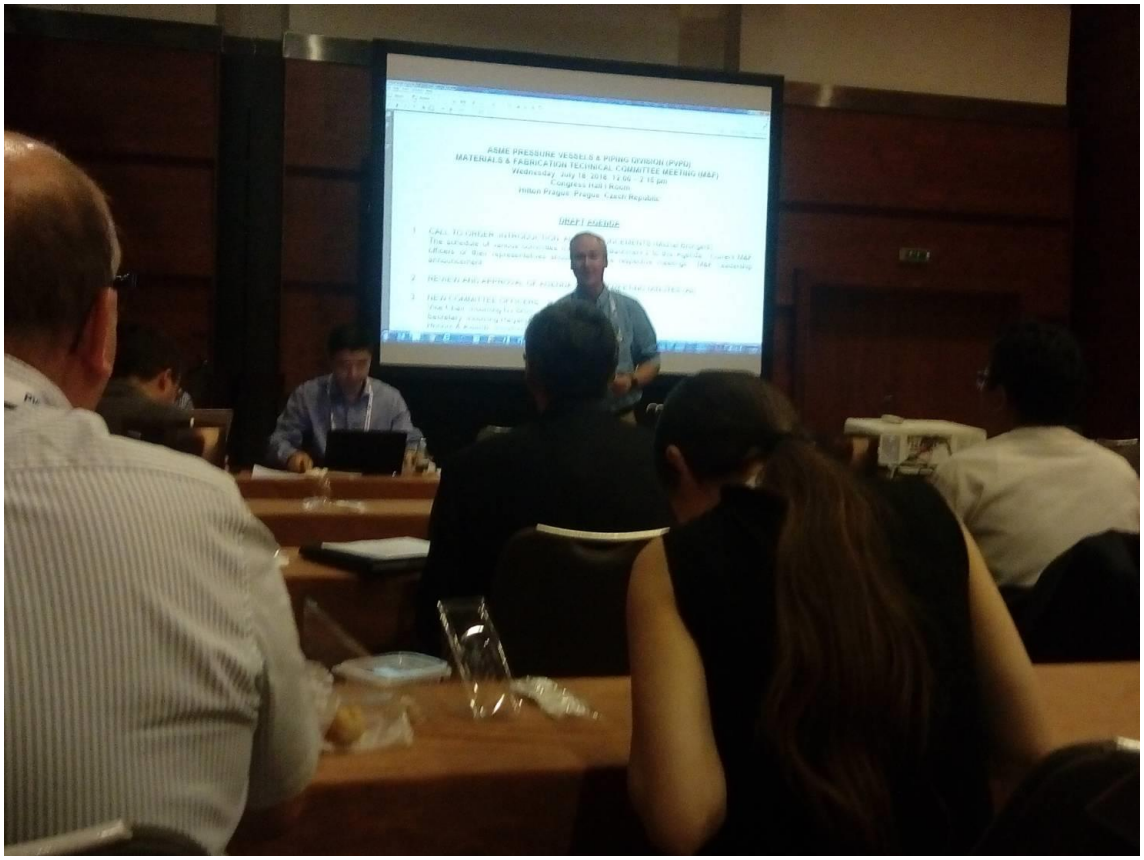
(Committee chair)為 DNV GL USA, Inc.的 Michiel Brongers 博士，技術計畫代表(Technical program representative, TPR)則為 GE Power 的錢海洋博士。此為職第一次參加 ASME PVP 的學術委員會議，會中推派後續學術委員會成員，並討論明年該領域之技術論文發表議程規劃，與其 Developer 人選。職於會議中表達明年之 Asian Programs in Structural Integrity 仍維持兩場次的論文發表，並增加 Amec Foster Wheeler 師金華博士與職為 Developer。

透過本次公差參加 2018 ASME PVP 研討會，包含論文發表、議程主持、多場次不同技術領域議題論文發表的聆聽，以及參加教育訓練與學術委員會議等，除自身研究成果的分享外，亦和國外專家有許多互動交流機會，不僅能精進研發技能，亦能開闊視野，掌握國際研發趨勢。特別是近年來 ASME PVP 研討會越來越重視核後端領域的研發成果發表，可配合我國目前非核家園的政策方向，以及即將面對的國內電廠停止運轉後的用過核子燃料貯存與處置議題，故本所未來研發能量也將積極朝向此方向規劃與推動。因此，職等參與相關場次的論文聆聽與教育訓練，對於未來研發工作的推動上，確有實質上的幫助。


Pressure Vessels & Piping Division
American Society of Mechanical Engineers
Certificate of Attendance
Hsoung-Wei Chou
Has participated in the 4-hour Technical Tutorial
Aging Management for Spent Fuel Dry Storage and Subsequent Transportation
Presented by
Zenghu Han and Yung Liu, Argonne National Laboratory, Argonne, IL 60439 USA
July 16, 2018, Prague, Czech Republic
Maher Y. A. Younan
Professional Development Chair
ASME
SETTING THE STANDARD

圖十四 乾貯老化管理教育訓練參訓證書

圖十五 美國沙瓦那河國家實驗室林寶生博士於 Session 4.1I (MF-32-1): Structural Integrity for Spent Fuel Canisters 進行開場介紹



圖十六 材料與製造領域學術委員會議，主席為 DNV GL USA, Inc.的 Michiel Brongers 博士(站立者)，以及技術計畫代表(TPR) GE Power 的錢海洋博士

7 月 21 日至 22 日(星期六至星期日)

20 日研討會結束後，職開始整理這幾天會議資料與收拾個人行李，並利用空餘時間於布拉格市區走走，體驗異國風情與欣賞古典之老城區建築風格，21 日上午 4 時 30 分搭車前往布拉格國際機場，搭乘 7 點 30 分之飛機開始返程，途經巴黎戴高樂機場於上午 11 時 20 分轉飛長榮航空飛返桃園機場，於 7 月 22 日抵達，結束這趟公差行程。

三、心得

此次公差主要前往捷克布拉格參加「2018年ASME壓力容器及管路國際研討會」。承襲往年，此次會議涵蓋議題廣泛，總計包含(1)法規及標準；(2)電腦模擬技術與螺栓接合；(3)設計及分析；(4)流體結構交互作用；(5)高壓技術；(6)材料與製造;(7)運轉,應用與組件;(8)地震工程;(9)學生論文競賽以及(10) ASME非破壞檢測、診斷與預測等10項不同議題之技術論文發表，4場次教育訓練，以及2領域專題討論會。職除發表撰寫的論文外，亦聽取許多不同領域的論文發表，與許多國際學者專家進行技術交流，收穫頗大。會議期間，職亦參加大會舉辦之用過核子燃料乾式貯存設施老化管理教育訓練，對於國際間即將面對之乾貯設施長期貯存老化管理議題、法規適用性與發展過程，以及評估方法論應用，有更進一步的了解。另外，職亦受邀主持兩場技術論文發表場次，以及參加材料與製造技術領域的學術委員會議，增加所內研發之國際能見度，並對於所內計畫的規劃推動，實有助益。各項心得報告說明如下：

(一)大會開幕演講

本次大會的開幕演講，分為兩個主題進行。首先是「美國商業核電面臨挑戰的應對」，此主題雖然已非新穎的題目，內容亦為老生常談，但從美國發電業界的觀點，陳述所面對的問題與挑戰，除以供需面的數據或圖形走勢說明與各種類型能源的發展規劃闡述外，也強調此行業亟待年輕新血的投入與傳承，以避免相關領域研究人員的老化結構持續惡化。另一主題為「再生能源對化石燃料發電廠的影響-考慮疲勞和潛變疲勞的適應性挑戰」,介紹為配合再生能源的能源產出特性，傳統型態的能源因此必須更具彈性地運轉，如此將使汽機渦輪面臨更嚴重之疲勞、熱負載和潛變疲勞負載。透過概念型的圖片輔以簡單數據說明，強調因應電網中再生能源占比逐漸增加下，應開發適用於未來靈活操作模式下的設計分析技術與精進疲勞-潛變壽命評估模式，相關議題可作為國內發展再生能源之參考。

(二)論文發表、議程主持與技術論文聆聽

本次會議職於美國南卡大學趙玉津教授等發展之 Asian Program in Structural Integrity-I & II 會議場次，發表兩篇學術論文，並協助擔任此兩場會議之議程主持人，提升本所之國際能見度。由參與聽眾的踴躍程度，特別是亦包含不少來自歐、美的專家學者聆聽，顯示國際間對亞洲地區的發展情形感到高度興趣。透過職與其他學者專家的論文發表，除了與國際專家分享亞洲國家在此議題的技術經驗與研究成果，也從各國專家提出的問題交流，激發研發構想並了解發展趨勢，收穫頗豐。

有別於過去該研討會技術議題多以核能電廠運轉議題為主，近年來在核後端組件的結構完整性與長期貯存及運輸議題，亦已為國際間所關注，且於大會議程中逐漸佔有一定比例。因應國內非核家園政策發展趨勢，本次公差職除了聆聽自身電廠運轉組件結構完整性與可靠度評估相關場次論文外，亦著重參加核後端領域相關技術場次，包含乾貯密封筒結構完整性與放射性物料貯存與運輸等場次，以逐步掌握國際間相關技術於核後端領域之應用。

(三)乾貯老化管理教育訓練

藉由來自美國阿港國家實驗室專家精闢的介紹，使職瞭解美國管制單位因用過核子燃料最終處置地點選址爭議，可能造成乾式貯存面臨之延長貯存期限的問題，而積極發展相關設施老化管理之相關評估準則與評估流程。此議題亦同為世界上許多國家所面臨的問題，雖然部分內容職亦曾透過本所今年成立的讀書團隊學習相關知識(例如 NUREG-1972 與 NUREG-2215 等)，但透過阿港國家實驗室詳細地介紹研究結果與相關經驗的分享傳承，更能瞭解國際間的作法與關注點，對於職的研發工作執行與未來計畫的規劃與推動，具有很大的參考價值。

(三)參加MF學術委員會

透過參加材料與製造(MF)領域之學術委員會議，更能深入地瞭解各技術領域間的運作模式。職亦加入為 Asian Programs in Structural Integrity 議程之 Developer，並和與會各領域議程代表討論，如此便更可掌握未來之規劃，使得本所之參與度增加，而不再僅限於論文的發表而已。對於提升本所的國際能見度，有實質的助益。

四、 建議事項

此次赴捷克公差主要是參加美國機械工程師學會(ASME)主辦的壓力槽與管路(PVP)研討會議，並主持兩場技術論文發表議程。透過國際研討會的參加與論文發表，不但可蒐集技術資料、掌握國際研發趨勢，並可國外專家學者交流研究成果，對於協助規劃國內研發方向確有助益。綜合此次公差的心得，有如下建議。

(一)透過發表論文與聆聽多場論文發表，可吸收交流各國研發方向與經驗。而受邀擔任相關議程主持，亦代表國際學者對本所人員研究能力的肯定。然而觀察其他亞洲鄰國，例如日本、韓國，以及近年來積極參與該研討會的中國，其論文數量與參加人數皆非常踴躍。尤其是中國，其參加人數目視初估超過兩百人以上，且年輕之研發新血亦佔相當之比例，顯示該國政府對於整體科研的重視與投資。因此，建議應持續適當地編列預算鼓勵同仁積極參與此類型之研討會，以發表研究成果並與國際學者專家技術交流，提升本所能見度，建立國際研究之合作與交流學習的對象。

(二)近年來核後端相關組件的結構應力分析與結構完整性議題於本研討會的占比逐漸增加，顯示國際間對於此議題之重視。職亦逐漸著重於相關領域技術場次的參與，包含乾貯老化管理教育訓練、放射性物料貯存與運輸結構分析，以及乾貯筒結構完整性評估等。反觀國內在此方面的研發資源分配比例較低，建議應將維護核電廠運轉安全之結構分析專業人才，逐步轉移至核後端相關組件的研究領域，並分配適當之研究資源，以維繫人才運用並確保非核家園後國內放射性放棄物的貯存安全。

(三)透過參加學術委員會議，討論並規劃未來研討會議程安排，可提升本所研發能見度及學術主導性，並建立長期技術交流管道。建議同仁可多利用參加是類會議的機會，嘗試更深入的參與相關委員會，以爭取主導性並增加本所曝光度。

五、附錄

附件一 2018 ASME PVP Conference 議程與論文發表場次

AMERICAN SOCIETY OF MECHANICAL ENGINEERS
PRESSURE VESSELS & PIPING DIVISION

2018 Pressure Vessels & Piping Conference Program

July 15 - 20, 2018

ASME
SETTING THE STANDARD

TABLE OF CONTENTS

Pierre Mertiny
Conference Chair

Welcome from the Chair

Welcome to the Czech Republic and beautiful Prague. The 2018 Pressure Vessels & Piping Conference (PVP 2018) promises to be a truly international event while fulfilling this year's conference theme — "Promoting Excellence in the Global Pressure Vessel and Piping Industry." This year's team of conference organizers made great efforts to make PVP 2018 an outstanding international venue for our participants in which to share their knowledge and experiences in diverse topics related to pressure vessels and piping technologies for the power and process industries. Our PVP conferences are recognized as a first-class forum for connecting with participants from industry and academia from more than 40 countries world -wide, from Europe, Africa, the Middle East, Asia, the Oceania islands and the Americas. Our team of conference organizers are committed to ensuring that PVP 2018 is a great place for networking with your colleagues to advance our global community of practice.

The ASME Pressure Vessels & Piping Division is the primary sponsor of this conference, with additional participation by the ASME Nondestructive Evaluation, Diagnosis and Prognosis Division (NDPD). This year, the Conference Technical Program includes: nearly 750 technical papers and presentations organized into approximately 200 technical and panel discussion sessions, four technical tutorials, two special tutorials, an EPRI Expert Workshop on Creep Continuum Damage Models for Structural Mechanics, and the 1st International Workshop on Risk and Resilience of Industrial installations Against Natural Threats and Mitigation Strategies; special events for students and Early Career Engineers; and our Rudy Scavuzzo Student Paper Symposium and 26th Annual Student Paper Competition. The Technology Demonstration Forum is also organized as part of our Technical Program. Also not to be missed is the keynote presentation by our expert speakers Christine King and Luboš Prchlík during the Opening Ceremony and Plenary Session on Monday morning.

Technical papers and presentations presented at this conference are separated into Tracks, according to their technical areas. Since fewer and fewer computers allow for playing CD-ROMs, and many companies discourage the use of USB memory sticks, we chose to make technical papers available online to registered attendees via the Conference App. At the conference, technical papers can also be obtained from our Download Station or picked up in the form of a CD-ROM.

A key component of every PVP Conference is the opportunity to engage with your colleagues and meet new and old friends. Please enjoy the Conference-wide Reception on Monday evening, grab a coffee and mingle during the three-day Technology Demonstration Forum, and join us for entertainment and great food at the Honors & Awards Gala and Dinner on Wednesday afternoon and evening.

A PVP Conference would not be complete without taking in the sights, attractions and delicacies of the conference locale. I encourage you to walk the streets of Prague's stunningly beautiful Old Town. We have also arranged for tours to attractions near Prague. Additional details regarding these tours can be found on page 15 in this program.

Enjoy!

Pierre Mertiny
Conference Chair

PVP 2018 Program Layout

	Sunday 15 July	Monday 16 July	Tuesday 17 July	Wednesday 18 July	Thursday 19 July	Friday 20 July
7:15 am 8:00 am	Arrival, Registration Open (8:00 am – 6:00 pm)	Authors' Breakfast/ Briefing, Registration Open (7:30 am – 4:00 pm)	Authors' Breakfast/ Briefing, Registration Open (7:30 am – 4:00 pm)	Authors' Breakfast/ Briefing, Registration Open (7:30 am – 3:00 pm)	Authors' Breakfast/ Briefing, Registration Open (7:30 am – 3:00 pm)	Open
8:15 am 10:00 am	**Block 0.1** Open	**Block 1.1** Technical Sessions, Technology Demonstration Forum	**Block 2.1** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 3.1** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 4.1** Technical Sessions, Workshops	**Block 5.1** Workshops
10:15 am 12:00 pm	**Block 0.2** Early Career Engineers / Students 'Photopoly' Treasure Hunt (10:00 am – 1:30 pm)	**Block 1.2** Plenary Session, Technology Demonstration Forum	**Block 2.2** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 3.2** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 4.2** Technical Sessions, Workshops	**Block 5.2** Workshops
12:00 pm 2:15 pm		Open	Technical Committee Meetings	Technical Committee Meetings	Open	Open
2:15 pm 4:00 pm	**Block 0.3** Special Tutorials (1:30 pm – 3:30 pm)	**Block 1.3** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 2.3** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 3.3** Technical Sessions, Technology Demonstration Forum	**Block 4.3** Technical Sessions, Workshops	**Block 5.3** Workshop
4:15 pm 6:00 pm	**Block 0.4** Student Paper Competition Orientation (3:30 pm – 4:00 pm), Early Career Engineers / Students Reception (3:30 pm – 5:00 pm)	**Block 1.4** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 2.4** Technical Sessions, Technical Tutorial, Technology Demonstration Forum	**Block 3.4** PVP Division Honors & Awards Gala and Dinner (5:00 pm - 10:00 pm)	**Block 4.4** Technical Sessions, Conference Evaluation, Workshops	**Block 5.4** Workshop
Evening	Open	Conference-Wide Reception (7:00 pm – 9:00 pm)	Open		Open	Open

ASME Pressure Vessels & Piping Division

The 2018 Pressure Vessels & Piping Conference marks the 52nd Anniversary of the Pressure Vessels & Piping (PVP) Division. The Division's rich history began with the Pressure Vessel Research Committee (PVRC), which was the research arm of ASME. The PVRC united the most experienced members in the design and manufacture of pressure vessels, valves and pumps; and sponsored research programs on thin and thick shells theory with the cooperation of the Atomic Energy Commission (AEC) and other organizations as early as 1958. Among a number of institutions that participated in the program, Pennsylvania State University dealt with stress analysis of pressure vessels with nozzle inserts with different types of reinforcement pads under combined loading. D. Hardenberg and S Zamrik published their results in WRC bulletins of 1963 and 1964. Contributions to this work were also made by C. Taylor at Illinois University using photoelasticity stress analysis, and E.O. Waters at Yale University using computational analysis. In view of the growing interest in pressure vessel technology and research results, F. Williams from Taylor Forge, who was a very active member, spearheaded an organizational meeting at the 1965 ASME Winter Annual Meeting (WAM) in Chicago to form a division dedicated to all technical aspects of pressure vessels and piping. Recommendations were introduced by F. Williams and D. Young to create the Pressure Vessels and Piping Division. The recommendation passed unanimously, and D. Young was named the first Division Chair on April 13, 1966.

The PVP Division evolved from a small division with four Technical Committees to the robust division it is today with eight committees and a strong, vital and international membership. The Division leadership in the early years had possessed a global vision: to represent an international membership with industry experts involved in the division growth. To ensure the achievement of their vision, PVPD leadership established a Mission and Core Values:

- The Mission is to provide a forum to the engineering and scientific communities to promote, share and disseminate state-of-the-art pressure technologies, relating to the power, petrochemical, and process industries, and sustainable and alternative energies.
- The Core Values are to embrace integrity and ethical conduct and a welcoming climate for a diverse global community of students and engineers to foster creativity, innovation, and intellectual growth.

To disseminate its mission, global conferences were organized to bring the technical community together and to exchange the technology development in the pressure vessels industry. The continued success of PVP Conferences is due to the dedication of our volunteers and the support of their companies.

ASME is truly an international organization and the PVP Division is an appropriate reflection of this worldwide reach. From 1991 to 2000, the number of contributors from outside of North America grew from approximately one-third to more than two-thirds. Our annual conferences continually host attendees from 35 to 42 different countries representing all regions of the globe. Needless to say, the technical content and the quality of PVP Conference sessions have benefited considerably from overseas participation.

To encourage students' active participation in the annual PVP Conference, the Rudy Scavuzzo Student Paper Symposium and Competition is organized each year. The PVP Division encourages students and early-career engineers to get involved with the Conference and the Division. PVP Conference attendees are also encouraged to include their spouses in their conference travel plans. This provides and promotes a welcoming atmosphere that further develops friendship, broadens relationships and extends interaction and networking. Our PVPD Senate Operations Committee (and spouses) actively participate in creating and maintaining the "PVP Family" atmosphere that makes our social events successful. The PVP Division is ever grateful for their unwavering commitment.

PVP 2018 Conference Committees

Pierre Mertiny
Conference Chair

Hakim A. Bouzid
Technical Program Chair

Sam Y. Zamrik
Conference Advisor

PVP Technical Program Representatives

Codes & Standards	Ryan L. Crane Kiminobu Hojo
Computer Technology & Bolted Joints	Bijan Azadi Borujeni Yasumasa Shoji
Design & Analysis	Shane Finneran Alicia Avery
Fluid-Structure Interaction	Victor Janzen Daniel Broc
High-Pressure Technology	Chris Tipple Kannan Subramanian
Materials & Fabrication	Haiyang Qian
Operations, Applications & Components	Alton Reich Joseph Cluever
Seismic Engineering	Osama Furuya Taichi Matsuoka
Student Paper Competition	Douglas A. Scarth Daniel Peters
ASME NPDP Division	Vivek Agarwal Sandra Dugan
EPRI Expert Workshop on Creep Continuum Damage Models for Structural Mechanics	Jonathan Parker Elizabeth Benton
1st International Workshop on Risk & Resilience of Industrial Installations Against Natural Threats & Mitigation Strategies	Fabrizio Paolacci Oreste Salvatore Bursi

Student Paper Competition Session Developers

Codes & Standards	Peter James
Computer Technology & Bolted Joints	Yasumasa Shoji
Design & Analysis	Bing Li
Fluid-Structure Interaction	Victor Janzen Daniel Broc
High-Pressure Technology	Mohamed Trabial Mahesh Aggarwal
Materials & Fabrication	Noel O'Dowd Haiyang Qian Sean Leen Carl Jaske
Operations, Applications & Components	Yasumasa Shoji
Seismic Engineering	Fabrizio Paolacci Osamu Furuya Taichi Matsuoka
PVP Senate	Douglas A. Scarth Daniel T. Peters

PVP Division Management Committee (2017-2018)

Maher Y.A. Younan	Chair
Pierre Mertiny	Vice Chair
Hakim A. Bouzid	Communications Chair
Trevor Seipp	Honors & Awards Chair
Matthew R. Feldman	Programs Chair
Maher Y.A. Younan	Professional Development Chair

PVP Senate of Past Division Chairs

Douglas A. Scarth, Chair	2016-2017
Marina B. Ruggles-Wrenn	2015-2016
Daniel T. Peters	2014-2015
Michael E. Nitzel	2012-2014
Ronald S. Hafner	2011-2012
Young W. Kwon	2010-2011
Luc H. Geraets*	2009-2010
Artin A. Dermenjian	2008-2009
James F. Cory, Jr.	2007-2008
Judith A. Todd	2006-2007
M.K. Au-Yang*	2005-2006
Ismail T. Kisisel	2004-2005
William J. Bees	2003-2004
Howard H. Chung	2002-2003
Joseph Sinnappan	2001-2002
A.G. (Jack) Ware	2000-2001
Robert F. Sammataro*	1999-2000
Thou-Han Liu	1998-1999
William E. Short, II	1997-1998
Richard C. Gwaltney*	1996-1997
Shoei-Sheng Chen*	1995-1996
Greg L. Hollinger	1994-1995
Carl E. Jaske	1993-1994
Rudy J. Scavuzzo*	1992-1993
Sam Y. Zamrik	1991-1992
G.E. Otto Widera	1990-1991
Robert H. Mallett	1989-1990
Robert W. Swinderman	1988-1989
Alexander H.C. Marr	1987-1988
Jeffrey T. Fong	1986-1987
Don B. Van Fossen	1985-1986
James R. Farr*	1984-1985
Charles F. Nash	1983-1984
Donald S. Griffin	1982-1983
Richard H. Gallagher*	1981-1982
L. Eugene Hulbert	1980-1981
Robert E. Nickell*	1979-1980
Roger F. Reedy	1978-1979
David H.C. Pai*	1977-1978
Pedro V. Marcal	1976-1977
Harold H. Waite*	1975-1976
Robert L. Cloud	1974-1975
Charles V. Moore	1973-1974
Irwin Berman*	1972-1973
Danos Kallas*	1971-1972
Robert J. Cepluch*	1970-1971
Charles F. Larson	1969-1970
Gunther P. Eschenbrenner	1968-1969
Vito Salerno*	1967-1968
Dana Young*	1966-1967

** Deceased*

PVP Division Technical Committee Chairs

Codes & Standards	Russell C. Cipolla
Computer Technology & Bolted Joints	Jerry Waterland
Design & Analysis	Ravi Baliga
Fluid-Structure Interaction	Tomoyo Taniguchi
High-Pressure Technology	Karl Simpson
Materials & Fabrication	Michiel Brongers
Operations, Applications & Components	Georges Bezdikian
Seismic Engineering	Fabrizio Paolacci

PVP Division Administrative Committee Chairs

Membership Chair	Bing Li
Website & PVPD Newsletter Editor	Hakim A. Bouzid
International Coordination	Xian-Kui Zhu

ASME Journal of Pressure Vessel Technology

Editor	Young W. Kwon

ASME President

Said Jahhanmir	2018-2019

ASME Staff

Program Manager	Jamie Hart

Opening Ceremony & Plenary Session:

Promoting Excellence in the Global Pressure Vessel & Piping Industry

The Conference opens in Congress Hall II on Monday, July 16th at 10:15 AM. Representatives of the American Society of Mechanical Engineers will welcome the attendees. The first presentation will be delivered by Christine King, Vice President and Chief Nuclear Officer Nuclear Division, Structural Integrity Associates, Inc. The second presentation will be delivered by Dr. Luboš Prchlík, Director of Turbogenerator Product, Doosan Škoda Power.

Addressing the Challenges of Commercial Nuclear Power in the United States

Christine King
Vice President & Chief Nuclear Officer, Nuclear Division
Structural Integrity Associates, Inc.

It is widely known that the US Nuclear industry is currently facing a diverse variety of challenges. There are technical challenges to safely and reliably operate the oldest fleet of plants in the world while matching evolving market conditions that are driven by low-cost natural gas and subsidized renewables. The human talent challenge is to ensure we attract new engineers, scientists, other professionals and craftsmen, and effectively transition decades of knowledge while embracing the advantages of the digital age and tools. The market challenges that must be overcome are that the technologies can compete on their own merits in a non-distorted manner, and the policies balance society's risk related to safety and security of supply. Addressing the market challenges should provide a diverse power supply inclusive of nuclear. With each challenge, we are required to be increasingly bold with our ideas and disciplined in our execution. Our excellence will be our creativity, our perseverance, and ultimately our shared success.

Impact of Renewble Energy Generation on Fossil Fuel Power Plants — Challenges of Flexibility Considering Fatigue and Creep-Fatigue

Dr. Luboš Prchlík
Director of Turbogenerator Product Doosan Škoda Power

With the massive deployment of renewable energy sources, which are unstable by their nature, in concurrence with the growing electricity demand, there are three major challenges of future energy production integrated into existing electricity grids that need to be addressed. These are stability, efficiency and, above all, flexibility. These define new requirements for modern steam and gas turbine operation that include a high number of turbine start-ups and load changes, short ramp-up times, or long-term low-load operation, while maintaining high efficiency and reliability. However, flexible operation leads to increased fatigue, thermo-mechanical loading and creep-fatigue loading. Therefore, design modifications and improved fatigue lifetime methods for flexible operational modes, while maintaining life cycle costs at current levels, must be developed. Specific examples of flexibility improvements for steam turbomachinery and related power equipment are presented.

Honors & Awards Gala

The ASME PVP Division Honors and Awards Gala, during which Division and selected ASME Society awards are presented, will be held on Wednesday, July 18, from 5:00 pm until 10:00 pm, in the Congress Hall. The top PVP Division award, the ASME S. Y. Zamrik PVP Medal, will be presented to Mordechai Perl.

Dr. Mordechai Perl
Ben Gurion University of the Negev, Emeritus

Prof. Mordechai Perl is a Professor Emeritus from the Department of Mechanical Engineering at Ben-Gurion University of the Negev (BGU) in Beer-Sheva, Israel, and is the first incumbent of the Aaron Fish Chair in Mechanical Engineering–Fracture Mechanics.

Prof. Mordechai Perl obtained his B.Sc. (1968), M.Sc. (1970), and D.Sc. (1979) in Aeronautical Engineering from the Technion–Israel Institute of Technology. As the recipient of the Rothschild Postdoctoral Fellowship he carried out his postdoctoral work at the University of Washington in Seattle, and at Georgia Tech in Atlanta. Prof. Perl was an active and prominent tenured faculty member at the Technion, where he served in many academic and administrative capacities for fourteen years until 1995. Prof. Perl then joined the Ben-Gurion University of the Negev (BGU) as a tenured Full Professor in the Department of Mechanical Engineering where he served as Associate Dean for Academic Development (1995-2000), Chairman of the Department of Mechanical Engineering (1998-2000), and as Dean of the Faculty of Engineering Sciences (2000-2003). As Dean he also implemented various innovative undergraduate and graduate programs. In 1997 he was appointed member of the Israeli Higher Education Council by the President of the State of Israel, contributing to policy formulation in higher education in general, and engineering education in particular (1997-2003).

Prof. Perl's main research fields are Fracture Mechanics and Biomechanics, and he is a world-renowned expert on the: *Fatigue and Fracture of Thick-Walled Autofrettaged Cylinders and Spheres* with an emphasis on *Large-caliber Autofrettaged Gun Barrels*. His work on the fracture of swaged and hydraulically autofrettaged gun barrels is considered to be the international benchmark. He has published more than 100 papers in the archival literature in a variety of international journals, participated in more than 110 international conferences, and served on the organizing and editorial committees of several international conferences.

Prof. Perl has been very active in promoting quality teaching through his career. He was elected Outstanding Lecturer many times both at Technion and at BGU, and was awarded two prestigious Technion prizes for excellence in teaching: The Muriel and David Jacknow Prize in 1989 and the Salomon Simon Mani Award in 1994. He has taught a wide range of undergraduate and graduate courses, and has supervised more than 35 graduate students towards their M.Sc. and D.Sc. degrees.

Apart from his academic career, and due to his vast professional experience Prof. Perl is a consultant in the area of fracture mechanics to many industries such as: The Israeli Military Industries, Israel Electric Company, Government of Israel (various Ministries), Soltam Systems and Spillis and Candela & Partners in the U.S.A. among others.

Prof. Perl has been a faculty member and a visiting scholar at a number of universities worldwide: University of Washington in Seattle, Georgia Institute of Technology in Atlanta, Florida International University in Miami, the National University of Singapore, the University of Canterbury in Christchurch New Zealand, Tokyo University of Science, Tokyo, Japan, the University of Hawaii at Manoa, Honolulu, Hawaii, and Pontificia Universidad Católica de Chile, Santiago, Chile, and Chulalongkorn University, Bangkok, Thailand.

Prof. Perl joined ASME and its PVP Division about thirty years ago. Since then, he has been an active member of the High Pressure Technology Technical Committee, publishing 34 original papers in the Journal of Pressure Vessel Technology (JPVT), participating in 23 PVP Conferences, reviewing numerous papers for both the JPVT and PVP Conferences. Prof. Perl served as the Associate Editor for the Journal of Pressure Vessel Technology for four terms from 2001 to 2014. He also served as the Guest Editor of JPVT for the "Third special issue on Pressure Vessel Technology Applied to Gun Tubes".

Prof. Perl was elected Fellow of the ASME in 2008, and was awarded Certificates of Appreciation for his service as Associate Editor to the Journal of Pressure Vessel Technology, and for his Outstanding Technical Paper under the High Pressure Technology Technical Committee at the PVP 2013 Conference.

In summary, Prof. Perl has provided outstanding service to the ASME, its PVP Division, and to the High- Pressure Technology Technical Committee.

Tutorials

Tutorials offer both the experienced and early-career engineers excellent opportunities to refresh their knowledge and to venture into specific technical areas outside their expertise. Admission to the tutorials is free for Conference Registrants.

Special Tutorials: These are one-hour or two-hour conference session, held on Sunday afternoon. The session leaders will make available the necessary presentation materials.

Technical Tutorials: These tutorials are approximately four hours in length. Technical Tutorials fill two consecutive conference session blocks, and are integrated into the conference session schedule. The Technical Tutorial notes will be available in either printed or electronic format.

Each attendee will receive a Certificate of Attendance, as proof that the attendee has participated in the Special Tutorial or the Technical Tutorial.

PVP Division will not assign Continuing Education Units (CEUs) on these certificates. However, attendees may negotiate CEU credits with their respective licensing boards.

An outline of the tutorial sessions for the 2018 PVP Conference is presented in the following pages.

Special Tutorials

Navigating Corporate Culture for Professional Advancement

Ike Ezekoye, Ph.D., PE
Sunday, July 15, 1:30 pm – 3:30 pm
Congress Hall I

The world is a very competitive environment no matter what you do. This is particularly true with regard to employment and professional advancement. Many decisions that affect you are made by your management without your knowledge, for example, who gets what job, who leads what project, who gets promoted, who gets fired, etc. Additionally, decisions about what happens to you are based on how you are perceived in the organization for which you work. Many engineers (early and mid-career) sometimes feel that they are not going anywhere professionally. Basically, their capabilities and contributions are often not recognized nor adequately compensated. Some, occasionally, wonder whether they are in the right place. Perhaps, the grass must be greener somewhere else. This tutorial explores the personal and corporate roadblocks that can limit professional advancement of engineers in their chosen fields. It covers the art of belonging and of selling your capabilities to your supervisor or manager. The workshop will also cover corporate mentoring and other areas such as participation in Codes and Standards like the ASME Boiler and Pressure Vessel Code development and associated technical divisions of the ASME.

Overview of ASME Section VIII Division 1 – Design Rules for Construction of Pressure Vessels

Daniel T. Peters, PE
Sunday, July 15, 1:30 pm – 3:30 pm
Congress Hall III

This two-hour tutorial will provide a high level overview of ASME Section VIII Division 1 for pressure vessels. It is intended as an overview for early career and beginning users who want to have a basis for application of ASME's most widely used Code or Standard. The tutorial will cover aspects of the code that include: Terms and Definitions; Scope of Standard; Thickness Equations; Openings and Reinforcement; Inspection, Test, Marking and Relief Devices; Fabrication and Examination; Materials; and Appendices.

Technical Tutorials

Aging Management for Spent Fuel Dry Storage and Subsequent Transportation

Zenghu Han, Ph.D. and Yung Liu, Sc.D., Argonne National Laboratory
Part 1: Monday, July 16, 2:15 pm – 4:00 pm
Part 2: Monday, July 16, 4:15 pm – 6:00 pm
Congress Hall III

The extended long-term storage of spent nuclear fuel (SNF) owing to the lack of a designated permanent geological repository requires increasing reliance on dry cask storage systems (DCSSs). Under Title 10 of Code of Federal Regulations Part 72 (10 CFR 72), the initial license term for an independent spent fuel storage installation (ISFSI) must not exceed 40 years from the date of license issuance. Licenses may be renewed by the U.S. Nuclear Regulatory Commission (US NRC) at the expiration of the initial license term upon application by the licensee, for a period not to exceed another 40 years. According to the NRC Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel (NUREG-1927, Revision 1), the license renewal application for an ISFSI must address aging-related degradation of structures, systems, and components (SSCs) of DCSSs that are in scope for license renewal. This tutorial examines issues related to aging management and license renewal of ISFSI for the extended long-term dry storage of SNF and subsequent transportation. The tutorial covers:1) summary of ISFSI license renewal process, 2) description of typical SNF DCSSs, 3) scoping evaluation process, 4) aging effects and aging mechanisms of the SSCs, 5) time limited aging analyses (TLAAs), 6) aging management programs (AMPs), and 7) aging management-related issues and R&D activities. The tutorial also describes TLAAs and AMPs that were developed by researchers at Argonne National Laboratory in the DOE report, Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel, Revision 2. The application of these TLAAs and AMPs to the aging management review process is illustrated for selected components in the DCSSs.

Fracture Mechanics Applications to Piping

Gery Wilkowski and Bud Brust, Emc²
Part 1: Tuesday, July 17, 8:15 am – 10:00 am
Part 2: Tuesday, July 17, 10:15 am – 12:00 pm
Congress Hall III

Fracture mechanics has been applied to plant piping and pipelines for flaw evaluation (assessment of an actual flaw found in service) and flaw tolerance evaluations (will leak-before-break behavior occur). This technology has evolved over the decades considerably from the early assumptions of brittle fracture using linear elastic fracture mechanics. This tutorial will show the developments over time and various current technical aspects for modern flaw evaluation/flaw tolerance analyses. The tutorial is targeted for those new to flaw assessment/tolerance analyses and provides some overview of methodologies for those willing to undertake advanced applications. This tutorial includes five modules over a half-day session:

- **Module 1:** Background on fundamental aspects of fracture mechanics, and historical developments
- **Module 2:** Subcritical crack growth analyses and considerations
- **Module 3:** Material toughness/strength conditions
- **Module 4:** Failure modes and criteria for flawed pipes under quasi-static loading assumptions
- **Module 5:** Failure modes and criteria for flawed pipes under dynamic loading

Advanced Fatigue Analysis

Kumarswamy Karpanan, TechnipFMC
Part 1: Tuesday, July 17, 2:15 pm – 4:00 pm
Part 2: Tuesday, July 17, 4:15 pm – 6:00 pm
Congress Hall III

This technical tutorial provides an overview of basic and advanced fatigue analysis and implementation of these methods in life cycle calculation. It aims at providing details of fatigue analysis methods in standards such as ASME Sec VIII Div-3, API-579 and DNV RP-C203. The topics to be covered are basics of stress, strain and constitutive equations, stress transformation, stress-based (SN) fatigue analysis, strain-based (eN) fatigue analysis, factors affecting fatigue life, low-cycle and high-cycle fatigue, mean stress effects, stress and strain controlled fatigue testing, weld fatigue analysis using nominal stress and effective notch stress method, proportional and non-proportional loading, multiaxial stress and strain based fatigue analysis methods such as Findley and Brown & Miller using critical plane search method. This tutorial is designed for students, beginners and users with experience in fatigue analysis.

Auto-Refrigeration & Brittle Fracture Prevention

Kannan Subramanian, Stress Engineering Services, Inc.
Part 1: Wednesday, July 18, 8:15 am – 10:00 am
Part 2: Wednesday, July 18, 10:15 am – 12:00 pm
Congress Hall III

Brittle fracture can result in catastrophic damages as witnessed in multiple events recorded by the petrochemical industry. Fracture toughness is the material property that is commonly referred as the measure of any material's resistance to such fractures. Carbon steel materials that are commonly used in the industry have been known to exhibit significantly lower toughness at lower temperatures including, but not limited to, low ambient temperature and lower metal temperatures resulting from process excursions which were not originally considered during the design phase. One of such process excursions is termed as "auto-refrigeration," wherein a process fluid changes phase from liquid to gas resulting in significantly lower temperature of the fluid and, in turn, the metal that contains the fluid. In this tutorial, the presenter will discuss the basics of brittle fracture, its effect on the petrochemical industry, the toughness rules in BPVC that are commonly used to prevent such fractures, auto-refrigeration, other common excursion events, and the assessment methods to protect the assets from an excursion event.

Technology Demonstration Forum

Monday, July 16, 8:15 am – 6:00 pm;
Tuesday, July 17, 8:15 am – 6:00 pm;
Wednesday, July 18, 8:15 am – 4:00 pm
Congress Hall Foyer

The Technology Demonstration Forum will be held from Monday, July 16th to Wednesday, July 18th. Vendors and Sponsors will present and discuss their capabilities, equipment, and services in Congress Hall Foyer.

EPRI Expert Workshop on Creep Continuum Damage Models for Structural Mechanics

Thursday, July 19, 8:15 am – 6:00 pm
Congress Hall I
Friday, July 20, 8:15 am – 12:00 pm
Tyrolka

This Workshop will cover state-of-the-art presentations regarding Creep Continuum Damage Mechanics (CDM). It is apparent that a CDM framework is particularly attractive to establishing relevant models that describe the creep behavior of advanced steels. Particular benefits of this approach are derived for metallurgically complex steels because, for the components and loading scenarios in which they are used, there is an emerging reality that performance cannot be explained simply based on strength, i.e. using deformation dominated expressions. Thus, it is apparent that creep damage susceptibility and ductility must be understood and properly considered in the models to reduce uncertainty and minimize the risks of fracture during service.

The Workshop will build on previous discussions that have considered the principles and requirements that should be followed to establish robust and relevant creep-continuum damage mechanics constitutive models. The three key requirements which should be embodied in a suitable model have been identified as:

Physically Informed
- Provide "physically reasonable" responses for relevant stresses and temperatures
- Activation energies, stress exponents and other parameters should have reasonable values
- State variables representing key aspects of the material response should be related to underlying physical (metallurgical) mechanisms
- Multiaxial forms should represent the underlying deformation and damage phenomena

Convenient Mathematics

- Key features of the creep response (creep rate, rupture time, etc.) should be readily derived
- Scalable for use in applications from simple calculations (e.g. constant stress) to complex finite element models
- Overall representation of the material response which can be simplified for specific cases by switching on or off features of the model

Pragmatic Approach to Data Fitting

- A relevant, but minimal number of vital coefficients (consistent with physical meaning)
- Easy-to-determine coefficients without the need to adopt complex regression
- Simple scaling to represent upper/lower bounds on material response by considering both strength and damage susceptibility

In addition to discussion of a framework for model development, review presentations considered alloy specific applications of CDM. The Workshop sessions include:

Metallurgical Factors affecting high-temperature performance for both Tempered Martensitic and Austenitic Stainless Steels with emphasis on:

- Pedigree of parent metal, including documenting factors which contribute to deformation and damage
- Metallurgical risk factors identified relating to variability in the as-fabricated condition and which influence changes in service performance
- Assessment of metallurgical risk factors in multiaxial tests
- Characterization of damage in parent metal and cross-weld creep tests

Evaluation of established CDM methods and potential developments with a view to seeking a unified approach for:

- Accommodating microstructural influences on deformation and damage
- Describing alloy specific susceptibilities to the initiation and growth of damage
- Incorporation of stress state effects
- Assessment of validity of the selected model by considering trends in behavior established independently to the results used in model development

Design by Rule compared to Design by Analysis:

- Options for design-by-analysis
- Application of design-by-analysis to susceptible component geometries
- Complexity – balancing need and simplicity

1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats and Mitigation Strategies

Thursday, July 19, 8:15am – 6:00 pm
Congress Hall III
Friday, July 20, 8:15 am – 6:00 pm
Palmovka & Rokoska

The tremendous impact of natural hazards, such as earthquakes, tsunamis, flooding, etc., which triggered technological accidents, referred to as natural-technological (NaTech) events, was demonstrated by the recent Tohoku earthquake and the following Fukushima disaster in 2011 or by the UK's 2015 winter floods which topped £5bn, with thousands of families and businesses that faced financial problems because of inadequate or non-existent insurance. The NaTech problem is quite relevant as up to 10% of industrial accidents, involving the release of Chemical, Biological, Radiological, Nuclear and high-yield Explosives (CBRNE) substances, were triggered by natural hazards. To implement and support the Seveso II Directive 2012/18/EU, which regulates the control of major accident hazards involving dangerous substances, the XP-RESILIENCE body intends to establish a network of individual research projects working towards Advanced Modelling and Protection –via metamaterial-based isolators/layouts- of Complex Engineering Systems for Disaster Reduction and Resilient Communities. In this respect, this Workshop will offer to students and scholars a clear overview of the problems and the available solutions and tools. With important experts on Resilience and Na-tech risk, the Workshop will be a unique occasion to familiarize with this hot topic and be in contact with the resilience and risk calculation community.

Objectives of the Workshop
The main objective of this Workshop is to familiarize Early Stage and Experienced Researchers with the state-of-the-art of the risks and the resilience of industrial installations. At the end of the course, attendees should gain knowledge on:

- Basic and advanced concepts for risk and resilience calculation
- Vulnerability analysis of the most critical industrial facility units
- Risk analysis methods of major-hazard industrial installations
- Resilience concepts applied to industrial facilities
- Concepts application through case studies

Social Programs and Tours

'Photopoly' and Reception for Early Career Engineers and Students

Sunday, July 15, 10:00 am – 1:30 pm (lunch on your own)
Congress Hall Foyer (Meet your team before departure at 10:00 am and pick up registration packets)

Early-career engineers (defined as the first five years of employment as an engineer) and students are invited to participate in 'Photopoly' — a treasure hunt brimming with fun and creative teamwork while exploring Prague. Think Monopoly, but instead of capturing property, you capture photos! Each team, armed with a Polaroid camera, a booklet of instructions and guidelines and a city plan will embark upon a living version of the world's most famous board game. But as you visit all the famous streets, the aim is not to buy them up and build houses and hotels, but to take photographs of your team recreating the extraordinary scenes described in the handbook.

This event is the perfect way to kick-off your week in Prague and explore the city. Meet your peers, make new friends and join a refreshing and fascinating teamwork adventure. Then, join us for the Early-Career Engineers and Students Reception on Sunday afternoon from 3:30 pm to 5:00 pm. Note that all Photopoly finishers will receive a beverage ticket valid for Sunday's Reception and a chance to win an iPad and other exciting prizes.

Registration: € 10 per person.
Register online at http://www.photopoly.cz/.

Conference-Wide Reception

Monday, July 16, 7:00 pm – 9:00 pm
Congress Hall Foyer and Congress Hall II

All registered attendees and their guests are invited to attend the Conference Wide Reception. Meet with your colleagues, many of whom you may not have seen for a while. Join with the registrants and guests for a relaxing evening. We will have displays of student paper posters at the Reception in Congress Hall II. All student authors who participate in the 26th Rudy Scavuzzo Student Paper Symposium and Competition are invited to present their posters.

No charge for registered conference participants and guests.

Tour 1: Kutná Hora

Monday, July 16, 9:00 am – 4:00 pm (lunch on your own)
Tour bus departs at front lobby

During the Middle Ages, profits from the Kutná Hora silver mines brought fame to the lands of the Czech Crown and Kutná Hora became the richest and most powerful town in the Czech lands. At the turn of the 14th and 15th centuries, Kutná Hora became the seat of King Václav IV. The Gothic St. James' Church (1330) and the St. Barbara's Cathedral (1388), devoted to the patroness of miners, are among the most important architectural monuments. Among other jewels is the former mint – The Vlašský dvůr (Italian Court) from the 13th century, and several patrician houses. The building called Hrádek (Little Castle), which is part of the former municipal fortifications, houses a museum of mining. Other worthwhile monuments are the cloister church in a suburb called Sedlec, which houses a curious Ossuary. Its interior is composed exclusively of human bones, dating mostly from the Thirty Years' War.

Registration: € 66 per person.
Register online at http://pvptours.cz/.

Tour 2: Glassblowing at RÜCKL Glassworks

Tuesday, July 17, 9:00 am – 2:00 pm (lunch on your own)
Tour bus departs at front lobby

Rückl Crystal has a 300-year-long family tradition in glass making. Visitors will get to know the individual stages of producing glass crystal by hand, i.e. the furnaces, processing, designing and polishing. The tour concludes with the visit to the glassworks' shop.

Registration: € 60 per person.
Register online at http://pvptours.cz/.

Conference Information

Technical Sessions and Programs
All technical sessions will be held in the meeting areas on the Mezzanine, Lobby and Lower Lobby levels of the Hilton Prague Hotel. Each room will be equipped with an LCD projector that can be connected to a personal computer for electronic presentations (e.g., Microsoft PowerPoint). Please note that ASME will not provide personal computers. Personal computers are the responsibility of the session developer or presenter. It is strongly recommended that authors provide their materials to the session developer at or before the Authors' Breakfast, so that all the papers in a session can be loaded onto a single computer. Authors are recommended to have their presentations on a USB flash (pen) drive, in the event that compatibility problems occur between their computers and the LCD projector.

The location of the session rooms is shown in the hotel floor plan on the Sessions-At-A-Glance sheet that is provided with the registration package.

Rudy Scavuzzo Student Paper Symposium and 26th Annual Student Paper Competition

Monday, July 16	**8:15 am – 10:00 am**
	2:15 pm – 4:00 pm
	4:15 pm – 6:00 pm
Tuesday, July 17	**8:15 am – 10:00 am**
	10:15 am – 12:00 pm
	2:15 pm – 4:00 pm
	Brussels

The 2018 Rudy Scavuzzo Student Paper Symposium and 26th Annual Student Paper Competition is sponsored by the PVPD Senate. Douglas A. Scarth, Chair of the PVP Senate Operations Committee, will conduct the sessions, together with the Student Symposium and Competition representatives from the PVP Technical Committees. The Review Committee will identify the outstanding finalist undergraduate and graduate student papers in two categories: the BS/MS level and the Ph.D. level. Finalist papers will be judged on written technical content (70%) and presentation effectiveness (30%). In each category (i.e., BS/MS and Ph.D.), $1,200 will be awarded to the presenting author of the Outstanding Student Paper; $1,000 will be awarded to the presenting author of the First Runner-Up Student Paper, and $800 will be awarded to the presenting author of the Second Runner-Up Student Paper. Students must attend the Conference, and must present their papers to be eligible for an award. The winners will be announced at the Honors and Awards Gala and Dinner.

Technical Committee Meetings

Tuesday, July 17	**12:15 pm – 2:15 pm**
Wednesday, July 18	**12:15 pm – 2:15 pm**

The Pressure Vessels & Piping Division Technical Committees will meet during the noon break on Tuesday, July 17, and Wednesday, July 18. Visitors are encouraged to attend and take an active part in PVP committee activities. All committee meetings, schedules and rooms are listed on Page 20.

PVP Division Honors & Awards Gala and Dinner

Wednesday, July 18 **5:00 pm – 10:00 pm**
Congress Hall

The Honors & Awards Gala, honoring all Division Award Recipients and the 2018 ASME S.Y. Zamrik PVP Medalist, Mordechai Perl, will be held on Wednesday, July 18, from 5:00 pm until 10:00 pm, in the Congress Hall. Entertainment will be provided throughout the evening. One ticket is included in the full Conference registration fee. Additional tickets may be purchased at the Conference Registration desk.

Authors' Breakfast/Briefing

Monday, July 16 – Thursday, July 19
7:15 am – 8:00 am
Congress Hall II

Authors, Panelists, Session Developers, Chairs, and Vice-Chairs are required to attend a breakfast briefing in the Congress Hall II on Monday through Thursday, at 7:15 am, on the morning of their sessions. Session protocol will be discussed, and the participants will have the opportunity to become better acquainted with one another before their scheduled sessions. Authors are encouraged to place all the presentation files for their session on a single computer either before or at the Authors' Breakfast.

Registration Hours
Chez Louis Salon

Located in the Congress Hall Foyer, the ASME Registration Desk will be open during the following hours, to provide advance registrants with their materials, to process on-site registrations, and to provide additional Conference information:

Sunday, July 15	**8:00 am – 6:00 pm**
Monday, July 16	**7:30 am – 4:00 pm**
Tuesday, July 17	**7:30 am – 4:00 pm**
Wednesday, July 18	**7:30 am – 3:00 pm**
Thursday, July 19	**7:30 am – 3:00 pm**

On-Site Registration Fees
For those not registered in advance, the On-Site Registration Fees are as follows:

	Full Registration*	**One Day Registration****
ASME Member	€ 1,293	€ 831
Author/Panelist	€ 1,293	€ 831
Session Chair	€ 1,293	€ 831
Session Vice Chair	€ 1,293	€ 831
Coop. Soc. Member***	€ 1,293	€ 831
Non-Member****	€ 1,559	€ 935
ASME Life Member †	€ 520	€ 520
ASME Member Student (Non-Author) ‡	€ 520	€ 520
ASME Member Student (Author) ‡	€ 520	€ 520
Student Non-Member (Author or Non-Author) ‡	€ 831	€ 831
Guest/Spouse ‡‡	N/C	N/C
Workshop Only	€ 363	-
Full Conference Registration Workshop Add-on	€ 80	-
Extra Ticket Awards Dinner (Wednesday Night)	€ 65	-

* Full Registration fees include admission to all technical sessions, coffee breaks, Conference-Wide Reception, one (1) ticket for the Honors & Awards Gala and Dinner, and online access to the Conference Technical Papers.

** One Day Registration fees include admission to all technical sessions, and coffee breaks for one-day.

*** To qualify for discounted registration fees, you must be a member of ASME, or one of the Cooperating Societies. Please fill in your society affiliation and membership number on the registration form.

**** Anyone paying the non-member fee is eligible to receive one year's membership to ASME as part of their registration fee.

† Registration under this category includes admission to all technical sessions, coffee breaks, Conference-Wide Reception, one (1) ticket for the Honors & Awards Gala and Dinner, and online access to the Conference Technical Papers.

‡ Student Registration Fees include admission to all technical sessions, coffee breaks, Conference-Wide Reception, and online access to the Conference Technical Papers. Students not in the Student Paper Competition and Symposium will be required to purchase a ticket to attend the Honors & Awards Gala and Dinner.

‡‡ Guests wishing to attend the Honors and Awards Gala and Dinner will be required to purchase a ticket.

Cooperating Societies

If you are a member of a Cooperating Society, you may register at the ASME member rate.

CrowdCompass App

The CrowdCompass app will be the digital hub for PVP-2018. It will allow you to access technical papers and explore the conference program. To download the app, access the App Store on iOS devices and the Play Store on Android. If you are using a Blackberry or Windows phone, skip these steps. You will need to use the web version of the app. Install the app by searching for CrowdCompass AttendeeHub. Once you have found the app, tap either Download or Install. After installing, a new icon will appear on the home screen. Once downloaded, open the AttendeeHub app, then search and tap "ASMEPVP2018" to access the Conference information and activate usage.

Conference Publications

Information on paper titles and authors are included in the Final Program. All attendees registered for the entire Conference (i.e., Full Registration) will receive online access to the Conference Technical Papers presented at the Conference.

A Download Station will be available at the Registration Desk for Conference Registrants who wish to copy the Conference Technical Papers to a digital device. It is recommended that attendees supply their own USB memory stick, which needs to have a capacity of 4GB. The Conference Organizers ask Conference Registrants to be mindful of their time using the Download Station so that other users can access this service in a timely manner.

Papers presented at the Conference will be available post-conference in printed bound volumes of the Official Conference Proceedings. Printed proceedings can be ordered through ASME Customer Service approximately three to four months after the Conference. A complete set of the volumes may be purchased as a package at a 10% discount. The Official Conference Proceedings will also be published post-conference as part of the ASME Digital Collection at http://asmedigitalcollection.asme.org. All ASME conference proceedings are submitted to be indexed in Scopus, Compendex, ISI Conference Proceedings Citations Index, and to multiple other indexing publishers.

Disabled Registrants

Whenever possible, arrangements can be made for disabled registrants, if advance notice is given. Please indicate any special needs on the registration form, or contact Jamie Hart at HartJE@asme.org to process your request.

FAQs on Czech VAT Refund

Why am I paying a VAT on the Meeting Registration Fee?
You are paying a Value Added Tax (VAT) on the registration fee because it is required by the laws and regulations of the European Union (EU) and its member states. They establish that VAT must be paid on the registration fees in the country where the meeting is held.

Can the VAT be recovered?
Business companies from the European Union and business companies from outside the European Union with a reciprocity agreement (Switzerland, Norway, Macedonia) can claim back the Czech VAT. To recover the VAT you must provide the details of your company - name, address, VAT number or Tax ID - for all expense invoices and submit all original documentation to your company for its processing. It is important to note that the Czech Tax Administration does not refund travel expenses, accommodation, meals or goods and services for personal consumption.

What process should companies follow to recover the VAT?

EU Companies
EU companies must contact the Tax Administration of their own country for instructions regarding the conditions and process to follow for reclaiming the Czech VAT. There are also minimum VAT amounts that must be met.

For the refund applications for one to three-quarters by an EU company, the minimum amount is € 400. If the refund application relates to a refund period of a calendar year or the remainder of a calendar year, the amount of VAT may not be less than € 50. For conversion of EURO currency into the CZK currency, it must be used the exchange rate mentioned by the Czech National Bank for the first working day in January of the year for which the application is submitted. Please note that these amounts refer to ALL the VAT from the expenses incurred FROM ALL ITS EMPLOYEES in the Czech Republic for this meeting and any other business-related VAT incurred in the Czech Republic.

Non-European Companies
Non-European companies must send the VAT refund application directly to Finanůní úůad pro Prahu 1 (Local Tax Office for Prague 1) at the address below. Please note that an application for a refund of VAT for the relevant calendar year must be filed at the latest by 30 June of the following calendar year. The Non-European companies must fill in the form in Czech language.

Finanůní úůad pro hlavní můsto Praha
Územní pracovištů pro Prahu 1
Štůpánská 28
112 33, Praha 1
Czech Republic
Tel: +420 224 041 111
Fax: +420 224 043 198
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There are also minimum VAT amounts that must be met. The VAT refund must be at least CZK 7,000, unless the refund period is the calendar year or the last period of the calendar year. The refund for these refund periods must be at least CZK 1,000. Please note that these amounts refer to ALL the VAT from the expenses incurred FROM ALL ITS EMPLOYEES in the Czech Republic for this meeting and any other business-related VAT incurred in the Czech Republic.
You can find the form under http://www.financnisprava.cz/assets/en/attachments/dt-databaze-aktualnich-danovych-tiskopisu/5247_1.pdf. The form must be completed and presented with the application.

The application for VAT refund must be supported by the relevant invoices and a Certification that the applicant is a taxable person registered for VAT or similar taxes issued by the tax authority from the country of his establishment (ex: for US companies = IRS form 6166).

Guest/Family Programs

Guests and family members of registrants are welcome to the Guest Programs that include: Kutná Hora tour (Monday), the Conference Wide Reception in the Congress Hall Foyer and Congress Hall II of the Hilton Prague Hotel (Monday evening), and the RÜCKL Glassworks tour (Tuesday). Tickets are required for admission to all events. Please also note that the tours have an associated fee for participants. Early registration is strongly recommended for the events that require fees, as they are available only on a first-come, first-served basis.

Breakfast for all attendees and guests is included in the hotel booking at the Hilton Prague Hotel.

Professional Development Hours Available

Professional Development Hours are available for your attendance at the PVP Conference. Simply stop by the Registration Desk and fill out a certificate request form with the sessions that you have attended. The certificates can then be picked up on Thursday at the registration desk.

Publishing Conference Papers in the ASME Journal of Pressure Vessel Technology

Technical papers presented at the ASME PVP 2018 Conference are published in the form of the ASME Conference Proceedings. Publication of papers in these proceedings does not preclude authors from publishing their papers in ASME archival journals, such as the ASME Journal of Pressure Vessel Technology (JPVT), which is the technical voice of the Pressure Vessels & Piping Division. Authors are encouraged to submit their papers to the Journal. The Journal is edited by Dr. Young W. Kwon, and manuscripts should be submitted to him at https://journaltool.asme.org/home/JournalDescriptions.cfm?JournalID=14&Journal=pVT. Manuscripts should be prepared according to the ASME Journals author resources, which can be found at https://journaltool.asme.org/home/AuthorResources.cfm

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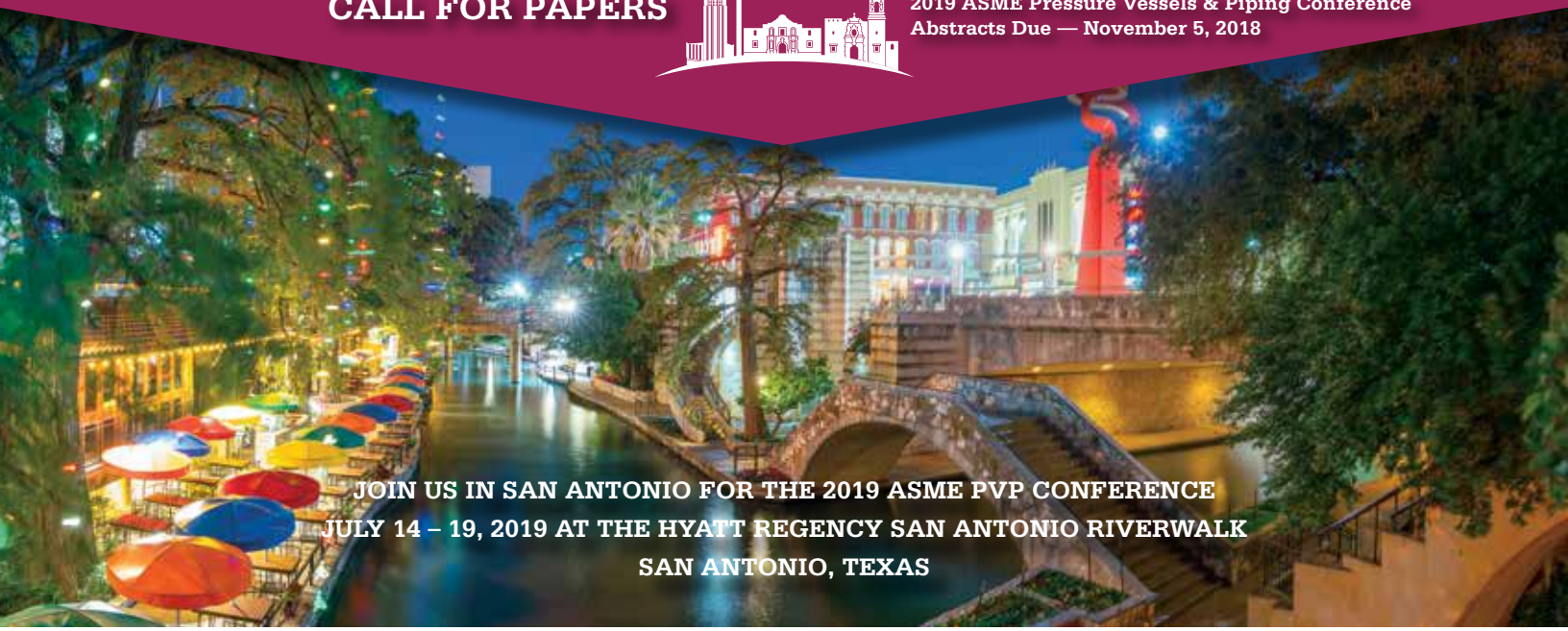
PVP 2018 Committee Meetings

Date/Time	Meeting	Room	Responsible Person
Saturday, July 14			
1:00 pm – 5:00 pm	PVP Division	Vienna	M. Younan
Monday, July 16			
8:15 am – 10:00 am	PVPD Professional Development	Vienna	M. Younan
8:15 am – 6:00 pm	Subgroup High Pressure Vessels Working Group on Design (BPV VIII-3)	Roma	D. Peters/ A. Maslowski
2:15 pm – 6:00 pm	NDPD Executive Committee	Vienna	V. Agrawal
Tuesday, July 17			
8:15 am – 10:00 am	PVPD Communications Committee	Vienna	H. Bouzid
8:15 am – 12:00 pm	Subgroup High Pressure Vessels Working Group on Design (BPV VIII-3)	Roma	D. Peters/ A. Maslowski
10:15 am – 12:00 pm	PVP 2019 Program Committee	Vienna	H. Bouzid
12:15 pm – 2:15 pm	PVPD Codes and Standards Technical Committee	Congress Hall III	R. Cipolla
12:15 pm – 2:15 pm	PVPD Fluid-Structure Interaction Technical Committee	Vienna	T. Taniguchi
12:15 pm – 2:15 pm	PVPD Operations, Applications and Components Technical Committee	Roma	G. Bezdikian
12:15 pm – 2:15 pm	PVPD Design and Analysis Technical Committee	Congress Hall I	R. Baliga
2:15 pm – 4:00 pm	PVPD International Coordination Committee	Vienna	X.-K. Zhu
4:15 pm – 6:00 pm	PVPD Honors and Awards Committee	Vienna	T. Seipp
Wednesday, July 18			
8:15 am – 10:00 am	Student Paper Competition Judging	Vienna	D. Scarth
10:15 am – 12:00 pm	JPVT Editors	Vienna	Y. Kwon
12:15 pm – 2:15 pm	PVPD Materials and Fabrication Technical Committee	Congress Hall I	M. Brongers
12:15 pm – 2:15 pm	PVPD Seismic Engineering Technical Committee	Vienna	F. Paolacci
12:15 pm – 2:15 pm	PVPD High Pressure Technology Technical Committee	Congress Hall III	K. Simpson
12:15 pm – 2:15 pm	PVPD Computer Technology and Bolted Joints Technical Committee	Roma	J. Waterland
2:15 pm – 4:00 pm	PVPD Early Career Engineers Committee	Vienna	K. Karpanan
Thursday, July 19			
8:15 am – 12:00 pm	PVP Division Leadership Team	Roma + Vienna	P. Mertiny
12:15 pm – 4:00 pm	PVPD General Committee	Roma + Vienna	P. Mertiny
4:15 pm – 6:00 pm	PVPD Conference Evaluation	Roma + Vienna	M. Feldman

CALL FOR PAPERS

2019 ASME Pressure Vessels & Piping Conference
Abstracts Due — November 5, 2018



Join us in beautiful San Antonio for the 2019 ASME Pressure Vessels & Piping Conference where we'll explore the futuristic technology trends in the global Pressure Vessel & Piping Industry. For more than half a century, the PVP Conference has been an ideal platform for staying current with emerging technologies, networking and meeting the world's leading experts and practitioners in our industry. As a recognized forum with participants from more than 40 countries in Europe, Africa, the Middle East, Asia, the Americas and Oceania islands, there is no better professional gathering to promote and advance PVP technologies. The ASME PVP Division is sponsoring this 2019 conference in cooperation with the ASME NDPD Division.

PAPER & PANEL SESSIONS

More than 180 paper and panel sessions are planned including workshops and tutorials, a Technology Demonstration Forum and the 27th Rudy Scavuzzo Student Paper Symposium and Competition.
General topics will include:

- Codes & Standards
- Computer Technology & Bolted Joints
- Design & Analysis
- Fluid Structure Interaction
- High Pressure Technology
- Materials & Fabrication
- Operations, Applications & Components
- Seismic Engineering
- Non-Destructive Examination
- 27th Rudy Scavuzzo Student Paper Symposium & Competition

Technical areas will further include developments in design methodologies including elastic-plastic analysis, fitness-for-service, operations and maintenance, creep, fatigue, stress corrosion cracking, residual stresses, fracture toughness, elevated temperature components, non-metallic components, dynamically loaded structures, flow-induced vibration and risk-based assessments.

SCHEDULE FOR SUBMISSION*

• **November 5, 2018**	**Abstracts are due**
• November 26, 2018	Abstract acceptance notification
• February 4, 2019	Draft papers due
• March 4, 2019	Peer review comments returned to authors
• April 1, 2019	Copyright Agreement Form due (for each paper)
• April 8, 2019	Final manuscripts* due for publication

** All final manuscripts must be submitted in the standard ASME format for publication. All presented technical papers will be published as citable documents available post-conference.*

FOR MORE INFORMATION

Please visit the 2019 PVP Conference website at http://www.asmeconferences.org/PVP2019/. Technical paper abstracts must be submitted electronically via the website.

PVP Conference Chair:
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Session Titles by Session Blocks

Sessions are arranged in Session Blocks in the format X.YZ (....), where: X indicates the Day number, Y indicates the Session Block number, and Z indicates the Conference Session Room letter. The parenthetical designations are the Technical Committee session references.

Day numbers are as follows
0 Sunday
1 Monday
2 Tuesday
3 Wednesday
4 Thursday
5 Friday

Session Block numbers are as follows (except for Sunday)
1 8:15 am – 10:00 am
2 10:15 am – 12:00 pm
3 2:15 pm – 4:00 pm
4 4:15 pm – 6:00 pm

Conference Session Rooms are as follows:
A Karlin I (Mezzanine)
B Karlin II (Mezzanine)
C Karlin III (Mezzanine)
D Palmovka (Mezzanine)
E Rokoska (Mezzanine)
F Hercovka (Mezzanine)
G Tyrolka (Mezzanine)
H Amsterdam (Lobby Level)
I Athens (Lobby Level)
J Barcelona (Lobby Level)
K Berlin (Lobby Level)
L Brussels (Lobby Level)
M Sofia (Lobby Level)
N Madrid (Lower Lobby)
O Congress Hall I (Lower Lobby)
Q Congress Hall III (Lower Lobby)
S Congress Hall Foyer (Lower Lobby)

Acronyms used for the Technical Committees and sponsoring organizations are shown below:

CS	Codes & Standards
CT	Computer Technology & Bolted Joints
DA	Design & Analysis
FSI	Fluid-Structure Interaction
HPT	High-Pressure Technology
MF	Materials & Fabrication
NDPD	ASME Nondestructive Evaluation, Diagnosis and Prognosis Divison
OAC	Operations, Applications and Components
SE	Seismic Engineering
SPC	Rudy Scavuzzo Student Paper Symposium & Student Paper Competition
EPRI	Electric Power Research Institute
XPR	XP-Resilience
TW	Technical Tutorials & Workshops

Note: Unless specifically listed in the individual sessions below, all sessions are sponsored by the indicated Technical Committee.

Sunday, July 15 — Block 0.3

Special Tutorial Session 0.3O (TW-1-1)
1:30PM - 3:30PM
Navigating Corporate Culture for Professional Advancement

Special Tutorial Session 0.3Q (TW-1-2)
8:15AM - 10:15AM
Overview of ASME Section VIII Division 1

Monday, July 16 — Block 1.1

Session 1.1A (CS-2-1)
Fatigue & Ratcheting Issues in Pressure Vessel & Piping Design

Session 1.1B (MF-1-1)
Application of Fracture Mechanics in Failure Assessment – 1

Session 1.1C (MF-3-1)
Welding Residual Stress and Distortion Simulation and Measurement - I

Session 1.1D (CS-11-1)
Extreme Pressure Equipment - I

Session 1.1E (FSI-1-1)
Leaks, Cracks, Breaks, Impacts and Vibrations - I

Session 1.1F (SE-2-1)
Seismic Isolation

Session 1.1G (CT-4-1)
Robert Noble Memorial Session on Assembly of Bolted Joints

Session 1.1H (DA-8-1)1.1H
FFS for High Temperature Applications

Session 1.1.I (CS-5-1)
Technical Harmonization and Emerging Code and Standards

Session 1.1J (CS-19-1)
Integrity of Cast Stainless Steel Pipe

Session 1.1K (CS-20-1)
Use of Modern FEA methods for Code Assessment

Session 1.1L (SPC-1-1)
Student Paper Competition - BS/MS -1

Session 1.1M (DA-19-1)
Special Considerations in the Design and Analysis of Supports, Restraints

Session 1.1N (DA-1-1)
Design and Analysis of Pressure Vessels, Heat Exchangers and Components - I

Monday, July 16 — Block 1.2 — 10:15AM - 12:00PM

Opening Ceremony & Plenary Sessions

Monday, July 16 — Block 1.3 — 2:15PM - 4:00PM

Session 1.3A (CS-3-1)
Environmental Fatigue Issues - I

Session 1.3B (MF-1-2)
Application of Fracture Mechanics in Failure Assessment - II

Session 1.3C (MF-3-2)
Welding Residual Stress and Distortion Simulation and Measurement - II

Session 1.3D (CS-11-2)
Developments of Chinese Codes and Standards - I

Session 1.3E (FSI-1-2)
Water Hammer and Scaling

Session 1.3F (SE-2-2)
Vibration Control and Damping - I

Session 1.3G
Design and Analysis of Bolted Flange Joints

Session 1.3H (DA-8-2)
FFS Involving Fracture Mechanics

Session 1.3I (CS-1-1)
Structural Integrity of Pressure Components - I

Session 1.3J (MF-27-1)
Additive Manufacturing Characterization

Session 1.3K (OAC-1-1)
Optimizing Operations via Risk Management

Session 1.3L (SPC-1-2)
Student Paper Competition - BS/MS - II

Session 1.3M (MF-19-1)
Uncertainty Quantification of Material Degradation Data and Failure Models - I

Session 1.3N (DA-1-2)
Design and Analysis of Pressure Vessels, Heat Exchangers, and Components - II

Technical Tutorial Session 1.3Q (TW-2-7)
Aging Management for Spent Fuel Dry Storage and Subsequent Transportation (Part 1)

Session 1.4L (SPC-1-3)
Student Paper Competition - PhD - I

Session 1.4M (MF-19-2)
Uncertainty Quantification of Material Degradation Data and Failure Models - II

Session 1.4N (DA-1-3)
Design and Analysis of Pressure Vessels, Heat Exchangers, and Components - III

Technical Tutorial Session 1.4Q (TW-2-8)
Aging Management for Spent Fuel Dry Storage and Subsequent Transportation Part 2

Monday, July 16 Block 1.4 4:15PM - 6:00PM

Session 1.4A (CS-3-2)
Environmental Fatigue Issues – II

Session 1.4B (MF-1-3)
Application of Fracture Mechanics in Failure Assessment - III

Session 1.4C (MF-3-3)
Welding Residual Stress and Distortion Simulation and Measurement - III

Session 1.4D (CS-11-3)
Example of Engineering Failure Analysis in China - I

Session 1.4E (FSI-1-3)
Leaks, Cracks, Breaks, Impacts and Vibrations – II

Session 1.4F (SE-2-3)
Vibration Control and Damping - II

Session 1.4G (CT-3-1)
Leak Tightness and Assembly of Bolted Joints

Session 1.4H (DA-8-3)
FFS - Understanding the Strength and Failures

Session 1.4I (CS-1-2)
Structural Integrity of Pressure Components - II

Session 1.4J (MF-27-2)
Additive Manufacturing Process and Modeling

Session 1.4K (OAC-1-2)
Predicting the Future: Risk Assessment and Management

Tuesday, July 17 Block 2.1 8:15AM - 10:00AM

Session 2.1A (CS-3-3)
Environment Fatigue Issues - III

Session 2.1B (MF-1-4)
Application of Fracture Mechanics in Failure Assessment - IV

Session 2.1C (MF-6-1)
Materials and Technologies for Nuclear Power Plants - I

Session 2.1D (CS-11-4)
Failure Analysis of Engineering Structure - I

Session 2.1E (HPT-2-1)
Impulsively Loaded Vessels

Session 2.1F (SE-9-1)
Multi-Hazards and Margins

Session 2.1G (CT-2-1)
Elevated Temperature Behavior of Bolted Joints

Session 2.1H (DA-8-4)
FFS - General Topics

Session 2.1I (DA-11-1)
CFD in Design and Analysis

Session 2.1J (NDPD-1-1)
William T. Springer Memorial Session on Emerging NDE Techniques and Applications - I

Session 2.1K (OAC-3-1)
Monitoring, Diagnostic & Inspection - I

Session 2.1L (SPC-1-4)
Student Paper Competition - PhD - II

Session 2.1M (MF-13-1)
Leak Before Break

Session 2.1N (DA-2-1)
Design and Analysis of Piping and Components - I

Session 2.1O (DA-15-1)
Coke Drums: Introduction & Life Cycle Management Strategies

Technical Tutorial Session 2.1Q (TW-2-3)
Fracture Mechanics Applications to Piping Part 1

Session 2.2L (SPC-2-1)
Student Paper Symposium - PhD - I

Session 2.2M (MF-20-1)
Advanced Manufacturing and Materials Technology

Session 2.2N (DA-2-2)
Design and Analysis of Piping and Components - II

Session 2.2O (DA-15-2)
Coke Drums: Bulges & Hot Spots - Operational Influences on Coke Drum Life Cycle & Analysis Methods

Technical Tutorial Session 2.2Q (TW-2-4)
Fracture Mechanics Applications to Piping (Part 2)

Tuesday, July 17 Block 2.2 10:15AM - 12:00PM

Session 2.2A (CS-3-4)
Environmental Fatigue Issues - IV

Session 2.2B (DA-12-1)
Fracture - I

Session 2.2C (MF-6-2)
Materials and Technologies for Nuclear Power Plants - II

Session 2.2D (CS-11-5)
Extreme Pressure Equipment - II

Session 2.2E (FSI-6-1)
Impact and Blast Loadings

Session 2.2F (SE-12-1)
Advanced Seismic Evaluation and Code - I

Session 2.2G (CT-6-1)
Special Applications of Bolted Joints

Session 2.2H (CS-37-1)
Improvement of Flaw Characterization Rules in Fitness-for-Service Codes - I

Session 2.2I (MF-16-1)
Probabilistic Assessment of Failure

Session 2.2J (NDPD-1-2)
Emerging NDE Techniques and Applications - II

Session 2.2K (OAC-3-2)
Monitoring, Diagnostic & Inspection - II

Tuesday, July 17 Block 2.3 2:15PM - 4:00PM

Session 2.3A (CS-3-5)
Environmental Fatigue Issues - V

Session 2.3B (DA-12-2)
Fracture - II

Session 2.3C (MF-6-3)
Materials and Technologies for Nuclear Power Plants - III

Session 2.3D (CS-11-6)
Developments of Chinese Codes and Standards - II

Session 2.3E (FSI-2-1)
Tube Arrays in Cross-Flow

Session 2.3F (SE-12-2)
Advanced Seismic Evaluation and Code - II

Session 2.3G (CT-8-1)
Threaded Fasteners - I

Session 2.3H (CS-37-2)
Improvement of Flaw Characterization Rules in Fitness-for-Service Codes - II

Session 2.3I (CS-28-1)
Uncertainty Characterization in Probabilistic Assessments of Structural Integrity

Session 2.3J (NDPD-2-1)
NDE for Petrochemical and Power Plant Components - I

Session 2.3K (OAC-5-1)
Design, Testing, Qualification and Failure of Valves - I

Session 2.3L (SPC-2-2)
Student Paper Symposium - PhD - II

Session 2.3M (DA-17-1)
Composite Materials and Structures - I

Session 2.3N (DA-2-3)
Design and Analysis of Piping and Components - III

Session 2.3O (DA-15-3)
Coke Drum Repairs - Materials and Welding Aspects

Technical Tutorial Session 2.3Q (TW-2-5)
Advanced Fatigue Analysis (Part 1)

Tuesday, July 17 Block 2.4 4:15PM - 6:00PM

Session 2.4A (DA-3-1)
Fatigue Design and Analysis

Session 2.4B (DA-12-3)
Fracture - III

Session 2.4C (MF-6-4)
Materials and Technologies for Nuclear Power Plants - IV

Session 2.4D (CS-11-7)
Example of Engineering Failure Analysis in China - II

Session 2.4E (FSI-2-2)
Fuel and Multi-Span Structure Flow-Induced Vibration

Session 2.4F (SE-12-3)
Advanced Seismic Evaluation and Code - III

Session 2.4G (CT-8-2)
Threaded Fasteners - II

Session 2.4H (MF-5-1)
Fitness for Service and Failure Assessment - I

Session 2.4I (MF-4-1)
FA3 RPV Positive Carbon Segregation Issue - I

Session 2.4J (NDPD-2-2)
NDE for Petrochemical and Power Plant Components - II

Session 2.4K (OAC-5-2)
Design, Testing, Qualification and Failure of valves - II

Session 2.4L (FSI-5-1)
International Symposium on Emerging Technologies: Engineering Applications

Session 2.4M (DA-17-2)
Composite Materials and Structures - II

Session 2.4N (DA-2-4)
Design and Analysis of Piping and Components - IV

Session 2.4O (DA-15-4)
Closing Session: What's Next for the Industry?

Technical Tutorial Session 2.4Q (TW-2-6)
Advanced Fatigue Analysis (Part 2)

Wednesday, July 18 Block 3.1 8:15AM - 10:00AM

Session 3.1A (DA-3-2)
Development of New Design Fatigue Curves in Japan

Session 3.1B (CS-22-1)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - I

Session 3.1C (MF-6-5)
Materials and Technologies for Nuclear Power Plants - V

Session 3.1D (CS-11-8
Failure Analysis of Engineering Structure - II

Session 3.1E (FSI-2-3)
Flutter, VIV and General FSI

Session 3.1F (SE-4-1)
Structural Dynamics - I

Session 3.1G (DA-10-4)
Bolted Joint Progress - International Liaison - I

Session 3.1H (MF-5-2)
Fitness for Service and Failure Assessment - II

Session 3.1I (MF-4-2)
FA3 RPV Positive Carbon Segregation Issue - II

Session 3.1J (CS-23-1)
Hydrogen Flakes Assessment in the RPV's

Session 3.1K (OAC-4-1)
Radioactive Materials (RAM) Storage and Transport - I

Session 3.1L (HPT-6-1)
Design and Evaluation of HPHT in Subsea Applications

Session 3.1M (MF-14-1)
Composite Systems for Pressure Vessels and Piping - I

Session 3.1N (DA-14-1)
Evaluation and Countermeasure for BDBE - I

Technical Tutorial Session 3.1Q (TW-2-1)
Auto-Refrigeration & Brittle Fracture Prevention (Part 1)

Wednesday, July 18 Block 3.2 10:15AM - 12:00PM

Session 3.2A (MF-17-1)
Fatigue Performance of Welded Joints

Session 3.2B (CS-22-2)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - II

Session 3.2C (MF-2-1)
Hydrogen-Assisted Fatigue of Austenitic Stainless Steel

Session 3.2D (CS-9-1)
ASME Section XI Code Activities - I

Session 3.2E (FSI-2-4)
Acoustics and Piping Vibrations

Session 3.2F (SE-4-2)
Structural Dynamics - II

Session 3.2G (DA-10-5)
Bolted Joint Progress - International Liaison - II

Session 3.2H (CS-6-1)
API 579/ASME Code Fitness-For-Service Activities

Session 3.2I (MF-4-3)
European Programs In Structural Integrity - I

Session 3.2J (CT-9-1)
New and Emerging Methods of Analysis and Applications

Session 3.2K (OAC-4-2)
Radioactive Materials (RAM) Storage and Transport - II

Session 3.2L (HPT-6-2)
Subsea Fatigue, Fracture and Vibration

Session 3.2M (MF-14-2)
Composite Systems for Pressure Vessels and Piping - II

Session 3.2N (DA-14-2)
Evaluation and Countermeasure for BDBE - II

Session 3.2O (CT-8-3)
Adhesive Joining

Technical Tutorial Session 3.2Q (TW-2-2)
Auto-Refrigeration & Brittle Fracture Prevention (Part 2)

Wednesday, July 18 Block 3.3 2:15PM - 4:00PM

Session 3.3A (MF-17-2)
Impact of Microstructure on Mechnical Properties

Session 3.3B (CS-22-3)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - III

Session 3.3C (MF-2-2)
Materials Evaluation Methods for Hydrogen Service

Session 3.3D (CS-9-2)
ASME Section XI Code Activities - II

Session 3.3E (FSI-2-5)
FIV of Multi-span Structures

Session 3.3F (SE-1-1)
Earthquake Resistance and Seismic Margin

Session 3.3G (DA-10-1)
Bolted Joint Codes and Standards

Session 3.3H (CS-38-1
Quality Assurance, Nondestructive Testing, and NDE Personnel Certification

Session 3.3I (MF-4-4)
European Programs In Structural Integrity - II

Session 3.3J (CT-14-1)
Computational FEA for Limit Load, Elastic-Plastic Analysis and Creep

Session 3.3K (OAC-4-3)
Radioactive Materials (RAM) Storage and Transport - III

Session 3.3L (HPT-6-6)
HPHT Equipment Design for Oil and Gas Applications

Session 3.3N (DA-9-1)
Piping and Equipment Dynamics

Wednesday, July 18 Block 3.4 5:00PM - 10:00PM

Honors Gala & Dinner

Thursday, July 19 Block 4.1 8:15AM - 10:00AM

Session 4.1A (MF-18-1)
Creep Deformation and Crack Growth

Session 4.1B (CS-22-4)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - IV

Session 4.1C (MF-2-3)
Hydrogen Embrittlement and Prevention

Session 4.1D (CS-7-1)
Recent Developments in ASME Codes and Standards - I

Session 4.1E (CS-12-1)
Recent Developments in European Codes and Standards - I

Session 4.1F (SE-8-1)
Seismic Evaluation of Systems, Structures and Components - I

Session 4.1G (DA-10-2)
Dr Bill Koves Memorial Session on Advanced Bolted Joint Design and Analysis

Session 4.1H (CS-14-1)
Repair, Replacement and Mitigation Activities

Session 4.1I (MF-32-1)
Structural Integrity for Spent Fuel Canisters

Session 4.1J (CT-12-1)
Computational Applications in Fatigue, Fracture and Damage Mechanics

Session 4.1K (OAC-8-1)
Aging and Life Management and Extension - I

Session 4.1L (HPT-1-1)
Design and Analysis of Pre-Service Equipment

Session 4.1M (MF-11-1)
Pipeline Integrity - I

Session 4.1N (DA-7-1)
Thermal Stresses and Elevated Temperature Design - I

Workshop Session 4.1O (EPRI-1-1)
Session 1 – Keynote Presentations

Workshop Session 4.1Q (XPR-1-1)
Key Issues in Resilience of Calculation of Critical Infrastructures

Thursday, July 19 Block 4.2 10:15AM - 12:00PM

Session 4.2A (MF-18-3)
Creep & Fatigue Damage Analyses

Session 4.2B (MF-12-1)
Small-Scale Testing and Statistical Analysis of Mechanical Properties - I

Session 4.2C (MF-2-4)
Hydrogen-Assisted Fatigue and Fracture of Ferritic Steels

Session 4.2D (CS-7-2)
Recent Developments in ASME Codes and Standards - II

Session 4.2E (CS-12-2)
Recent Developments in European Codes and Standards - II

Session 4.2F (SE-8-2)
Seismic Evaluation of Systems, Structures and Components - II

Session 4.2G (DA-10-3)
Robert Noble Memorial Session on Bolted Joint Assembly

Session 4.2H (CS-14-2)
Repair, Replacement and Mitigation Activities

Session 4.2I (MF-24-1)
Asian Programs in Structural Integrity - I

Session 4.2J (MF-23-1)
Emerging Manufacturing and Mitigation Process Simulation

Session 4.2K (OAC-8-2)
Aging and Life Management and Extension - II

Session 4.2L (HPT-3-1)
Darren Stang Memorial Session on Design, Analysis and Life Prediction of High-Pressure Vessels and Equipment

Session 4.2M (MF-11-2)
Pipeline Integrity - II

Session 4.2N (DA-7-2)
Thermal Stresses and Elevated Temperature Design - II

Workshop Session 4.2O (EPRI-2)
Session 2 - Properties and Models for Low Alloy Steels

Workshop Session 4.2Q (XPR-2)
Problems and Perspectives in Seismic Risk and Resilience of Chemical Process Plants for Decision Making

Thursday, July 19 Block 4.3 2:15AM - 4:00PM

Session 4.3A (MF-18-4)
Creep Modelling and Assessment Methodologies

Session 4.3B (MF-12-2)
Small-Scale Testing and Statistical Analysis of Mechanical Properties - II

Session 4.3C (CS-8-1)
Compatibility and Suitability of Materials for Hydrogen Service

Session 4.3D (CS-7-3)
Recent Developments in ASME Codes and Standards - III

Session 4.3E (CS-25-1)
Integrity of Reactor Pressure Vessels and Internals for Codes

Session 4.3F (SE-6-1)
Seismic Analysis and Design of Piping Systems

Session 4.3G (MF-31-1)
3D Crack Growth Simulation Using FEA

Session 4.3H (OAC-6-1)
Reliability and Optimization

Session 4.3I (MF-24-2)
Asian Programs in Structural Integrity - II

Session 4.3J (MF-9-1)
Mechanistic Modelling of Deformation and Fracture - I

Session 4.3K (DA-16-1)
Vessel Design Philosophy - I : The Owner / Purchaser Perspective

Session 4.3L (HPT-3-2)
Design and Evaluation of LDPE Equipment

Session 4.3N (DA-4-1)
Inelastic, Nonlinear and Limit Load Analysis - I

Workshop Session 4.3O (EPRI-3)
Properties and Models for Martensitic Steels

Workshop Session 4.3Q (XPR-3)
A Probabilistic Methodology for the Risk Assessment of Process Plants Including Domino Effects

Thursday, July 19 Block 4.4 4:15PM - 6:00PM

Session 4.4A (MF-18-5)
Creep Life Prediction and Microstructural Analyses

Session 4.4C (CS-8-2)
Hydrogen from Non-Gaseous Environments

Session 4.4D (CS-10-1)
Structural Integrity Assessment of Pressure Boundary Components

Session 4.4E (CS-24-1)
International Session for Fast Reactor Design and Construction

Session 4.4F (SE-13-1)
Ratcheting Deformation of Materials and Piping

Session 4.4G (CS-21-1)
Fatigue Monitoring and Related Assessment Methods

Session 4.4H (OAC-6-2)
Fitness for Service and Continued Safe Operation

Session 4.4I (CS-15-1)
Probabilistic and Risk-informed Methods for Structural Integrity Assessment

Session 4.4J (MF-9-2)
Mechanistic Modelling of Deformation and Fracture - II

Session 4.4K (DA-16-2)
Vessel Design Philosophy - II: The Fabricators' Perspective

Session 4.4N (DA-4-2)
Inelastic, Nonlinear and Limit Load Analysis -II

Workshop Session 4.4O (EPRI-4)
Properties and Models for Stainless Steels

Workshop Session 4.4Q (XPR-4)
Metamaterial-Based Shield for Resilience Enhancement of Petrochemical Plants

Friday, July 19 Block 5.1 8:15AM - 10:00AM

Workshop Session 5.1O (EPRI-5)
Session 5: Fundamental Approaches for Modelling - Considering BOTH Damage Tolerant and Damage Susceptible Steels

Workshop Session 5.1Q (XPR-5)
Coastal Resilience of Chemical and Petrochemical Storage Tanks

Friday, July 19 Block 5.2 10:15AM - 12:00PM

Workshop Session 5.2O (EPRI-6)
Session 6: Design and Component Assessment Applications

Workshop Session 5.2Q (XPR-6)
Decision Making, Maintenance, Operation and Resilience

Friday, July 19 Block 5.3 2:15PM - 4:00PM

Workshop Session 5.3Q (XPR-7)
Efficient Simulation Techniques For Reliability And Resilient Analysis Of Complex Systems

Friday, July 19 Block 5.4 4:15PM - 6:00PM

Workshop Session 5.4Q (XPR-8)
Metamodels For Uncertainty Quantification And Structural Reliability Analysis

Daily Sessions

Block 0 Sunday, July 15 1:30PM – 3:30PM

Special Tutorial Session 0.3O (TW-1-1)
Navigating Corporate Culture for Professional Advancement
Lower Lobby, Congress Hall I 1:30pm - 3:30pm

Session Developer/Chair: **Maher Younan**,
American University in Cairo, New Cairo 11835, Egypt
Presented by: **L. Ike Ezekoye**,
Ezekoye Engineering Services LLC, Pittsburgh, PA, USA

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Special Tutorial Session 0.3Q (TW-1-2)
Overview of ASME Section VIII Division 1: Design Rules for Construction of Pressure Vessels
Lower Lobby, Congress Hall III 1:30pm - 3:30pm

Session Developer/Chair: **Maher Younan,**
American University in Cairo, New Cairo 11835, Egypt
Presented by: **Daniel Peters**,
Structural Integrity Associates, Edinboro, PA, USA

Block 1.1 Monday, July 16 8:15AM – 10:00AM

Session 1.1A (CS-2-1)
Fatigue & Ratcheting Issues in Pressure Vessel & Piping Design
Mezzanine, Karlin I 8:15am - 10:00am

Session Developer/Co-Chair: **Wolf Reinhardt**, *Candu Energy Inc, Mississauga, ON, Canada*
Session Chair: **Juergen Rudolph**, *Framatome GmbH, Erlangen, Bavaria, Germany*

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8:15am
Beyond Shakedown-Ratcheting Boundary
Technical Paper Publication: PVP2018-85050

Reza Adibiasl, *Kinectrics NSS, Toronto, ON, Canada*
Wolf Reinhardt, *Candu Energy Inc, Mississauga, ON, Canada*

8:41am
Effect of Nozzle Flexibilities/Stiffness on Equipment Nozzle Loads and Local Stresses
Technical Paper Publication: PVP2018-84952

Sujay Pathre *and* **Govindan Krishnamoorthy**, *Lloyd's Register Asia, Andheri East, Mumbai, India*

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9:07am
Application of the Enhanced Reference Stress Method to Fatigue Propagation of a Surface Crack in a Plate Subjected to Cyclic Bending
Technical Paper Publication: PVP2018-84233

Ippei Yamasaki, Terutaka Fujioka, Yasuhiro Shindo *and* **Yusuke Kaneko**, *Toyo University, Saitama, Japan*

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9:33am
Development of a Flexible Mobile Fatigue Monitoring System for Nuclear and Conventional Applications
Technical Presentation: PVP2018-85132

Florian Bruckmüller, *NEW NP GmbH, Erlangen, Bavaria, Germany*
Juergen Rudolph, *Framatome GMBH, Erlangen, Bavaria, Germany*
Steffen Bergholz, *AREVA GmbH, Erlangen, Bavaria, Germany*

Session 1.1B (MF-1-1)
Application of Fracture Mechanics in Failure Assessment - I
Mezzanine, Karlin II 8:15am - 10:00am

Session Developer: **Gustavo Donato**,
Centro Universitário da FEI, Sao Paulo 03227-130, Brazil
Session Co-Developer/Chair: **Poh-Sang Lam**,
Savannah River National Lab, Aiken, SC, USA
Session Co-Chair: **Harry Coules**, *University of Bristol, Bristol, UK*

8:15am
Fracture Toughness Testing Using Non-Standard PCVN Specimens: Experiments and Specimen Geometry Effects on T0 Reference Temperature
Technical Paper Publication: PVP2018-84115

Vitor S. Barbosa *and* **Claudio Ruggieri**, *University of Sao Paulo USP, Sao Paulo, Sao Paulo, Brazil*

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8:41am
Evaluation of CTOD-Resistance Curve Testing and Its Standard Test Methods for SENB Specimens
Technical Paper Publication: PVP2018-84975

Xiankui Zhu, *EWI - Structural Integrity, Columbus, OH, USA*
Tom McGaughy, *EWI, Columbus, OH, USA*

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9:07am
Effect of Constraint Induced by Specimen Geometries on Crack Growth Behavior Under Creep-Fatigue Interaction
Technical Paper Publication: PVP2018-84816

Lei Zhao, *Tianjin University, Tianjin, China*
Lianyong Xu, *Tianjin University, Tianjin,, China*

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9:33am
Fracture Toughness of Defects Orientated Parallel to a Dissimilar Metal Weld Boundary
Technical Paper Publication: PVP2018-84405

Alison O'Connor *and* **Catrin Mair Davies**, *Imperial College London, London, UK*
Kamran Nikbin, *ICL, London, UK*

Session 1.1C (MF-3-1)
Welding Residual Stress and Distortion Simulation and Measurement - I
Mezzanine, Karlin III 8:15am - 10:00am

Session Developer/Chair: **Frederick (Bud) Brust,** *Engineering Mechanics Corp of Columbus, Upper Arlington, OH, USA*
Session Developer/Co-Chair: **David Rudland**, *US NRC, Frederick, MD, USA*

8:15am
The Influence of Resistance Wires Density on Local Heat Treatment
Technical Paper Publication: PVP2018-84370

Hongchen Liu, *Tianjin University/Tianjin Special Equipment Inspection Institute, Tianjin, China,*
Jun Zhao *and* **Liyan Liu**, *Tianjin University, Tianjin, China*

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8:50am
A Designer-Driven Welding Simulation Analysis to Define the Best Weld Sequence for Panel Structures
Technical Paper Publication: PVP2018-84207

Mahyar Asadi, Majid Tanbakuei Kashani, Mohammad Mohseni *and* **Mathew Smith**, *Applus+ Canada, Vancouver, BC, Canada*

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9:25am
Determination of Residual Stress Directionality Using Anisotropic Indenter in Instrumented Indentation Testing
Technical Paper Publication: PVP2018-84846

Sungki Choi, Jong Hyoung Kim, Jun Sang Lee, *Seoul National University, Seoul, Korea (Republic),*
Kyungyul Lee *and* **Dongil Kwon**, *Seoul National University, Seoul, Korea (Republic),*
Min-Jae Choi, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic),*
HeeJun Ahn, *Samsung Electronics, Seoul, Korea (Republic)*

Session 1.1D (CS-11-1)
Extreme Pressure Equipment - I
Mezzanine, Palmovka 8:15am - 10:00am

Session Co-Developer/Co-Chair: **Jinyang Zheng**, *Zhejiang University, Hangzhou, China*
Session Co-Developer/Chair: **Jianfeng Shi**, *Zhejiang University, Hangzhou, China*

8:15am
Development of Lightweight Design and Manufacture of Heavy-Duty Pressure Vessels in China
Technical Paper Publication: PVP2018-84176

Xuedong Chen *and* **Zhichao Fan**, *Hefei General Machinery Research Institute, Hefei, Anhui, China*
Yongdong Chen, *Heat Exchanger Branch of CPVI, Hefei, China*
Xiaohu Zhang, *Hefei Gen Machinery Rsch Inst, Hefei, China*
Jun Cui, *Design Branch of CPVI, Hefei, China*
Jinyang Zheng, *Zhejiang University, Hangzhou, China*
Binan Shou, *China Special Equipment Inspection and Research Institute, Beijing, China*

8:41am
Creep Analysis for Pressurized Components Under Creep Conditions Based on Isochronous Stress-Strain Curve and Elastic-Perfectly Plastic Material Model
Technical Paper Publication: PVP2018-84265

Qi-wei Xia, Jian-Guo Gong *and* **Fuzhen Xuan**, *East China University of Science and Technology, Shanghai, China*

9:07am
Light-Weight Mechanism of Pressure Strengthening of Cryogenic Vessels from Austenitic Stainless Steel
Technical Paper Publication: PVP2018-84451

Qunjie Lu, Gai Huang, Yingzhe Wu, Huiming Ding *and* **Jinyang Zheng**, *Zhejiang University, Hangzhou, China*

9:33am
Low-Cycled Fatigue Life of S30408 Stainless Steel at Liquid-Nitrogen Temperature
Technical Paper Publication: PVP2018-84498

Yingzhe Wu, Huaijian Xu, Qunjie Lu, Jinyang Zheng *and* **Ping Xu**, *Zhejiang University, Hangzhou, Zhejiang, China*

Session 1.1E (FSI-1-1)
Leaks, Cracks, Breaks, Impacts and Vibrations - I
Mezzanine, Rokoska 8:15am - 10:00am

Session Developer/Chair: **Arris Tijsseling**, *TU Eindhoven, Eindhoven, Netherlands*
Session Developer/Co-Chair: **Jong Chull Jo**, *Korea Institute, Nuclear Safety/Pusan National University, Daejon, Korea (Republic)*

8:15am
Modeling Hypervelocity Impacts Using Smoothed Particle Hydrodynamics
Technical Paper Publication: PVP2018-84609

Christina Giannopapa, M. Ganser *and* **B.J. van der Linden**, *Eindhoven University of Technology, Eindhoven, Netherlands*

8:41am
Study on Characteristics of Wall Temperature Fluctuation at a Mixing Tee With an Upstream Elbow
Technical Paper Publication: PVP2018-84182

Koji Miyoshi, *Institute of Nuclear Safety System, Inc., Fukui, Japan*
Akira Nakamura, *Institute of Nuclear Safety System, Inc., Mikata-gun, Japan*

9:07am
Investigation of Fluid Diffusion Properties From Various Flaw Geometries of Piping
Technical Paper Publication: PVP2018-84212

Shun Watanabe, Ryo Morita *and* **Yuta Uchiyama**, *Central Research Institute of Electric Power Industry, Yokosuka, Kanagawa, Japan*

9:33am
When the Joukowsky Equation Does Not Predict Maximum Water Hammer Pressures
Technical Paper Publication: PVP2018-84050

Trey Walters, *Applied Flow Technology, Colorado Springs, CO, USA*
Robert Leishear, *Leishear Engineering, LLC., Aiken, SC, USA*

Session 1.1F (SE-2-1)
Seismic Isolation
Mezzanine, Hercovka 8:15am - 10:00am

Session Developer/Chair: **Osamu Furuya**,
Tokyo Denki University, Saitama, Japan
Session Developer/Co-Chair: **Satoshi Fujita**,
Tokyo Denki University, Tokyo 101-8457, Japan

8:15am
A Study of Self-Powered Active Seismic Isolation Floor Device Using Rotational Inertia Mass Damper
Technical Paper Publication: PVP2018-84354

Keita Aoshima *and* **Nanako Miura**, *Kyoto Institute of Technology, Kyoto, Japan,*
Akira Sone, *Kyoto Institute of Technology, Kyoto, Japan*

8:41am
Verification of the Relation Between the Directions of Control Force and Responses in Active Seismic Isolation Device
Technical Paper Publication: PVP2018-84446

Keigo Nakamura, *Kyoto Institute of Technology, Osaka, Japan*
Nanako Miura and Akira Sone, *Kyoto Institute of Technology, Kyoto, Japan*

9:07am
Research and Development of Three-Dimensional Isolation System for Sodium-Cooled Fast Reactor
Technical Paper Publication: PVP2018-84491

Takahiro Somaki, *Obayashi Corporation, Tokyo, Japan*
Tsuyoshi Fukasawa, *Mitsubishi FBR Systemes, Tokyo, Japan*
Takayuki Miyagawa, *Japan Atomic Power Company, Tokyo, Japan*
Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*
Yoshifumi Yamamoto, Masanari Okamoto, *Kayaba System Machinery Co., Ltd., Tsu-City, Mie Pref., Japan*
Futoshi Ishizuka, Osamu Noda, *Heiwa Hatsujyo Industry Co., Ltd., Sasayama-city, Hyogo Pref., Japan*

9:33am
Research and Development of Three-Dimensional Isolation System for Sodium-Cooled Fast Reactor (Part 1) Proposal of Analytical Models Based on Loading Tests
Technical Paper Publication: PVP2018-84532

Tsuyoshi Fukasawa, *Mitsubishi FBR Systemes, Tokyo, Japan*
Shigeki Okamura, *Mitsubishi FBR Systems Inc, Shibuya-Ku, Japan*
Takahiro Somaki, *Obayashi Corporation, Tokyo, Japan*
Takayuki Miyagawa *and* **Masato Uchita**, *Japan Atomic Power Company, Tokyo, Japan*
Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*
Tomoyoshi Watakabe, *Japan Atomic Energy Agency, Ibaraki, Japan*
Satoshi Fujita, *Tokyo Denki Univ, Tokyo 101-8457, Japan*

Session 1.1G (CT-4-1)
Robert Noble Memorial Session on Assembly of Bolted Joints
Mezzanine, Tyrolka 8:15am - 10:00am

Session Developer/Chair: **A. Fitzgerald Waterland, III**,
VSP Technologies, Prince George, VA, USA
Session Co-Chair: **Jose Veiga**,
Teadit Industriae Comercio Ltda, Rio De Janeiro/RJ, Brazil

8:15am
The Effects of Fluoropolymer Coated Fasteners on Nut Friction Factors
Technical Paper Publication: PVP2018-84027

Karson Clark, *VSP Technologies Inc., South Prince George, VA, USA*

8:41am
The Follow Up on Profiled Wire Gasket Development and Testing With Case Studies
Technical Paper Publication: PVP2018-84067

Anthony R Currie, *Flexitallic Canada Limited, Sherwood Park, AB, Canada*

9:07am
Study of Alternative Assembly Patterns Using Finite Element Analysis and Lab Tests
Technical Paper Publication: PVP2018-84465

Gonghyun Jung *and* **Wesley Pudwill**, *Shell Global Solutions, Houston, TX, USA*
Elysia Sheu, *Shell, Houston, TX, USA*

9:33am
Experimental Measurement of the Shank Torque as a Function of the Stiffness and Frictional Characteristics of the Bolted Joint
Technical Paper Publication: PVP2018-84531

Dario Croccolo, *Massimiliano De Agostinis, Stefano Fini,*
Giorgio Olmi, *Francesco Robusto,*
Omar Cavalli, *University of Bologna, Bologna, Italy,*
Nicolò Vincenzi, *Giuliani A Bucci Automations S.p.A. Division, Faenza, Italy*

Session 1.1H (DA-8-1)
FFS for High Temperature Applications
Lobby, Amsterdam 8:15am - 10:00am

Session Developer/Chair: **Gysbert Van Zyl**, *Sabic, Jubail, Saudi Arabia*
Session Developer/Co-Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*

8:15am
Premature Degradation and Failure of Steam-Methane Reformer Heater System Components
Technical Paper Publication: PVP2018-84006

John Aumuller, *Engineering Design & Analysis Ltd., Edmonton, AB, Canada*
Vincent Carucci, *Carmagen Engineering Inc., Florham Park, NJ, USA*

8:41am
Case Study: Continuing a Best in Class Fitness for Service Program on P91 Main Steam Piping / Non-Destructive Testing
Technical Presentation: PVP2018-84032

Lange Kimball, *Stress Engineering Services Inc, Houston, TX, USA*
Kuda Mutama, *Newmont Nevada Energy Investment, Elko, NV, USA*

9:07am
Effects of Primary and Secondary Creep Formulations on API 579-1 Residual Life Evaluation
Technical Paper Publication: PVP2018-84407

Lorenzo Scano, *Studio Scano Associato, Safety & Integrity, Udine, Italy*
Luca Esposito, *University of Naples, Naples, Naples, Italy*

9:33am
A Comparative Evaluation of Finite Element Modeling of Creep Deformation of Fuel Channels in CANDU Nuclear Reactors
Technical Paper Publication: PVP2018-84982

Fernando Tallavo, Mahesh Pandey, Mikko Jyrkama *and* **Nikos Christodoulou**, *University of Waterloo, Waterloo, ON, Canada,*
Grant Bickel and Brian Leitch, *Canadian Nuclear Laboratory, Chalk River, ON, Canada*

Session 1.1.I (CS-5-1)
Technical Harmonization and Emerging Code and Standards
Lobby, Athens 8:15am - 10:00am

Session Developer/Chair: **Cécile Petesch**, *CEA Saclay, Gif-sur-Yvette, France*
Session Developer/Co-Chair: **Jorge-Enrique Munoz-Garcia**, *French Alternative Energies and Atomic Energy Commission (CEA), Gif-sur-Yvette, France*

8:15am
UK Approach to Highest Reliability Safety Cases
Technical Presentation: PVP2018-84051

Alexander Price, Samaneh Nouraei, Office for Nuclear Regulation, Liverpool, Mersyside, UK

8:41am
An Updated Comparison of Fatigue Analysis Methods for Selected Codes and Standards
Technical Presentation: PVP2018-84075

Jinhua Shi *and* **Liwu Wei**, *Amec Foster Wheeler, Gloucester, UK*
Claude Faidy, *CF Integrity Engineering, Tassin, France,*
Andrew Wasylyk, *FRAMATOME, Courbevoie, Ile-de-France, France,*
Nawal Prinja, *Amec Foster Wheeler, Knutsford, UK*

9:07am
Discussion on KEPIC Development for Manufacturing Safety Class Metallic Parts Using 3D Printing Technology
Technical Presentation: PVP2018-84537

Myoung Sung Sohn, *Korea Electric Association, Seoul, Korea (Republic)*,
Sangwoo Song, *Korea Institute of Materials Science, Changwon, Korea (Republic)*,
Jonghae Kim, *Korea Electric Association, Seoul, Korea (Republic)*

9:33am
Rapid Thermal Stress Ratcheting Assessment for Pressured Components
Technical Paper Publication: PVP2018-84549

Jun Shen, *Tsinghua University, Beijing, China*,
Haofeng Chen, *University of Strathclyde, Glasgow, UK*,
Yinghua Liu, *Tsinghua University, Beijing, China*

8:50am
Recent Improvements in Toughness Prediction of Cast Duplex Stainless Steel Components
Technical Paper Publication: PVP2018-84707

Patrick Le Delliou, *EDF - Electricite De France, Moret Sur Loing Cedex, France*
Sebastien Saillet, *EDF/R&D, Moret-sur-Loing Cedex, France*

9:25am
Improvement of Target Flaw Sizes of CASS Pipe for PD Approval Using PFM Code PREFACE
Technical Paper Publication: PVP2018-85015

Wataru Nishi, *Mitsubishi Heavy Industries, LTD., Kobe, Hyogo, Japan*
Takatoshi Hirota, *Mayumi Ochi and Daiki Takagoshi, Mitsubishi Heavy Industries, LTD., Takasago, Japan*
Kiminobu Hojo, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*

Session 1.1J (CS-19-1)
Integrity of Cast Stainless Steel Pipe
Lobby, Barcelona 8:15am - 10:00am

Session Developer/Chair: **Do-Jun Shim**, *Structural Integrity Associates, Inc., San Jose, CA, USA*
Session Developer/Co-Chair: **Kiminobu Hojo**, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*

8:15am
Tensile tests for cast stainless steel - Evolution of the RCC-M code
Technical Paper Publication: PVP2018-84601

Arnaud Blouin, *Areva Np, Paris La Defense, France*,
Mathieu Couvrat, *Manoir Industries, Val de Reuil, France*
Felix Latourte, *EDF R&D, Moret sur Loing, France*
Julian Soulacroix, *EDF CEIDRE Laboratoire de Chinon, Avoine, France*

Session 1.1K (CS-20-1)
Use of Modern FEA methods for Code Assessment
Lobby, Berlin 8:15am - 10:00am

Session Developer/Chair: **Michael Martin**, *Rolls-Royce, Derbyshire, UK*
Session Co-Chair: **Qin Ma**, *Walla Walla University, College Place, WA, USA*

8:15am
The Reciprocal Effect Among a Quarter-Circle Corner Crack and a Non-Aligned Surface Crack of Comparable Size in an Infinitely Large Plate Under Uniaxial Tension
Technical Paper Publication: PVP2018-84035

Mordechai Perl, *BenGurion University of the Negev, Beer Sheva, Beer Sheva, Israel*
Cesar Levy, *Florida International University, Miami, FL, USA*
Qin Ma, *Walla Walla University, College Place, WA, USA*

8:50am
PTS on Embedded Rotated Cracks and Projection Rules
Technical Paper Publication: PVP2018-84055

Lorenzo Stefanini, *Nuclear Research & Consultancy Group - NRG, Petten, North Holland, Netherlands*
Frederic Blom, *NRG - The Netherlands, Petten, Netherlands*

9:25am
Tentative Thickness for Torispherical and Ellipsoidal ASME Section III Class 1 Heads
Technical Paper Publication: PVP2018-84934

Pankaj Shah, *Magnus Engineering Services, Inc., Walpole, MA, USA*
Robert M. Wilson, Sr., *Consultant, Honolulu, HI, USA*
Mark Belloni, *Magnus Engineering Services, Inc., Walpole, MA, USA*

Session 1.1L (SPC-1-1)
Student Paper Competition - BS/MS - I
Lobby, Brussels 8:15am - 10:00am

Session Developer: *Noel P. O'Dowd, University of Limerick, Limerick, Ireland*
Session Co-Developer: **Victor P. Janzen**, *Canadian Nuclear Laboratories, Chalk River, ON, Canada*
Session Co-Chair: **Peter James**, *Wood, Warrington, Cheshire, UK*
Session Chair: **Bing Li**, *Kinectrics NSS, Kincardine, ON, Canada*

8:15am
Investigation of Blast Wave Effects on Containment Wall and Steam Generator
Technical Paper Publication: PVP2018-84325

Tae-Jin Kim, *KyungHee University, Yongin, Korea (Republic)*
Yoon-suk Chang, *Kyung Hee University, Kyunggi-do, Korea (Republic)*

8:41am
Stress Evaluation Method by Frequency Response Function for Elbow Pipes Under Thermal Stratification
Technical Paper Publication: PVP2018-84211

Salman Alrakan, Hiroshi Kuribayashi *and* **Naoto Kasahara**, *The University of Tokyo, Tokyo, Japan*

9:07am
An Improved Phased Array Ultrasonic Testing Technique for Thick-Wall Polyethylene Pipe Used in Nuclear Power Plant
Technical Paper Publication: PVP2018-84452

Yinkang Qin, Jianfeng Shi *and* **Jinyang Zheng**, *Zhejiang University, Hangzhou, China*

9:33am
Investigation into Applications of Local Failure Criterion for X70 Pipeline With Corrosion Defect
Technical Paper Publication: PVP2018-84566

Ji-Hee Moon and Nam-Su Huh, *Seoul National University of Science and Technology, Seoul, Korea (Republic)*
Ki-Seok Kim, *POSCO, Incheon, Korea (Republic)*

Session 1.1M (DA-19-1)
Special Considerations in the Design and Analysis of Supports, Restraints and Welded Attachments
Lobby, Sofia 8:15am - 10:00am

Session Developer/Chair: **Phillip Wiseman**, *Lisega Inc., Kodak, TN, USA*
Session Developer/Co-Chair: **Kshitij Gawande**, *Lisega Inc., Kodak, TN, USA*

8:15am
A Case for Avoiding Hydraulic Shock Suppressors (Snubbers) in the Vibratory Environment
Technical Paper Publication: PVP2018-85035

Kshitij Gawande, Phillip Wiseman *and* **Alex Mayes**, *Lisega Inc. Kodak, TN, USA*

8:45am
A Study of Dynamic Pipe Clamp Design
Technical Paper Publication: PVP2018-84312

Phillip Wiseman *and* **Alex Mayes**, *Lisega, Inc., Kodak, TN, USA*

9:15am
Effect of Steam Hammer Pressure Wave Steepening on Pipe Supports
Technical Paper Publication: PVP2018-84775

Alex Maye *and* **Kshitij Gawande**, *Lisega INC, Kodak, TN, USA*

Session 1.1N (DA-1-1)
Design and Analysis of Pressure Vessels, Heat Exchangers and Components - I
Lower Lobby, Madrid 8:15am - 10:00am

Session Developer/Co-Chair: **Nathan Barkley**,
Contract Fabricators, Inc., Holly Springs, MS, USA
Session Co-Developer/Chair: **Jaan Taagepera**,
Chevron ETC, Richmond, CA, USA
Session Co-Developer: **Clay Rodery**,
C&S Technology, LLC, League City, TX, USA

8:15am
A General Comparison of the Design Margins and Design Rules for ASME Section VIII Division 1 and 2 Pressure Vessels
Technical Paper Publication: PVP2018-84974

Nathan Barkley, *Contract Fabricators, Inc., Holly Springs, MS, USA*

8:35am
Numerical Study on Buckling Strength of Vertical Vessel Skirts with Access Opening
Technical Paper Publication: PVP2018-84469

Takuma Takahashi, Takuya Sato, Yoshiaki Uno, Shunji Kataoka *and* **Toshikazu Miyashita**, *JGC Corporation, Yokohama, Japan*

8:55am
Buckling Assessment of Carbon Steel Pressure Vessels Subjected to Axial Load During PWHT
Technical Paper Publication: PVP2018-84571

Shunji Kataoka, *JGC Corporation, Yokohama, Kanagwa, Japan*

9:15am
Construction of 3D Primary Structure and Stress Classification of Cylindrical Shell with Nozzle
Technical Paper Publication: PVP2018-84391

Cheng-Hong Duan, Xin-Chen Wei and **Jinhao Huang**,
College of Mechanical Engineering, Beijing University of Chemical Technology, Beijing, China
Ming-wan Lu, *Tsinghua University, Beijing, China*

Block 1.2 Monday, July 16 10:15AM - 12:00PM

Plenary Session
Congress Hall II

Block 1.3 Monday, July 16 2:15PM - 4:00PM

Session 1.3A (CS-3-1)
Environmental Fatigue Issues - I
Mezzanine, Karlin I 2:15pm - 4:00pm

Session Developer/Chair: **Seiji Asada**,
Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan
Session Co-Chair: **Claude Faidy**,
CF Integrity Engineering, Tassin, France

2:15pm
INCEFA-PLUS: Increasing Safety in NPPs by Covering Gaps in Environmental Fatigue Assessment
Technical Paper Publication: PVP2018-84034

Kevin Mottershead, *Wood, Warrington, Cheshire, UK*
Matthias Bruchhausen, *European Commission, Joint Research Centre, Petten, Netherlands Antilles*
Sergio Cicero, *University of Cantabria, Santander, Spain*
Sam Cuvilliez, *EDF - DIPNN - Direction Technique, Lyon, France*

2:41pm
INCEFA-PLUS Project: Status of the Test Program
Technical Presentation: PVP2018-84282

Matthias Bruchhausen, *European Commission, Joint Research Centre, Petten, Netherlands Antilles*
Roman Cicero, *Inesco Ingenieros, Santander, Spain*
C. Hurley, *VTT, Espoo, Finland*
Jean-Christophe Le-Roux, *EDF, Villeurbanne, France*
Kevin Mottershead, *Wood, Warrington, Cheshire, UK*
M Vankeerberghen, *SCK-CEN, Mol, Belgium*

3:07pm
INCEFA-PLUS Project: Ongoing Work On Fatigue Methods And Impact On Experimental Plan
Technical Presentation: PVP2018-84244

Sam Cuvilliez, *EDF - DIPNN - Direction Technique, Lyon, France*
Matthias Bruchhausen, *European Commission, Joint Research Centre, Petten, Netherlands Antilles*
Chu Mai, *EDF R&D, Moret-Loing-et-Orvanne, France*
Thomas Metais, *EDF China, Beijing, China*
Jean-Christophe Le-Roux, *EDF, Villeurbanne, France*

3:33pm
Standards-Based Technologies for Exchanging Fatigue Test Data
Technical Paper Publication: PVP2018-84610

Tim Austin, *European Commission - JRC, Petten, Netherlands*,
Lianshan Lin, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Thomas Metais, *EDF China, Beijing, China*

Session 1.3B (MF-1-2)
Application of Fracture Mechanics in Failure Assessment - II
Mezzanine, Karlin II 2:15pm - 4:00pm

Session Developer: **Preeti Doddihal**, *Kinectrics Inc., Toronto, ON, Canada*
Session Co-Developer: **Douglas Scarth**, *Kinectrics, Toronto, ON, Canada,* **Jessica Lam**, *Ontario Power Generation (OPG), Pickering, ON, Canada*
Session Chair: **Blair Carroll**, *Canadian Nuclear Safety Commission, Ottawa, ON, Canada*
Session Co-Chair: **Christopher Manu**, *Kinectrics Inc., Toronto, ON, Canada*

2:15pm
Evaluation of Bending Limit of 9Cr-1Mo-V Steel by Master Curve and Failure Assessment Diagram Method – Evaluation for Base Metal
Technical Paper Publication: PVP2018-84944

Kazuo Oda, *Hitachi Zosen Corporation, Osaka, Japan*,
Tomohiro Tanaka, *Hitachi Zosen Corporation, Kumamoto, Japan*,
Mitsuyoshi Nakatani, *Hitachi Zosen Corporation, Osaka, Japan*,
Masamitsu Abe, *Hitachi Zosen Corporation, Kumamoto, 0), Japan*,
Yasuhito Takashima *and* **Fumiyoshi Minami**, *Joining and Welding Research Institute, Osaka University, Osaka, Japan*

2:41pm
Evaluation of Bending Limit of 9Cr-1Mo-V Steel by Master Curve and Failure Assessment Diagram Method - Evaluation for Welding Joint
Technical Paper Publication: PVP2018-84949

Mitsuyoshi Nakatani *and* **Kazuo Oda**, *Hitachi Zosen Corporation, Osaka, Japan*,
Tomohiro Tanaka, Masamitsu Abe, *Hitachi Zosen Corporation, Kumamoto, Japan*,
Yasuhito Takashima *and* **Fumiyoshi Minami**, *Joining and Welding Research Institute, Osaka University, Osaka, Japan*

3:07pm
Fracture Mechanical Assessment of VVER Reactor Internals
Technical Paper Publication: PVP2018-84589

Vladislav Pistora, Miroslav Svrcek, Peter Ferko *and* **Ihor Mirzov**, *UJV Rez, a.s., Husinec - Rez, Czech Republic*

3:33pm
Effects of Strain-Rate and Temperature on Ductile Damage of Metals
Technical Paper Publication: PVP2018-85158

Alexander Sancho, *Imperial College London, London, UK*,
Mike Cox and Tim Cartwright, *AWE, Reading, Berkshire, UK*,
Paul A Hooper, John Dear and Catrin Mair Davies, *Imperial College London, London, UK*

Session 1.3C (MF-3-2)
Welding Residual Stress and Distortion Simulation and Measurement - II
Mezzanine, Karlin III 2:15pm - 4:00pm

Session Developer/Chair: **Elisabeth Keim**, *AREVA, Erlangen, Germany*
Session Developer/Co-Chair: **Frederick (Bud) Brust**, *Engineering Mechanics Corp of Columbus, Upper Arlington, OH, USA*

2:15pm
The Effect of Low Temperature Annealing on Distribution of Residual Stresses of T24 Steel Welds
Technical Paper Publication: PVP2018-84073

Pavol Mikula, Charles Hervoches *and* **Miroslav Vrána**, *Nuclear Physics Institute ASCR, v.v.i., Rez near Prague, Czech Republic*
Lubo' Mráz, *Welding Research Institute - Industrial Institute, Bratislava, Slovakia(Slovak Republic)*
Ján Kotora, *Slovenské Energetické Strojárne Joint-Stock Company, Tlma'e, Slovakia (Slovak Republic)*

2:41pm
Exploring Finite Element Validation for Weld Residual Stress Prediction
Technical Paper Publication: PVP2018-84931

*M***ichael Benson** *and* **Patrick Raynaud**, *U. S. Nuclear Regulatory Commission, Washington, DC, USA*
Jay Wallace, *U.S. Nuclear Regulatory Commission, Rockville, MD, USA*

3:07pm
Parameter Study of a Thermal Analysis of a Bead-On Plate Weld
Technical Paper Publication: PVP2018-84999

Spyridon A. Alexandratos, Lei Shi *and* **Noel P. O'Dowd**, *University of Limerick, Limerick, Ireland*

3:33pm
Best Practices - Material Characterization and Material Behavior Law to Model Residual Stresses in Weldments
Technical Presentation: PVP2018-85055

Vincent Robin *and* **Sofiane Hendili**, *EDF, Chatou Cedex, France*,
Olivier Doyen *and* **Harry Pommier**, *CEA, Gif-sur-Yvette, France*

Session 1.3D (CS-11-2)
Developments of Chinese Codes and Standards - I
Mezzanine, Palmovka 2:15pm - 4:00pm

Session Developer/Chair: **Guodong Jia**, *AQSIQ, Beijing, China*
Session Developer/Co-Chair: **Guide Deng**, *China Special Equipment Inspection and Research Institution, Beijing, China*

2:15pm
Consideration of Pressure Vessels Codes and Standards for Fire Emergency Rescue in China: Now and Future
Technical Paper Publication: PVP2018-84059

Junjun Wang, *Shanghai Fire Research Institute of MPS, Shanghai, China*
Lin Xue, *Jiangsu University, Zhenjiang, China*
Zhen Ruan, Lei Zhang *and* **Peiying Wu**, *Shanghai Fire Research Institute of MPS, Shanghai, China*

2:41pm
Research on Phased Array Ultrasonic Testing for the Girth Weld of 4mm~10mm Austenitic Stainless Steel Pipeline
Technical Paper Publication: PVP2018-84201

Luyun Zhou, Weipu Xu *and* **Minghai Fu**, *Shanghai Institute of Special Equipment Inspection and Technology Research, Shanghai, China*

3:07pm
Development of Small Diameter and Thin-Walled Tube Docking Girth Joint Ultrasonic Testing Probe and Block
Technical Paper Publication: PVP2018-84275

Luyun Zhou, **Minghai Fu** *and* **Weipu Xu**, *Shanghai Institute of Special Equipment Inspection and Technology Research, Shanghai, China*

3:33pm
The Notched C-Ring Test to Evaluate Reheat Cracking Susceptibility of Cghaz in 2¼Cr-1mo-¼V Steel Welded Joints
Technical Paper Publication: PVP2018-84331

Yu Huang, Chi Xu, Jin Chen, Changjun Liu, Jianjun Chen *and* **Li Zhang**, *East China University of Science and Technology, Shanghai, Shanghai, China*

Session 1.3E (FSI-1-2)
Water Hammer and Scaling
Mezzanine, Rokoska 2:15pm - 4:00pm

Session Developer/Chair: **Jong Chull Jo**, *Korea Inst. Nuclear Safety/Pusan National University, Daejon, Korea (Republic)*
Session Developer/Co-Chair: **Arris Tijsseling**, *T U Eindhoven, Eindhoven, Netherlands*

2:15pm
Moving Liquid Column with Entrapped Gas Pocket and Fluid-Structure Interaction at a Pipe's Dead End: A Nonlinear Spring-Mass System
Technical Paper Publication: PVP2018-84570

Arris Tijsseling, *TU Eindhoven, Eindhoven, Netherlands*
Qingzhi Hou, *Tianjin University, Tianjin, China*
Zafer Bozkus, *Middle East Technical University, Ankara, Turkey*

2:41pm
A Proposed Guideline for Applying Waterhammer Predictions Under Transient Cavitation Conditions Part 1: Pressures
Technical Paper Publication: PVP2018-84338

Matthew Stewart, *AECOM Management Services, Greenwood Village, CO, USA*
Trey Walters, *Applied Flow Technology, Colorado Springs, CO, USA*
Greg Wunderlich, *AECOM Management Services, Greenwood Village, CO, USA*
Erin Onat, *Applied Flow Technology, Colorado Springs, CO, USA*

3:07pm
A Proposed Guideline for Applying Waterhammer Predictions Under Transient Cavitation Conditions Part 2: Imbalanced Forces
Technical Paper Publication: PVP2018-84339

Matthew Stewart, *AECOM Management Services, Greenwood Village, CO, USA*
Trey Walters, *Applied Flow Technology, Colorado Springs, CO, USA*
Greg Wunderlich, *AECOM Management Services, Greenwood Village, CO, USA*

3:33pm
Scaling Distortion For Integral System Test Facilities
Technical Presentation: PVP2018-84406

Peter Lien, *US Nuclear Regulatory Commission, Rockville, MD, USA*
Upendra Rohatgi, *Brookhaven National Laboratory, Upton, NY, USA*

Session 1.3F (SE-2-2)
Vibration Control and Damping - I
Mezzanine, Hercovka 2:15pm - 4:00pm

Session Developer/Chair: **Taichi Matsuoka**, *Meiji University, Kawasaki, Kanagawa, Japan*
Session Developer/Co-Chair: **Akira Sone**, *Kyoto Institute of Technology, Kyoto, Japan*

2:15pm
Vibration Reduction Mechanism & NPPs Seismic Safety of TMD Shield Building for AP1000 NPPs
Technical Paper Publication: PVP2018-84388

Gang Zheng, Yaodong Chen *and* **Feng Shen**, *State Power Investment Corporation Central Research Institute, Beijing, China*,
Gangling Hou, *Harbin Engineering University, Harbin, China*

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2:41pm
A Resonating Lattice TMD to Reduce Pipeline Vibrations
Technical Paper Publication: PVP2018-84377

Mahesh Murugan Jaya, Rosario Ceravolo *and* **Emiliano Matta**, *Politecnico di Torino, Torino, Torino, Italy*,
Luca Zanotti Fragonara, *Cranfield University, Cranfield, Cranfield, UK*

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3:07pm
Large-Scale Simulation Method for Particle Damping
Technical Paper Publication: PVP2018-84544

Masato Saeki *and* **Mika Bitoh**, *Shibaura Institute of Technology, Koto-ku, Tokyo, Japan*

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3:33pm
Study on TMD for Long Period Structure Using Air Floating Technique
Technical Paper Publication: PVP2018-84943

Osamu Furuya, *Tokyo Denki University, Saitama, Japan*,
Hiroshi Kurabayashi, *Vibro-System, Tokyo, Japan*,
Osamu Takahashi, *Tokyo University of Science, Tokyo, Japan*,
Kunio Sanpei, Shoichi Sakamoto *and* **Koji Yamazaki**, *Sansei AIR Danshin System, Tokyo, Japan*,
Manabu Muto, Nihon Boushin, *Tokyo, Japan*

Session 1.3G (CT-1-1)
Design & Analysis of Bolted Flange Joints
Mezzanine, Tyrolka 2:15pm - 4:00pm

Session Developer/Chair: **Toshiyuk Sawa**, *Hiroshima University, Tokyo, Japan*
Session Developer/Co-Chair: **Manfred Schaaf**, *AMTEC Advanced Measurement Messtechnischer Service GmbH, Lauffen am Neckar, Germany*

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2:15pm
Flange Gasket Behavior Characterization for Service in Arctic Environment
Technical Paper Publication: PVP2018-84284

Hubert Lejeune, Stéphane Javanaud *and* **Kevin Richard**, *Cetim, Nantes 44000, France*

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2:35pm
FEM Stress Analysis and Mechanical Characteristics of Bolted Pipe Connections With Larger Nominal Diameter Inserting PTFE Blended Gasket Under Internal Pressure
Technical Paper Publication: PVP2018-84224

Koji Sato, *Nippon Valqua Industries, Ltd., Gojo, Nara, Japan*
Toshiyuk Sawa, *Hiroshima University, Tokyo, Japan*
Xing Zheng, *Valqua Seal Products Shanghai Co., Ltd., Shanghai, China*

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2:55pm
A Simple Calculation Method of the Load Factor and a Bolt Preload Determination Satisfying Allowable Leak Late for Bolted Pipe Flange Connections With Gaskets Subjected to Internal Pressure
Technical Paper Publication: PVP2018-84217

Toshiyuk Sawa, *Hiroshima University, Tokyo, Japan*
Koji Sato, *Nippon Valqua Industries,Ltd., Gojo, Nara, Japan*
Toshio Mabuchi, *Chiyoda Corporation, Yokohama, Japan, Japan*

3:15pm
Friction between Gasket and Flange Surface
Technical Paper Publication: PVP2018-85104

Manfred Schaaf, *AMTEC Advanced Measurement Messtechnischer Service GmbH, Lauffen am Neckar, Germany*
Rainer Zeuss, *SGL Carbon GmbH, Meitingen, Germany*

Session 1.3H (DA-8-2)
FFS Involving Fracture Mechanics
Lobby, Amsterdam 2:15pm - 4:00pm

Session Developer/Chair: **Jan Keltjens**, *SABIC, Geleen, Netherlands*
Session Co-Developer: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*
Session Co-Chair: **Mahendra Rana**, *Consultant, Niantic, CT, USA*

2:15pm
Fitness for Service Assessments on Cracked Heavy Wall Reactors
Technical Paper Publication: PVP2018-84046

Jan Keltjens, *SABIC, Geleen, Netherlands*
Gysbert Van Zyl, *Sabic, Jubail, Saudi Arabia*
Fahad Mohammed Hamad Mudhayeq, *Saudi Basic Industries Corp, Jubail, Saudi Arabia*

2:41pm
Comparison of ASME XI and BS7910 Allowable Surface Flaw Size Evaluation Procedures in Piping Components
Technical Paper Publication: PVP2018-84276

Juha Kuutti, Ahti Oinonen, *VTT Technical Research Centre of Finland, Espoo, Finland*

3:07pm
Three Dimensional Finite Element Analyses of Welding Residual Stresses of a Repaired Weld
Technical Paper Publication: PVP2018-84343

Mingya Chen, Weiwei Yu, Xue Fei *and* **Chen Zhilin**, *Suzhou Nuclear Power Research Institute, Suzhou, Jiangsu Province, P.R. China*
Francis Ku, *Structural Integrity Associates, San Jose, CA, USA*
Jinhua Shi, *Amec Foster Wheeler, Gloucester, UK*

3:33pm
Estimation of Residual Stress Levels in Fitness for Service Evaluations of Linepipe
Technical Paper Publication: PVP2018-84973

Robert Andrews, *ROSEN UK, Newcastle upon Tyne, UK*
Simon Slater, *ROSEN USA, Gahanna, OH, USA*

Session 1.3I (CS-1-1)
Structural Integrity of Pressure Components - I
Lobby, Athens 2:15pm - 4:00pm

Session Developer/Chair: **Michael Benson**, *U. S. Nuclear Regulatory Commission, Washington, DC, DC, USA*
Session Developer/Co-Chair: **Steven Xu**, *Kinectrics, Toronto, ON, Canada*

2:15pm
Formable Duplex Stainless Steel for High Pressure GPHE Applications
Technical Paper Publication: PVP2018-84195

Anders Groth, Chang-Ching Sun *and* **Erik Schedin**, *Outokumpu Stainless AB, Avesta, Sweden*,
Hailan He, Guan Li, *Shanghai Heat Transfer Equipment Co. Ltd, Shanghai City, China*

2:41pm
Factors Affecting the Oxidation and Carburisation Behaviour of an Austenitic Stainless Steel Used in the UK Advanced Gas-Cooled Reactors
Technical Paper Publication: PVP2018-84279

Sándor Palkó, Fabio Scenini *and* **Robert A. Ainsworth**, *The University of Manchester, Manchester, UK*

3:07pm
Demonstrate ASME Section XI Appendix G Margins for Pressurized Water Reactor Inlet and Outlet Nozzle Corner Regions
Technical Paper Publication: PVP2018-84345

Anees Udyawar, *Westinghouse Electric Company, Cranberry Township, PA, USA*,
J. Brian Hall, *Westinghouse, Churchill, PA, USA*,
Alexandria Carolan, *Westinghouse, Pittsburgh, PA, USA*,
Justin Webb, *Westinghouse, Windsor, CT, USA*

3:33pm
Application of the FAVOR-OCI Fracture Mechanics Computer Program to ASME Code Section XI, IWB-3610 Flaw Acceptance Criteria Evaluations
Technical Paper Publication: PVP2018-84412

Terry Dickson, *OakRidge Consulting International, Oak Ridge, TN, USA*,
B. Richard Bass, *Oakridge Consulting International, Inc., Farragut, TN, USA*,
Paul T. Williams, *Oakridge Consulting International, Inc., Knoxville, TN, USA*,
Hilda Klasky, *ORNL - UT Battelle, Oak Ridge, TN, USA*

Session 1.3J (MF-27-1)
Additive Manufacturing Characterization
Lobby, Barcelona 2:15pm - 4:00pm

Session Developer/Chair: **Chris San Marchi**,
Sandia National Laboratories, Livermore, CA, USA
Session Developer/Co-Chair: **Paul Korinko**,
Savannah River National Laboratory, Aiken, SC, USA

2:15pm
Effect of Heat Treatment on the Properties of Additively Manufactured Type 316L Stainless Steel
Technical Paper Publication: PVP2018-84334

Paul Korinko *and* **Michael Morgan**, *Savannah River National Laboratory, Aiken, SC, USA*

2:50pm
Fracture Toughness Behaviour of 316L Stainless Steel Samples Manufactured through Selective Laser Melting
Technical Paper Publication: PVP2018-84393

Catrin Mair Davies, Ruijan Zhou, **Olivia Withnell**, **Tobias Ronneberg, Richard Williams** *and* **Paul A. Hooper**, *Imperial College London, London, UK*

3:25pm
Microstructure-Property Relationships in Selective Laser Melting of Type 304L Austenitic Stainless Steel
Technical Paper Publication: PVP2018-84901

Chris San Marchi, Joshua D. Sugar, Thale R. Smith *and* **Dorian Balch**, *Sandia National Laboratories, Livermore, CA, USA*

Session 1.3K (OAC-1-1)
Optimizing Operations via Risk Management
Lobby, Berlin 2:15pm - 4:00pm

Session Developer/Chair: **Alton Reich**,
Streamline Automation LLC, Huntsville, AL, USA
Session Developer/Co-Chair: **Joseph Cluever**,
LPI, Inc., Richland, WA, USA

2:15pm
Value-Based Bayesian Optimization of a Preventive Maintenance Program
Technical Paper Publication: PVP2018-84832

Joseph Cluever, *LPI, Inc., Richland, WA, USA*
Thomas C. Esselman, *LPI, Inc., Amesbury, MA, USA*
Sam Harvey, *Electric Power Research Institute, Charlotte, NC, USA*

2:50pm
Financial Optimization of a Preventive Replacement Strategy for Individual Components
Technical Paper Publication: PVP2018-84833

Joseph Cluever, *LPI, Inc., Richland, WA, USA*
Thomas C. Esselman, *LPI, Inc., Amesbury, MA, USA*
Sam Harvey, *Electric Power Research Institute, Charlotte, NC, USA*

3:25pm
Research on Risk Assessment Method of Stick-Slip Vibration of the Bit Based on BP Neural Network Algorithm
Technical Paper Publication: PVP2018-84144

Chong Chen, Shimin Zhang *and* **Hang Zhang**, *China University of Petroleum-Beijing, Beijing, China*
Xiaojun Li, *CNPC Xibu Drilling Engineering Company Limited, Urumqi, China*
Zichen He, *China University of Petroleum-Beijing, Beijing, China*

Session 1.3L (SPC-1-2)
Student Paper Competition - BS/MS - II
Lobby, Brussels 2:15pm - 4:00pm

Session Developer: **Bing Li**,
Kinectrics NSS, Kincardine, ON, Canada
Session Chair: **Douglas Scarth**,
Kinectrics, Toronto, ON, Canada
Session Co-Chair: **Peter James**,
Wood, Warrington, Cheshire, UK

2:15pm
Fatigue Life Analysis of Storage Tanks In Service Based on Exponential Curve Settlement Prediction Model
Technical Paper Publication: PVP2018-84431

DeLin Zhang, Zhiping Chen *and* **You Li**, *Zhejiang University, Hangzhou, China*

2:50pm
Application of T-Scaling Method to Account for the Effects of Notch Acuity on Notch Fracture Toughness in the Ductile-to-Brittle Transition Temperature Region
Technical Paper Publication: PVP2018-84165

Hiroki Nakano *and* **Toshiyuki Meshii**, *University of Fukui, Fukui-city, Japan*,

3:25pm
Plastic Collapse Evaluation of Fuel Channel Assembly in Pressurized Heavy Water Reactor
Technical Paper Publication: PVP2018-84463

Jun Hyeok Choi, Seok Jun Kang *and* **J B Choi**,
Sungkyunkwan University, Suwon, Korea (Republic)

Session 1.3M (MF-19-1)
Uncertainty Quantification of Material Degradation Data and Failure Models - I
Lobby, Sofia 2:15pm - 4:00pm

Session Developer/Chair: **Jeffrey Fong**,
NIST, Gaithersburg, MD, USA
Session Co-Developer: **Andrew Duncan**,
Savannah River National Laboratory, Aiken, SC, USA
Session Co-Chair: **Li Ma**,
NIST, Gaithersburg, MD, USA

2:15pm
StrainLife: Efficient Fatigue Life Data Generation for an Enhanced Ageing Assessment of Metallic Components
Technical Paper Publication: PVP2018-84538

Klaus Heckmann *and* **Jürgen Sievers**, *Gesellschaft für Anlagen-und Reaktorsicherheit (GRS) GmbH, Cologne, Germany*
Ruth de Acosta, Peter Starke *and* **Christian Boller**
Universität des Saarlandes, Saarbrücken, Germany,
Tim Schopf, *Materialprüfungsanstalt Universität Stuttgart, Stuttgart, Germany*
Xaver Schuler, *Materials Testing Institute (MPA) University of Stuttgart, Stuttgart, Baden-Württemberg, Germany*
Michael Jamrozy, Marina Knyazeva *and* **Frank Walther**, *Technische Universität Dortmund, Dortmund, Germany*

2:50pm
A Nonlinear Least Squares Logistic Fit Approach to Quantifying Uncertainty in Fatigue Stress-Life Models and An Application to Plain Concrete
Technical Paper Publication: PVP2018-84739

Jeffrey Fong, N. Alan Heckert *and* **James J. Filliben**,
National Institute of Standards and Technology, Gaithersburg, MD, USA,
Paul Ziehl, *University of South Carolina, Columbia, SC, USA*

3:25pm
The Role of Uncertainty in Machine Learning as an Element of Control for Material Systems and Structures
Technical Paper Publication: PVP2018-84930

Kenneth Reifsnider, *University of Texas Arlington, Colleyville, TX, USA*
Muthu Elenchezhian, *University of Texas Arlington, Arlington, TX, USA*
MD Rassel Raihan, *University of Texas Arlington, Fort Worth, TX, USA*

Session 1.3N (DA-1-2)
Design and Analysis of Pressure Vessels, Heat Exchangers, and Components - II
Lower Lobby, Madrid 2:15pm - 4:00pm

Session Developer/Chair: **Nathan Barkley**,
Contract Fabricators, Inc., Holly Springs, MS, USA
Session Developer/Co-Chair: **Jaan Taagepera**,
Chevron ETC, Richmond, CA, USA
Session Co-Developer: **Clay Rodery**,
C&S Technology, LLC, League City, TX, USA

2:15pm
Analysis and Design for Fixed Type Refrigerant Chiller in LNG and Ethylene Plant
Technical Paper Publication: PVP2018-84499

Jongyoon Cho *and* **Runze Zhou**, *Chiyoda Corporation, Yokohama, Kanagawa, Japan*
Yoshiyuki Waki, *Chiyoda Corp., Yokohama, Japan*
Hiroyuki Ishiyama *and* **Yasuhiro Mitarai**, *Chiyoda Corporation, Yokohama, Kanagawa, Japan*

2:35pm
Experimental Study on Characteristics of Condensation and Flow Resistance Inside Horizontal Corrugated Low Finned Tubes
Technical Paper Publication: PVP2018-84656

Bin Ren, Xiaoying Tang, Hongliang Lu, Dongliang Fu, Yannan Du, Shaojun Wang, Pan Song *and* **Ju Ding**, *Shanghai Institute of Special Equipment Inspection and Technical Research, Shanghai, China*

2:55pm
Transient Thermal Stress and Temperature Change Rate Analysis of Fixed Tubesheet
Technical Paper Publication: PVP2018-84328

Zhijian Wang, Qianyu Shi, Qi Li *and* **Hui Tang**, *Harbin Boiler Co., Ltd., Harbin, China*
Liping Wan, *Sinopec Engineering Incorporation, Beijing, China*

Technical Tutorial 1.3Q (TW-2-7)
Aging Management for Spent Fuel Dry Storage and Subsequent Transportation Part 1
Lower Lobby, Congress Hall III 2:15pm - 4:00pm

Session Developer/Chair: **Maher Younan**,
American University in Cairo, New Cairo 11835, Egypt
Presented by: **Zenghu Han and Yung Liu**,
Argonne National Laboratory, Lemont, IL, USA

Block 1.4 Monday, July 16 4:15PM - 6:00PM

Session 1.4A (CS-3-2)
Environmental Fatigue Issues - II
Mezzanine, Karlin I 4:15pm - 6:00pm

Session Developer: **Seiji Asada**,
Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan
Session Chair: **Claude Faidy**,
CF Integrity Engineering, TASSIN, France
Session Co-Chair: **Thomas Metais**,
EDF China, Beijing, China

4:15pm
Ensuring Data Quality for Environmental Fatigue: INCEFA-PLUS Testing Procedure and Data Evaluation
Technical Paper Publication: PVP2018-84081

Marc Vankeerberghen, *Sck'cen, Mol, Belgium*
Matthias Bruchhausen, *European Commission, Joint Research Centre, Petten, Netherlands Antilles*
Roman Cicero, *Inesco Ingenieros, Santander, Spain*
Luc Doremus, *Framatome, Le Creusot, France*
Jean-Christophe Le-Roux, *EDF, Villeurbanne, France*
Norman Platts, *Amec Foster Wheeler, Warrington, UK*
Philippe Spaetig, *PSI, Villigen, PSI, Switzerland*
Marius Twite, *Rolls-Royce Plc, Derby, UK*
Kevin Mottershead, *Wood, Warrington, Cheshire, UK*

4:41pm
Cyclic, Monotonic and Fatigue Performance of Stabilized Stainless Steel in PWR Water and Research Laboratory
Technical Paper Publication: PVP2018-84935

Jussi Solin, *VTT, Espoo, Finland*
Jouni Alhainen, *Tommi Seppänen, VTT Technical Research Centre of Finland Ltd., Espoo, Finland*
H. Ertugrul Karabaki, *PreussenElektra GmbH, Dormagen, Germany*
Wolfgang Mayinger, *Preussenelektra Gmbh., Hanover 30457, Germany*

5:07pm
Hidden Roles of Time and Temperature in Cyclic Behavior of Stainless Nuclear Piping
Technical Paper Publication: PVP2018-84936

Jussi Solin, *VTT, Espoo, Finland*
Tommi Seppänen, *VTT Technical Research Centre of Finland Ltd., Espoo, Finland*
Wolfgang Mayinger, *Preussenelektra Gmbh., Hanover 30457, Germany*
H. Ertugrul Karabaki, *PreussenElektra GmbH, Dormagen, Germany*

5:33pm
Low Cycle Fatigue (EAF) of AISI 304L and 347 in PWR Water
Technical Paper Publication: PVP2018-84197

Tommi Seppänen, Jouni Alhainen *and* **Esko Arilahti**, *VTT Technical Research Centre of Finland Ltd., Espoo, Finland*
Jussi Solin, *VTT, Espoo, Finland*

Session 1.4B (MF-1-3)
Application of Fracture Mechanics in Failure Assessment - III
Mezzanine, Karlin II 4:15pm - 6:00pm

Session Developer/Chair: **Abdel-Hamid Ismail Mourad**,
UAE University, Al Ain 15551, UAE
Session Co-Developer: **Poh-Sang Lam**,
Savannah River National Lab, Aiken, SC, USA
Session Co-Chair: **Imad Barsoum**,
PI Abu Dhabi, Abu Dhabi, UAE

4:15pm
Structure Integrity Evaluation of Supercritical Water Cooled Pressure Tube Subjected to Accident Conditions
Technical Paper Publication: PVP2018-85017

Jiacheng Luo, Li Yu, Pengzhou Li *and* **Lei Sun**, *Nuclear Power Institute of China, Chengdu, China*

4:41pm
3D FEM Modeling of Crack Initiation in a Reactor Pressure Vessel During a PTS Event (LBLOCA)
Technical Paper Publication: PVP2018-85024

Diego F Mora M, Markus Niffenegger, Guian Qian, Michal Jaros *and* **Bojan Niceno**, *Paul Scherer Institute, Villigen, Zurich, Switzerland*,

5:07pm
Leak Before Break Fracture Assessment for X 70 Steel Pressurized Tubes with Axial Surface Crack
Technical Paper Publication: PVP2018-85073

Mohamed El-Sayed, Aly Eldomiaty *and* **Mohamed Lotfy**, *Suez Canal University, Ismailia, Egyp*,
Abdel-Hamid Ismail Mourad, *UAE Univ, Al Ain 15551, UAE*

5:33pm
Modeling of Crack Extensions in Arc-Shaped Specimens of Austenitic Stainless Steels without and with Charged Hydrogen Using Cohesive Zone Model
Technical Paper Publication: PVP2018-84919

Shengjia Wu, Shin-Jang Sung *and* **Jwo Pan**, *University of Michigan, Ann Arbor, MI, USA*
Poh-Sang Lam, Michael Morgan *and* **Paul Korinko**, *Savannah River National Laboratory, Aiken, SC, USA*

Session 1.4C (MF-3-3)
Welding Residual Stress and Distortion Simulation and Measurement - III
Mezzanine, Karlin III 4:15pm - 6:00pm

Session Developer/Chair: **David Rudland**,
US NRC, Frederick, MD, USA
Session Developer/Co-Chair: **Mike Smith**,
University of Manchester, Manchester, UK

4:15pm
Two-Dimensional Weld Residual Stress Analysis of a Weld Overlay Mockup on a VVER Feedwater Nozzle Dissimilar Metal Weld
Technical Paper Publication: PVP2018-84981

Francis Ku, *Structural Integrity Associates, San Jose, CA, USA*
Steven McCracken, *EPRI, Harrisburg, NC, USA*

4:41pm
Further Investigation of Weld Residual Stress of Layered Pressure Vessels and Additional Fracture Assessment Studies
Technical Presentation: PVP2018-85129

Frederick (Bud) Brust, *Engineering Mechanics Corp of Columbus, Upper Arlington, OH, USA*

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5:07pm
Prediction of Residual Stresses in a Multipass Pipe Weld by a Novel 3D Finite Element Approach
Technical Paper Publication: PVP2018-85044

Hui Huang *and* **Jian Chen**, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Blair Carlson *and* **Hui-ping Wang**, *General Motors, Warren, MI, USA*
Paul Crooker, *Electric Power Research Institute, Palo Alto, CA, USA*
Gregory Frederick, *Electric Power Research Institute, Charlotte, NC, USA*
Zhili Feng, *ORNL, Oak Ridge, TN, USA*

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5:33pm
Experimental Study of the Weld Residual Stress in Manually and Mechanically Fabricated Dissimilar Metal Weld
Technical Paper Publication: PVP2018-84136

Xinjian Duan, *SNC-Lavalin, Mississauga, ON, Canada*
Andrew Glover, *Bruce Power, Toronto, ON, Canada*
Dongmei (Donna) Sun, *Liburdi Group, Dundas, ON, Canada*
Sanjooram Paddea, *The Open University, Milton Keynes, UK*

Sesson 1.4D (CS-11-3)
Example of Engineering Failure Analysis in China - I
Mezzanine, Palmovka 4:15pm - 6:00pm

Session Developer/Chair: **Xuedong Chen**, *Hefei General Machinery Research Institute, Hefei, Anhui, China*
Session Developer/Co-Chair: **Zhichao Fan**, *Hefei General Machinery Research Institute, Hefei, Anhui, China*

4:15pm
Fracture Failure Analysis of 304 Stainless Steel Elbow
Technical Paper Publication: PVP2018-84171

Yian Wang, Guoshan Xie, Libin Song, Fakun Zhuang *and* **Xiaopeng Li**, *China Special Equipment Inspection and Research Institute, Beijing, China*
Meng He, *Beijing Institute of Technology, Beijing, China*,

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4:41pm
Experimental Investigation of Post-fire Mechanical Properties of Quenched and Tempered High Strength Steel 07MnMoVR
Technical Paper Publication: PVP2018-84378

Shanshan Shao, *CSEI, Beijing, China*,
Guodong Jia, *AQSIQ, Beijing, China*,
Luowei Cao *and* **Fakun Zhuang**, *China Special Equipment Inspection & Research Institute, Beijing, China*

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5:07pm
Study on the Risk Based Inspection and Evaluation System for Polyethylene Gas Pipeline
Technical Paper Publication: PVP2018-84507

Zhangwei Ling, Junfang Xia,Cai Gangyi, Ping Tang, Chang Chen *and* **Weican Guo**, *Zhejiang Provincial Special Equipment Inspection and Research Institute, Hangzhou, China*

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5:33pm
Finite Element Analysis for Failure of Dividing Wall of MMDI Distillation Column
Technical Paper Publication: PVP2018-84527

Jielu Wang *and* **Xiaoying Tang**, *Shanghai Institute of Special Equipment Inspection, Shanghai, China*,
Wenxian Su *and* **Qinghai Shi**, *University of Shanghai for Science and Technology, Shanghai, China*,
Bo Yang, Ju Ding, Yichang Huang, Yantian Zuo *and* **Xiaolong Xue**, *Shanghai Institute of Special Equipment Inspection and Technical Research (SSEI), Shanghai, China*

Session 1.4E (FSI-1-3)
Leaks, Cracks, Breaks, Impacts and Vibrations - II
Mezzanine, Rokoska 4:15pm - 6:00pm

Session Developer/Chair: **Arris Tijsseling**, *TU Eindhoven, Eindhoven, Netherlands*
Session Developer/Co-Chair: **Jong Chull Jo**, *Korea Inst. Nuclear Safety/Pusan National University, Daejon, Korea (Republic)*

4:15pm
Williams-Wittrick Approach Application for an Effective Search for Natural Vibration Frequencies of Pipeline Systems with Fluid-Structure Interaction
Technical Paper Publication: PVP2018-84933

Igor Orynyak, *G.S. Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*,
Anatolii Batura *and* **Yaroslav Dubyk**, *IPP-Centre, Kiev, Ukraine*

4:50pm
Prediction of Transient Hydrodynamic Loads on the PWR Steam Generator Tubes at a Main Feed Water Line Break Accident
Technical Paper Publication: PVP2018-84152

Jong Chull Jo, *Korea Institute. Nuclear Safety/Pusan National University, Daejon, Korea (Republic)*,
Jae Jun Jeong, Byongjo Yun, *Pusan National University, Busan, Korea (Republic)*

5:25pm
Dynamic Instability Analysis of a Spring-Loaded Pressure Safety Valve Connected to a Pipe by using CFD method
Technical Paper Publication: PVP2018-84992

Fengjie Zheng, Chaoyong Zong, Fuzheng Qu, Wei Sun *and* **Xueguan Song**, *Dalian University of Technology, Dalian, China*

Session 1.4F (SE-2-3)
Vibration Control and Damping - II
Mezzanine, Hercovka 4:15pm - 6:00pm

Session Developer: **Fabrizio Paolacci**, *University Roma Tre, Rome, Italy*
Session Co-Developer/Chair: **Keisuke Minagawa**, *Saitama Institute of Technology, Saitama, Japan*
Session Co-Chair: **Taichi Mat Suoka**, *Meiji University, Kawasaki, Kanagawa, Japan*

4:15pm
Electromagnetic Damper Using Brushless DC Motor With Capacitance
Technical Paper Publication: PVP2018-84021

Taichi Matsuoka, *Meiji University, Kawasaki, Kanagawa, Japan*

4:41pm
Research and Development of Viscous Fluid Dampers for Improvement of Seismic Resistance of Thermal Power Plants: Part 4 Experimental Study on Environmental Applicability and Durability of Damper
Technical Paper Publication: PVP2018-84556

Go Tanaka, *Oiles Corp, Tochigi, Japan*
Keisuke Minagawa, *Saitama Institute of Technology, Saitama, Japan*
Kiyoshi Aida, *Mitsubishi Hitachi Power Systems, Ltd., Kure-Shi, Japan*
Satoshi Fujita, *Tokyo Denki Univ, Tokyo 101-8457, Japan*

5:07pm
Research and Development of Viscous Fluid Dampers for Improvement of Seismic Resistance of Thermal Power Plants: Part 5 Influence of Damper Properties on Lifetime
Technical Paper Publication: PVP2018-84514

Kiyoshi Aida, *Mitsubishi Hitachi Power Systems, Ltd., Kure-Shi, Japan*
Keisuke Minagawa, *Saitama Institute of Technology, Saitama, Japan*
Go Tanaka, *Oiles Corp, Tochigi, Japan*,
Satoshi Fujita, *Tokyo Denki Univ, Tokyo 101-8457, Japan*

5:33pm
Research and Development of Viscous Fluid Dampers for Improvement of Seismic Resistance of Thermal Power Plants: Part 6 Influence of Damper Properties on Vibration Control Performance
Technical Paper Publication: PVP2018-84518

Keisuke Minagawa, *Saitama Institute of Technology, Saitama, Japan*
Kiyoshi Aida, *Mitsubishi Hitachi Power Systems, Ltd., Kure-Shi, Japan*
Go Tanaka, *Oiles Corp, Tochigi, Japan*
Satoshi Fujita, *Tokyo Denki Univ, Tokyo 101-8457, Japan*

Session 1.4G (CT-3-1)
Leak Tightness and Assembly of Bolted Joints
Mezzanine, Tyrolka 4:15pm - 6:00pm

Session Developer/Chair: **Takashi Kobayashi**, *National Institute of Technology, Numazu College, Numazu City, Shizuoka, Japan*
Session Co-Developer/Chair: **Satoshi Nagata**, *Toyo Engineering Corporation, Narashino, Chiba, Japan*
Session Co-Chair: **Dale Rice, P.E.**, *VSP Technologies, Leland, NC, USA*

4:15pm
Review of Mechanical and Sealing Performance Aspects of Commercially Available PTFE Based Gasket Materials
Technical Paper Publication: PVP2018-84082

Dale Rice, P.E., *VSP Technologies, Leland, NC, USA*,
A. Fitzgerald Waterland, III, *VSP Technologies, Prince George, VA, USA*

4:41pm
Numerical Analysis of Bolt Elastic Interaction in Non-Gasketed Flange
Technical Paper Publication: PVP2018-84826

Wei Zhang, Yongsong Ye, Dean Chen, Gingkai Han *and* **Yue Ma**, *Dalian University of Technology, Dalian, China*

5:07pm
The Influence of Material, Hardness, Roughness and Surface Treatment on the Frictional Characteristics of the Underhead Contact in Socket-Head Screws
Technical Paper Publication: PVP2018-84530

Dario Croccolo, Massimiliano De Agostinis, Stefano Fini, Giorgio Olmi, Francesco Robusto, Omar Cavalli, *University of Bologna, Bologna, Italy*
Nicolò Vincenzi, *Giuliani A Bucci Automations S.p.A. Division, Faenza, Italy*

5:33pm
Experimental Investigation of Interfacial and Permeation Leak Rates in Sheet Gaskets and Valve Stem Packing
Technical Paper Publication: PVP2018-85112

Ali Salah Omar Aweimer *and* **Abdel-Hakim Bouzid**, *Ecole Technologie Superieure, Montreal, QC, Canada*

Session 1.4H (DA-8-3)
FFS - Understanding the Strength and Failures
Lobby, Amsterdam 4:15pm - 6:00pm

Session Developer/Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*
Session Developer/Co-Chair: **Simon Yuen**, *Suncor Energy Inc, Calgary, AB, Canada*
Session Co-Developer: **Gysbert Van Zyl**, *Sabic, Jubail, Saudi Arabia*

4:15pm
Root Cause and FFS Analysis of a Dent in a 22mm Thick Elliptical Head
Technical Paper Publication: PVP2018-84516

Pascal Schreurs *and* **Stan Kusters**, *Sintra Engineers, Geleen, Netherlands*

4:41pm
Sulfidation Rate Prediction on Tube-to-Tubesheet Joints in a Waste Heat Boiler in a Sulphur Plant
Technical Paper Publication: PVP2018-85070

Feng Ju, Simon Yuen *and* **Brian Tkachyk**, *Suncor Energy Inc, Calgary, AB, Canada*
Allen Miller, *Shell Projects and Technology, Houston, TX, USA*

5:07pm
Failure Analysis of Furnace Tube in the Radiation Section of Ethylene Cracking Furnace
Technical Paper Publication: PVP2018-84037

Wen Liu, Jian Xing, Zhenlong Hu, Luowei Cao *and* **Fakun Zhuang**, *China Special Equipment Inspection and Research Institute, Beijing, China*
Guodong Sun, *Sinopec Beijing Yanshan Company, Beijing, China*,

5:33pm
Evaluation of Strength of Pipe with Metal-Loss Due to CUI by FFS and FEA which Considered the Fracture Ductility
Technical Paper Publication: PVP2018-84741

Atsushi Yamaguchi, *National Institute of Occupational Safety and Health, JAPAN, Kiyose, Tokyo, Japan*
Nobuyuki Yoshida, *Sumitomo Chemical Co., Ltd., Niihama, Ehime, Japan*

Session 1.4I (CS-1-2)
Structural Integrity of Pressure Components - II
Lobby, Athens 4:15pm - 6:00pm

Session Developer: **Steven Xu**, *Kinectrics, Toronto, ON, Canada*
Session Developer/Co-Chair: **Michael Benson**, *U. S. Nuclear Regulatory Commission, Washington, DC, USA*
Session Chair: **Blair Carroll**, *Canadian Nuclear Safety Commission, Ottawa, ON, Canada*

4:15pm
A Comparative Study of Pressure Area Method of Nozzle Compensation in ASME Section VIII Division 2 and PD 5500 for Restrictions in Nozzle Dimensions
Technical Paper Publication: PVP2018-84582

Ameya Mathkar, *Lloyd's Register Asia, Thane, Maharashtra, India*,
Shyam Gopalakrishnan, *Lloyd's Register Asia, Thane-West, India*

4:41pm
HRSG-Header Welds Residual-stress Evaluation and Creep-assessment through the Application of Italian Code, American Standard
Technical Paper Publication: PVP2018-84662

Ottaviano Grisolia, *INAIL, Central Research Directorate, Department of Technology, Rome, RM, Italy*
Lorenzo Scano, *Studio Scano Associato, Safety & Integrity, Udine, Italy*

5:07pm
Proposed Review Framework for Design of Pressure Retaining Components in Small Modular Reactor (SMR)
Technical Paper Publication: PVP2018-85106

Seyun Eom, Khalid Chaudhry, Nabel Sadek, Christopher Cole *and* **Raoul Awad**, *CNSC, Ottawa, ON, Canada*
Xinjian Duan, *SNC-Lavalin, Mississauga, ON, Canada*

5:33pm
Investigations of Very High Cycle Fatigue Behavior of Metastable Austenitic Steels Using Servohydraulic and Ultrasonic Testing Systems
Technical Paper Publication: PVP2018-84639

Tobias Daniel, Annika Boemke, Marek Smaga *and* **Tilmann Beck**, *Institute of Materials Science and Engineering/TU Kaiserslautern, Kaiserslautern, Germany*

Session 1.4J (MF-27-2)
Additive Manufacturing Process and Modeling
Lobby, Barcelona 4:15pm - 6:00pm

Session Developer: **Chris San Marchi**, *Sandia National Laboratories, Livermore, CA, USA*
Session Co-Chair: **Catrin Mair Davies**, *Imperial College London, London, UK*
Session Co-Developer/ Session Chair: **Paul Korinko**, *Savannah River National Laboratory, Aiken, SC, USA*

4:15pm
Microstructure and Mechanical Properties Correlation in Selective Laser Melting of 17-4 PH Stainless Steel
Technical Presentation: PVP2018-84870

Somayeh Pasebani, Peyman Samimi *and* **Milad Ghayoor**, *Oregon State University, Corvallis, OR, USA*

4:50pm
Towards an Integrated Computational Model for Additive Manufacturing Process: Heat Source-Particle Interaction and Effective Thermal Conductivity of Powder Bed
Technical Paper Publication: PVP2018-84970

Jian Chen, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*,
Zhili Feng, *ORNL, Oak Ridge, TN, USA*

5:25pm
Stress and Distortion Simulation of Additive Manufacturing Process by High Performance Computing
Technical Paper Publication: PVP2018-85045

Hui Huang, Jian Chen *and* **Zhili Feng**, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*,
Blair Carlson *and* **Hui-ping Wang**, *General Motors, Warren, MI, USA*,
Paul Crooker, *Electric Power Research Institute, Palo Alto, CA, USA*,
Gregory Frederick, *Electric Power Research Institute, Charlotte, NC, USA*

Session 1.4K (OAC-1-2)
Predicting the Future: Risk Assessment and Management
Lobby, Berlin 4:15pm - 6:00pm

Session Developer/Chair: **Joseph Cluever**, *LPI, Inc., Richland, WA, USA*
Session Developer/Co-Chair: **Alton Reich**, *Streamline Automation LLC, Huntsville, AL, USA*

4:15pm
Effect of Nozzle Geometry on the Near-field Flow Characteristics of High-Pressure Gas Leak Jets
Technical Paper Publication: PVP2018-84362

Xiaopeng Li, Fakun Zhuang,Yian Wang, Libo Wang *and* **Guoshan Xie**, *China Special Equipment Inspection and Research Institute, Beijing, China*
Rui Zhou, *Institute of Applied Physics and Computational Mathematics, Beijing, China*

4:41pm
Environmental Risk Analysis of Accidental Releases from Onshore Oil Pipelines
Technical Paper Publication: PVP2018-84617

Shengli Liu *and* **Yongtu Liang**, *China University of Petroleum-Beijing, Beijing, China*

5:07pm
Fire Accident Inversion Method Base on STAMP and Topological Network for LNG Depot
Technical Paper Publication: PVP2018-85113

Jinqiu Hu, Laibin Zhang, Ronghan Wang *and* **Qingchun Ma**, *China University of Petroleum (Beijing), Beijing, China*

5:33pm
Comparison of DSMC and CFD models of Heat Transfer in a Rarefied Two-Dimensional Geometry
Technical Paper Publication: PVP2018-84986

Dilesh Maharjan, Mustafa Hadj-Nacer *and Miles Greiner, University of Nevada-Reno, Reno, NV, USA*
Stefan K. Stefanov, *Bulgarian Academy of Sciences, Sofia, Bulgaria*

Session 1.4L (SPC-1-3)
Student Paper Competition - PhD - I
Lobby, Brussels 4:15pm - 6:00pm

Session Developer: **Fabrizio Paolacci**, *University Roma Tre, Rome, Italy*
Session Chair: **Douglas Scarth**, *Kinectrics, Toronto, ON, Canada*
Session Co-Chair: **Bing Li**, *Kinectrics NSS, Kincardine, ON, Canada*

4:15pm
Effects of Crack Introduction History On Fracture Initiation In Residually Stressed Components
Technical Paper Publication: PVP2018-84414

Molly Probert, Harry Coules *and* **C.E. Truman**, *University of Bristol, Bristol, UK*

4:41pm
Creep Fatigue Damage Assessment of V-butt Weld Pipe with an Extended Direct Steady Cycle Analysis
Technical Paper Publication: PVP2018-84568

Manu Puliyaneth, Haofeng Chen, *University of Strathclyde, Glasgow, UK*
Weiling Luan, *East China University of Science and Technology, Shanghai, China*

5:07pm
Novel Metamaterial-Based Foundation Concept Applied to a Coupled Tank-Pipeline System
Technical Paper Publication: PVP2018-84624

Moritz Wenzel, Oreste Salvatore Bursi, *University of Trento, Trento, Italy*
Francesco Basone, University of Enna "Kore", Enna, Italy

5:33pm
A Seismic Vulnerability Analysis of a Liquefied Natural Gas Subplant
Technical Paper Publication: PVP2018-84731

Massimiliano Pedot, *Silesian University of Technology, Faculty of Mechanical Engineering, Gliwice, Poland*
Rocco di Filippo, *University of Trento - Department of Civil, Environmental and Mechanical Engineering (DICAM), Trento, TN, Italy*
Oreste Salvatore Bursi, *University of Trento, Trento, Italy*

Session 1.4M (MF-19-2)
Uncertainty Quantification of Material Degradation Data and Failure Models - II
Lobby, Sofia 4:15pm - 6:00pm

Session Developer/Chair: **Jeffrey Fong**, *NIST, Gaithersburg, MD, USA*
Session Co-Chair: **Robert Rainsberger**, *XYZ Scientific Applications, Inc., Pleasant Hill, CA, USA*

4:15pm
A Multiple-Loading Single-Sample Exploratory Method of Estimating Damage in Polymer Composite Materials through Analysis of X-Ray Tomography Images
Technical Paper Publication: PVP2018-84411

Raghu Prakash, *Indian Institute of Technology Madras, Chennai, India*
Mathew John, *Government Engineering College, Tiruvananthapuram, India*
Michele Carboni, *Politecnico di Milano, Milano, Italy*

4:50pm
Uncertainty Quantification of Finite Element Analysis of Uni-axial Strength Test Holed Composite Laminates
Technical Paper Publication: PVP2018-84730

Li Ma, Jeffrey Fong, *N. Alan Heckert and James J. Filliben, National Institute of Standards & Technology, Gaithersburg, MD, USA*
Pedro V. Marcal, *MPACT, Corp., Oak Park, CA, USA*
Robert Rainsberger, *XYZ Scientific Applications, Inc., Pleasant Hill, CA, USA*

5:25pm
Application of an *a priori* Jacobian-based Error Estimation Metric to the Accuracy Assessment of 3D Finite Element Simulations
Technical Paper Publication: PVP2018-84784

Robert Rainsberger, *XYZ Scientific Applications, Inc., Pleasant Hill, CA, USA*
Jeffrey Fong, *NIST, Gaithersburg, MD, USA*
Pedro V. Marcal, *MPACT, Corp., Oak Park, CA, USA*

Session 1.4N (DA-1-3)
Design and Analysis of Pressure Vessels, Heat Exchangers, and Components - III
Lower Lobby, Madrid 4:15pm - 6:00pm

Session Developer/Co-Chair: **Nathan Barkley**, *Contract Fabricators, Inc., Holly Springs, MS, USA*
Session Co-Developer/ Session Chair: **Jaan Taagepera**, *Chevron ETC, Richmond, CA, USA*
Session Co-Developer: **Clay Rodery**, *C&S Technology, LLC, League City, TX, USA*

4:15pm
Failure Analysis of a High Pressure Air Cooled Heat Exchanger
Technical Paper Publication: PVP2018-84801

Boris Volfson, *JSC "Vniineftemash", Moscow 115230, Russia*

4:35pm
Mechanical Design of Electrical Isolation Joint
Technical Paper Publication: PVP2018-84947

Giovanni Ricco, *BSS LTD, Beijing, China*

4:55pm
A Novel Approach for Assessment of Pressurised Equipment for Slow Depressurisation During Fire
Technical Paper Publication: PVP2018-84236

Kaveh Ebrahimi *and* **Saeid Rahimi Mofrad**, *Fluor Ltd, Farnborough, UK*
Barry Millet, George Miller *and* **Kenneth Kirkpatrick**, *Fluor, Sugar Land, TX, USA*

5:15pm
Design and Optimization of High-Pressure Hydrogen Cylinders for Intermodal Container Transportation
Technical Paper Publication: PVP2018-84842

Jialei Chen, *Georgia Institute of Technology, Atlanta, GA, USA*,
Jianfeng Shi, *Zhejiang University, Hangzhou, Zhejiang, China*,
Chuck Zhang, *Georgia Institute of Technology, Marietta, GA, USA*

Technical Tutorial 1.4Q (TW-2-8)
Aging Management for Spent Fuel Dry Storage and Subsequent Transportation Part 2
Lower Lobby, Congress Hall III 4:15pm - 6:00pm

Session Developer/Chair: **Maher Younan**, *American University in Cairo, New Cairo 11835, Egypt*
Presented by: **Zenghu Han and Yung Liu**, *Argonne National Laboratory, Lemont, IL, USA*

Block 2.1 Tuesday, July 17 8:15AM - 10:00AM

Session 2.1A (CS-3-3)
Environment Fatigue Issues - III
Mezzanine, Karlin I 8:15am - 10:00am

Session Developer/Chair: **Thomas Metais**, *EDF China, Beijing, China*
Session Developer/Co-Chair: **Seiji Asada**, *Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan*

8:15am
Influence of Mean Strain on Fatigue Life of Stainless Steel in PWR Water Environment
Technical Paper Publication: PVP2018-84461

Masayuki Kamaya, *Institute of Nuclear Safety System, Mikata-gun Fukui 919-1205, Japan*

8:41am
Effect of Surface Condition on the Fatigue Life of Austenitic Stainless Steels in High Temperature Water Environments
Technical Paper Publication: PVP2018-84251

Norman Platts, *Amec Foster Wheeler, Warrington, UK*
Alec Mc Lennan, *Wood Plc, Warrington, UK*
Marius Twite, Andrew Morley, Chris Currie, *Rolls-Royce Plc, Derby, UK*

9:07am
Explicit Quantification of the Interaction Between the PWR Environment and Component Surface Finish in Environmental Fatigue Evaluation Methods for Austenitic Stainless Steels
Technical Paper Publication. PVP2018-84240

Thomas Metais, *EDF China, Beijing, China*
Andrew Morley, *Rolls-Royce Plc, Derby, UK*
Gary Stevens, *EPRI, Charlotte, NC, USA*
Laurent De Baglion, *AREVA, Paris La Défense Cedex, France*
David R. Tice, *Wood Group plc., Warrington, Cheshire, UK*
Sam Cuvilliez, *EDF - DIPNN - Direction Technique, Lyon, France*

9:33am
A Thermomechanical PWR Test Facility to Investigate Thermal Shock Loading on a Small Scale Tubular Specimen
Technical Paper Publication: PVP2018-84923

Peter J Gill, Norman Platts, *Amec Foster Wheeler, Warrington, UK*
Chris Currie, *Eleanor Grieveson, Rolls-Royce, Derby, UK*

Session 2.1B (MF-1-4)
Application of Fracture Mechanics in Failure Assessment - IV
Mezzanine, Karlin II 8:15am - 10:00am

Session Developer/Chair: **Abilio Jesus**, *Faculty of Engineering - University of Porto, Porto, Portugal*
Session Co-Chair: **Yun-Jae Kim**, *Korea Univ, Seoul 136-701, Korea (Republic)*

8:15am
Development of Burst Pressure Estimation Equations for Steam Generator Tubes with Multiple Axial Surface Crack
Technical Paper Publication: PVP2018-84855

Ji-Seok Kim *and* **Myeong Woo Lee**, *Korea University, Seoul, Korea (Republic)*,
Yun-Jae Kim, *Korea Univ, Seoul 136-701, Korea (Republic)*,
Jin Weon Kim, *Chosun Univ, Kwangju, Korea (Republic)*

8:41am
Application of Energy-Based Damage Model to Simulate Ductile Fracture Under Cyclic Loading and Validation Against Piping System Test Data
Technical Paper Publication: PVP2018-84861

Gyo-Geun Youn, Hyun-Suk Nam *and* **Jong-Min Lee**, *Korea University, Seoul, Korea (Republic)*,
Hune-Tae Kim, *Korea University, Seongbuk-Gu, Seoul, Korea (Republic)*,
Yun-Jae Kim, *Korea University, Seoul 136-701, Korea (Republic)*

9:07am
Pre-strain Effects on Mixed-mode Fatigue Crack Propagation Behaviour of the P355NL1 Pressure Vessels Steel
Technical Paper Publication: PVP2018-85089

Joao Pedro Mota Ferreira, *Faculty of Engineering - University of Porto, Porto, Portugal*
Jose Antonio Fonseca De Oliveira Correia, *University of Porto, Porto, Portugal*
Grzegorz Lesiuk, *Wroclaw University of Science and Technology, Wroclaw, Poland*
Sergio Blason Gonzalez, *Maria Cristina Rodriguez Gonzalez, Universidad de Oviedo, Gijon, Spain*
Abilio Jesus, *Faculty of Engineering - University of Porto, Porto, Portugal*
Alfonso Fernandez Canteli, *Universidad de Oviedo, Gijón, Spain*

9:33am
Evaluation of Fatigue Design Curves for a Double-Side Welded Connection Used in Offshore Applications
Technical Paper Publication: PVP2018-85156

Jose Antonio Fonseca De Oliveira Correia, *University of Porto, Porto, Portugal*
Miguel Correia, *Mads Holm, Force Technology Norway AS, Hvalstad, Norway*
Julle Ekeborg, *Force Technology Norway, Hvalstad, Norway*
Grzegorz Lesiuk, *Wroclaw University of Science and Technology, Wroclaw, Poland*
José Castro, *University of Porto, Porto, Portugal*
Abilio Jesus, *Faculty of Engineering - University of Porto, Porto, Portugal*
Rui Calçada, *University of Porto, Porto, Portugal*

Session 2.1C (MF-6-1)
Materials and Technologies for Nuclear Power Plants - I
Mezzanine, Karlin III 8:15am - 10:00am

Session Developer/Chair: **Weiju Ren**, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Session Co-Chair: **Randy K Nanstad**, *R&S Consultants LLC, Oak Ridge, TN, USA*

8:15am
Development of Nickel-Based Superalloy for Molten Salt Reactors
Technical Presentation: PVP2018-85026

Martina Koukolíková *and* **Peter Slama**, *COMTES FHT a.s., Dobrany, Czech Republic*

8:41am
Considerations of Alloy N Code Extension for Commercial Nuclear Reactor Deployment
Technical Paper Publication: PVP2018-84716

Weiju Ren, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*

9:07am
Effects of Strain Amplitude and Loading Path on Cyclic Behavior and Martensite Transformation of 304 Stainless Steel
Technical Paper Publication: PVP2018-84888

Yajing Li, Dunji Yu *and* **Chen Xu**, *Tianjin University, Tianjin, China*

9:33am
Multiscale Stress-Diffusion Analysis of Notch-Tip Hydrogen Profiles in Zircaloy-4
Technical Paper Publication: PVP2018-84555

Said El Chamaa, Mitesh Patel, Mark R. Wenman *and* **Catrin Mair Davies**, *Imperial College London, London, UK*

Session 2.1D (CS-11-4)
Failure Analysis of Engineering Structure - I
Mezzanine, Palmovka 8:15am - 10:00am

Session Developer/Chair: **Yinghua Liu**, *Tsinghua University, Beijing, China*
Session Developer/Co-Chair: **Jun Shen**, *Tsinghua University, Beijing, China*

8:15am
Buckling of Tanks with a Conical Roof Under Harmonic Settlement
Technical Paper Publication: PVP2018-84048

Haigui Fan, Zewu Wang *and* **Kun Yan**, *Dalian University of Technology, Dalian, Liaoning, China*

8:41am
Erosion-Corrosion of a Carbon Steel Elbow in a Natural Gas Gathering Pipeline
Technical Paper Publication: PVP2018-84262

Wei Wu, Qiao Qiao, Guangxu Cheng, Yun Li *and* **Dongpeng Liu**, *Xi'an Jiaotong University, Xi'an, Shaanxi, China*,
Tinggang Pei, *The First Natural Gas Plant, PetroChina Changqing Oilfield Company, Jingbian, China*,
Hailong Yin, *Shaanxi Coal and Chemical Industry Group Co., Ltd., Xi'an, Shaanxi, China*,

9:07am
Case Study of Nonlinear Buckling with Shape Distortion Due to Thermal Loads
Technical Paper Publication: PVP2018-84335

Jun Shen, Heng Peng, Hui Peng *and* **Yinghua Liu**, *Tsinghua University, Beijing, China*,
Yanfang Tang, *Wison Engineering Ltd., Shanghai, China*,

9:33am
Regulating Fe3O4 Micro/Nanostructure to Obtain Super-Hydrophobicity
Technical Presentation: PVP2018-85119

He Shijun, Wang Zhen *and* **Hu Jun**, *Northwest University, Xi`an, China*

Session 2.1E (HPT-2-1)
Impulsively Loaded Vessels
Mezzanine, Rokoska 8:15am - 10:00am

Session Developer/Chair: **David Gross**, *Dominion Engineering, Reston, VA, USA*
Session Developer/Co-Chair: **Matthew Edel**, *BakerRisk, San Antonio, TX, USA*
Session Co-Developer: **Victor P. Janzen**, *Canadian Nuclear Laboratories, Chalk River, ON, Canada*

8:15am
Experimental Determination of the Static Equivalent Pressures of Detonative Explosions of Ethylene/O2/N2-Mixtures and of Cyclohexane/O2/N2-Mixtures in Long and Short Pipes
Technical Paper Publication: PVP2018-84493

Hans-Peter Schildberg, *BASF SE, Ludwigshafen, Germany*

8:40am
Importance of Connections in High-Pressure Barricade Design
Technical Paper Publication: PVP2018-84765

Jodi Kostecki *and* **Matthew Edel,** *Bakerrisk, San Antonio, TX, USA*
John Montoya, *Baker Engineering and Risk Consultants, San Antonio, TX, USA*

9:05am
Prediction of the Leakage Threshold for Hertzian Contact Seals: An Experimental Approach
Technical Paper Publication: PVP2018-84622

Jeroen Van Wittenberghe, *OCAS, Ghent, Belgium*,
John Vande Voorde, *OCAS NV, Zelzate, Belgium*

9:30am
Influence of Defect Distribution on Dynamic Elastic Buckling of Rings Under Internal Uniformly-Distributed Pressure Pulse
Technical Paper Publication: PVP2018-84041

Qi Dong, Sha Yang *and* **Liucheng Zhang**, *Institute of Chemical Materials, China Academy of Engineering Physics, Mianyang, China*

Session 2.1F (SE-9-1)
Multi-Hazards and Margins
Mezzanine, Hercovka 8:15am - 10:00am

Session Developer/Chair: **Constantine Petropoulos**, *Sargent & Lundy, Llc, Chicago, IL, USA*
Session Developer/Co-Chair: **Oreste Salvatore Bursi**, *University of Trento, Trento, Italy*
Session Co-Developers: **Antonio Caputo**, *Roma Tre University Department of Engineering, Rome, Italy,*
Ismail Kisisel, *Surgent & Lundy LLC, Chicago, IL, USA*

8:15am
Structural Stability Evaluation of Independent Spent Fuel Storage Casks
Technical Paper Publication: PVP2018-84602

Gunup Kwon, Phuong Hoang *and* **Khaled Ata**, *Sargent & Lundy LLC, Chicago, IL, USA*

8:36am
High-Frequency Responses in Relation to the Use of Explicit Time Integration Method
Technical Paper Publication: PVP2018-85083

Sungjin Bae, *Sargent and Lundy, Chicago, IL, USA*

8:57am
Seismic Behaviour of Torsionally Coupled Structures Equipped with Viscoelastic Dampers
Technical Paper Publication: PVP2018-84373

Fabrizio Paolacci, *University Roma Tre, Rome, Italy*,
Mariano Ciucci, *National Institute for Insurance Against Accidents at Work (INAIL), Rome, Italy*

9:18am
A Probabilistic Approach for the Assessment of LOC Events in Steel Storage Tanks Under Seismic Loading
Technical Paper Publication: PVP2018-84374

Fabrizio Paolacci, *University Roma Tre, Rome, Italy*,
Daniele Corritore *and* **Antonio Caputo**, *University Roma Tre - Department of Engineering, Rome, Italy*,
Oreste Salvatore Bursi, *University of Trento, Trento, Italy*,
Bledar Kalemi, *University Roma Tre, Roma, Italy*

9:39am
Enhanced Seismic Fragility Analysis of Unanchored Above-Ground Steel Liquid Storage Tanks
Technical Paper Publication: PVP2018-84367

Hoang Nam Phan, Fabrizio Paolacci *and* **Silvia Alessandri**, *Roma Tre University, Rome, RM, Italy*,
Phuong Hoa Hoang, *The University of Da nang - University of Science and Technology, Da nang, VNM*

Session 2.1G (CT-2-1)
Elevated Temperature Behavior of Bolted Joints
Mezzanine, Tyrolka 8:15am - 10:00am

Session Developer/Chair: **Jose Veiga**, *Teadit Indústria e Comércio Ltda, Rio de Janeiro, RJ, Brazil*
Session Co-Chair: **Carlos D. Girão**, *T eadit Indústria e Comércio Ltda, Rio de Janeiro, RJ, Brazil*

8:15am
The Influence of Elevated Temperature in Creep Relaxation of Various PTFE Gaskets Production Methods
Technical Paper Publication: PVP2018-84077

Florian Werner, *TEADIT Deutschland GmbH, Cologne, Germany*
Ana Claudia Silva, *Teait Indústria e Comércio LTDA, Rio de Janeiro, Brazil*
Lucas Xavier, *Teadit International Produktions GmbH, Kufstein, Tyrol, Austria*

8:41am
FEM Stress Analysis of Bolted Flange Joints in Elevated Temperature Service Condition
Technical Paper Publication: PVP2018-84444

Lu Wang, Xuedong Chen, Zhichao Fan, Jilin Xue, *Hefei General Machinery Research Institute, Hefei, China*

9:07am
Calculation of Leakage Rate for Bolted Flanged Joint during the Long Term Service at High Temperature
Technical Paper Publication: PVP2018-84445

Jilin Xue, Xuedong Chen, Zhichao Fan, Lu Wang, *Hefei General Machinery Research Institute, Hefei, China*

9:33am
Application of Miniaturized Experiments for Constitutive Modeling of Creep Relaxation of a Novel Textured Gasket Product
Technical Paper Publication: PVP2018-84040

Ali Gordon, John Albury, Matthew Lopez *and* **Evren Tasci**, *University of Central Florida, Orlando, FL, USA*,
Zachary Poust, James Drago, Steve Pitolaj *and* **Paul Nichols**, *Garlock Sealing Technologies, Palmyra, NY, USA*

Session 2.1H (DA-8-4)
FFS - General Topics
Lobby, Amsterdam 8:15am - 10:00am

Session Developer/Chair: **Gysbert Van Zyl**, *Sabic, Jubail, Saudi Arabia*
Session Co-Developer: **Simon Yuen**, *Suncor Energy Inc, Calgary, AB, Canad*
Session Developer/Co-Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*

8:15am
Fitness for Service Assessment and Repair of the Liner of a High Pressure Heat Exchanger
Technical Paper Publication: PVP2018-85001

Gysbert Van Zyl, *Sabic, Jubail, Saudi Arabia*,
Sultan G Al-Harthi, *Saudi Arabian Fertilizer Company, Jubail, Saudi Arabia*

8:50am
Integral Mean of Yield Concept Applied to Thermal Hot Spots - Validation of a Level 2 Damage Assessment Method
Technical Paper Publication: PVP2018-85068

Henry Kwok, *Brighton Solutions Inc, Calgary, AB, Canada*,
Simon Yuen, *Suncor Energy Inc, Calgary, AB, Canada*,
Jorge Penso, *Shell Oil, Cypress, TX, USA*

9:25am
Development of Fitness-for-Service Approach for Low Toughness Carbon Steel Fittings & Flanges
Technical Presentatio: PVP2018-84692

Kannan Subramanian, *Stress Engineering Services, Metairie, LA, USA*,
Ralph King, Daniel Ayewah, *Stress Engineering Services, Inc., Houston, TX, USA*

Session 2.1I (DA-11-1)
CFD in Design and Analysis
Lobby, Athens 8:15am - 10:00am

Session Developer/Chair: **Sean McGuffie**, *Porter Mcguffie Inc, Lawrence, KS, USA*
Session Co-Developer: **Yanzhen He**, *Porter McGuffie, Inc., Lawrence, KS, USA*
Session Co-Chair: **William Dempster**, *University Of Strathclyde, Glasgow, Scotland*

8:15am
Optimization Design of PDC Bit Gauge Using CFD-DPM and Central Composite Design
Technical Paper Publication: PVP2018-84360

Huihui Hou *and* **Zhong Liu**, *China University of Petroleum, Beijing At Karamay, Beijing, China*
Hongwu Zhu, Boyu Zhang *and* **Tingting Wu**, *China University of Petroleum, Beijing, Beijing, China*

8:50am
Limitations in the Use of Pressure Scaling for Safety Relief Valve Design
Technical Paper Publication: PVP2018-84737

William Dempster, *University Of Strathclyde, Glasgow, Scotland*
Steven Taggart, *Broady Flow Control Ltd, Hull, UK*
Christopher Doyle, *University of Strathclyde, Glasgow, UK*

9:25am
CFD Prediction of Safety Valve Disc Forces Under Two Phase Flow Conditions
Technical Paper Publication: PVP2018-84745

William Dempster, *University of Strathclyde, Glasgow, Scotland*
Moftah Alshaikh, *Omar Almukhtar University, Demah, Libyan Arab Jamahiriya*

Session 2-1J (NDPD-1-1)
William T. Springer Memorial Session on Emerging NDE Techniques and Applications - I
Lobby, Barcelona 8:15am - 10:00am

Session Developer/Chair: **Sandra Dugan**, *Swiss Federal Nuclear Safety Inspectorate ENSI, Brugg, AG, Switzerland*
Session Co-Chair: **Anne Jüngert**, *MPA University of Stuttgart, Stuttgart, Germany*

8:15am
Acoustic Data Analysis for Detecting Alkali-Silica Reaction Degradation in Concrete
Technical Paper Publication: PVP2018-84704

Ankit Dubey, *North Carolina State University, Raleigh, NC, USA*
Sarah Miele, *Vanderbilt University, Nashville, TN, USA*
Vivek Agarwal, *Idaho National Laboratory, Idaho Falls, ID, USA*
Sankaran Mahadevan, *Vanderbilt University, Nashville, TN, USA*

8:40am
In-Situ Inspection of Pipes and Pressure Vessels Using Thin Film Sensors
Technical Presentation: PVP2018-84750

Cole Brubaker, *Raymond Bond and Xuanli Deng, Vanderbilt University, Nashville, TN, USA*
Vivek Agarwal, *Idaho National Laboratory, Idaho Falls, ID, USA*
Kane Jennings *and* **Douglas Adams**, *Vanderbilt University, Nashville, TN, USA*

9:05am
Defect Localization for Pressure Vessel Based on Circumferential Guided Waves: An Experimental Study
Technical Paper Publication: PVP2018-85108

Shuangmiao Zhai, Chaofeng Chen, Gangyi Hu *and* **Shaoping Zhou**, *East China University of Science and Technology, Shanghai, China*

Session 2.1K (OAC-3-1)
Monitoring, Diagnostic & Inspection - I
Lobby, Berlin 8:15am - 10:00am

Session Developer: **Milan Brumovsky**, *UJV Rez, Rez, Czech Republic*
Session Chair: **Milos Kytka**, *UJV Rez, Rez, Czech Republic*
Session Co-Chair: **Radim Kopriva**, *UJV Rez, a.s., Husinec, Czech Republic*

8:15am
An Application of Singular Spectrum Analysis for Internal Valve Leakage Signals Denoising in a Natural Gas Pipeline
Technical Paper Publication: PVP2018-84036

Shenbin Zhu, Zhenlin Li, Shimin Zhang *and* **Ying Yu**, *China University of Petroleum-Beijing, Beijing, China*

8:41am
Application of Genetic-Algorithm-Based Data Reconciliation on Offshore Virtual Flow Metering of Gas-Condensate Field Production
Technical Paper Publication: PVP2018-84268

Dan Wang, Jing Gong, Di Fan, Guoyun Shi *and* **Juheng Yang**, *China University of Petroleum-Beijing, Beijing, China*

9:07am
New Generation of Monitoring Systems: From Measurement to Numerical Simulation
Technical Paper Publication: PVP2018-84598

Benoit Joua, *and* **Benedikt Heinz**, *Gantner Instruments, Darmstadt, Germany*
Oana-Zenaida Pascan, *EDF, Palaiseau, France*

9:33am
Application of 3D Optical Measurement and FFS System for LTA in Pressure Equipment
Technical Presentation: PVP2018-84815

Takayasu Tahara, *T&T Technology, Saitama Pref, Japan*, **Minoru Niimura**, *Seikowave K.K., Tokyo, Japan*

Session 2.1L (SPC-1-4)
Student Paper Competition - PhD - II
Lobby, Brussels 8:15am - 10:00am

Session Developer: **Peter James**, *Wood, Warrington, Cheshire, UK*
Session Chair: **Fabrizio Paolacci**, *Roma Tre University, Roma, Italy*
Session Co-Chair: **Noel P. O'Dowd**, *University of Limerick, Limerick, Ireland*

8:15am
Effects of Flaw Shape (Idealization) on the Interaction of Co-Planar Surface Flaws
Technical Paper Publication: PVP2018-84506

Kaveh Samadian, Stijn Hertelé *and* **Wim De Waele**, *Ghent University, Zwijnaarde, Belgium*

8:41am
Field Measurement and Numerical Study of the Vibration in the Pipeline of Centrifugal Compressor
Technical Paper Publication: PVP2018-84399

Jia Wu *and* **Shui Y. Zheng**, *Zhejiang University, Hangzhou, Zhejiang Province, China*

9:07am
Numerical Study of Orifice Cavitation-Induced Instability and Pipe Vibration
Technical Paper Publication: PVP2018-84204

Wenjie Bai, *Xi'an Jiaotong University, Eindhoven University of Technology, Xi'an, China*
Quan Duan, *Xi'an Jiaotong University, Xi'an, China*
Arris Tijsseling, *TU Eindhoven, Eindhoven, Netherlands*

9:33am
The Effect of a Low Constraint Geometry on Measured T0 Values for a Nuclear Reactor Pressure Vessel Ferritic Steel
Technical Paper Publication: PVP2018-84167

Geena Rait, Catrin Mair Davies *and* **Stephen Garwood**, *Imperial College London, London, UK*

Session 2.1M (MF-13-1)
Leak Before Break
Lobby, Sofia 8:15am - 10:00am

Session Developer/Chair: **John Sharples**, *AMEC Foster Wheeler, Warrington, Cheshire, UK*
Session Co-Developer: **David Rudland**, *US NRC, Frederick, MD, USA*
Session Developer/Co-Chair: **Peter J Gill**, *Amec Foster Wheeler, Warrington, UK*

8:15am
Probabilistic Leak Before Break
Technical Paper Publication: PVP2018-84056

Lorenzo Stefanini, *Nuclear Research & Consultancy Group - NRG, Petten, North Holland, Netherlands*
Frederic Blom, *NRG - The Netherlands, Petten, Netherlands*

8:41am
Leak Rate Computation: Flow Resistance vs. Thermal-hydraulic Aspects
Technical Paper Publication: PVP2018-84534

Klaus Heckmann, *GRS, Cologne, Germany*
Fabian Weyermann, *Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Garching bei München, Germany*
Jürgen Sievers, *Gesellschaft für Anlagen- und Reaktorsicherheit (GRS) gGmbH, Cologne, Germany*

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9:07am
A Study on the Effect of Non-Idealized Crack on a 90 Elbow by Using Finite Element Analysis
Technical Paper Publication: PVP2018-84758

Jae-Hee Kim, Min-Kyu Kim, Yerin Choi, *Sungkyunkwan University, Suwon, Korea (Republic)*
Doo Ho Cho, *Korea Institute of Nuclear Safety, Daejeon, Korea (Republic)*
Moon Ki Kim, *Sungkyunkwan University, Suwon, Korea (Republic)*
J B Choi, *Sungkyunkwan Univ, Kyungi-do 440-746, Korea (Republic)*

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9:33am
Simplified LbB Guidance - Stage 1: Development of a New Software Tool and Initial Scoping Calculations
Technical Paper Publication: PVP2018-84926

Peter J Gill *and* **John Sharples**, *Amec Foster Wheeler, Warrington, UK,*
Chris Aird, *EDF Energy, Gloucester, UK*

Session 2.1N (DA-2-1)
Design and Analysis of Piping and Components - I
Lower Lobby, Madrid 8:15am - 10:00am

Session Developer/Chair: **Chakrapani Basavaraju**, *US Nuclear Regulatory Commission, North Potomac, MD, USA*
Session Co-Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*

8:15am
Pneumatic Testing of Piping: Managing the Hazards for High Energy Tests
Technical Paper Publication: PVP2018-84078

Bader Arti, *Kuwait National Petroleum Co., Al-Ahmadi, Kuwait*
Robert Weyer, *Amesk, Craigie WA, Australia*
Thanh Dang, *Chevron Energy Technology Company, Houston, TX, USA*
Jaan Taagepera, *Chevron ETC, Richmond, CA, USA*

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8:41am
Failure Analysis of Ring Hoop Tension Test (RHTT) Specimen Under Different Loading Conditions
Technical Paper Publication: PVP2018-84198

Tarek El-Bagory, *Helwan University, Cairo, Egypt*
Maher Younan, *American University in Cairo, New Cairo 11835, Egypt*
Ibrahim Alarifi, *Mechanical and Industrial Engineering Department, Majmaah University, Majmaah, Saudi Arabia*

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9:07am
Study on Forming Mechanism of Bimetal-Pipe by External Hydraulic Contraction
Technical Paper Publication: PVP2018-84277

Quanzhao Sun, Guolai Yang, Jianli Ge *and* **Baochun Lu**, *Nanjing University of Science and Technology, Nanjing, China,*
Yanming Song, *Inner Mongolia North Heavy Industries Group Corp. Ltd, Baotou, China*

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9:33am
Leak Failure Cause Analysis of One Crude Oil Pipeline Lifting Segment
Technical Paper Publication: PVP2018-84483

Qiang Liu, Qiang Bai, Neng LV, Sheng-yin Song, *Tubular Goods Research Institute of CNPC, Xi'An, Shaanxi, China*

Session 2.1O (DA-15-1)
Coke Drums: Introduction & Life Cycle Management Strategies
Lower Lobby, Congress Hall I 8:15am - 10:00am

Session Developer/Chair: **Clay Rodery**,
C&S Technology, LLC, League City, TX, USA
Session Developer/Co-Chair: **Kannan Subramanian**,
Stress Engineering Services, Metairie, LA, USA

8:15am
API 934J - Inspection, Assessment and Repair of Coke Drums and Peripheral Components in Delayed Coking Units
Technical Presentation: PVP2018-84890

Jorge Penso, *Shell Oil, Cypress, TX, USA*

8:41am
Further Considerations for the Determination of Service Life for Delayed Coker Drums
Technical Paper Publication: PVP2018-84005

John Aumuller, *Engineering Design & Analysis Ltd., Edmonton, AB, Canada*
Toshiya Yamamoto, *Japan Bridge Engineering Center, Yokohama, Kanagawa, Japan*
Zengtao Chen, *University of Alberta, Edmonton, AB, Canada*

9:07am
Coke Drum Skirts: Common Ailments - the Good, the Bad and the Ugly
Technical Presentation: PVP2018-84718

Julian Bedoya *and* **John Huang**, *Stress Engineering Services, Houston, TX, USA*

9:33am
A Non-Bolted Restraint for Coke Drums
Technical Paper Publication: PVP2018-84734

Mahmod Samman, *Houston Engineering Solutions, LLC, Houston, TX, USA*
Alwyn Kaye, *Canadian Natural Resources Limited, Edmonton, AB, Canada*

Technical Tutorial 2.1Q (TW-2-3)
Fracture Mechanics Applications to Piping Part 1
Lower Lobby, Congress Hall III 8:15am - 10:00am

Session Developer/Chair: **Maher Younan**,
American University in Cairo, New Cairo 11835, Egypt
Presented by: **Gery Wilkowski** and **Frederick (Bud) Brust**,
Engineering Mechanics Corporation of Columbus, Columbus, OH, USA

Block 2.2 Tuesday, July 17 10:15AM - 12:00PM

Session 2.2A (CS-3-4)
Environmental Fatigue Issues - IV
Mezzanine, Karlin I 10:15am - 12:00pm

Session Developer/Chair: **Claude Faidy**,
CF Integrity Engineering, Tassin, France
Session Developer/Co-Chair: **Seiji Asada**,
Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan

10:15am
Negative R Fatigue Crack Growth Rate Testing on Austenitic Stainless Steel in Air and Simulated Primary Water Environments
Technical Paper Publication: PVP2018-84252

Norman Platts, *Amec Foster Wheeler, Warrington, UK*, **Ben Coult, Wenzhong Zhang** *and* **Peter J Gill**, *Wood Plc, Warrington, UK*

10:41am
ASME Section XI Appendix L Flaw Tolerance Evaluation of Pressurized Water Reactor Piping Systems to Support Second License Renewal (80-years Operation)
Technical Paper Publication: PVP2018-84346

Anees Udyawar, Stephen Marlette *and* **Warren Bamford**, *Westinghouse Electric Company, Cranberry Township, PA, USA*,
Charles Thomes, *Dominion Generation, Glen Allen, VA, USA*,
Alexandria Carolan *and* **Thomas Meikle**, *Westinghouse, Pittsburgh, PA, USA*,

11:07am
Study on the Influence of Strain Rate on Fatigue Crack Initiation and Growth in Simulated Reactor Coolant Environmental of Type 316 Stainless Steel
Technical Paper Publication: PVP2018-84490

Takahisa Nose, Takanori Kitada, *Osaka University, Osaka, Japan*,
Takao Nakamura, *Graduate School of Engineering, Osaka University, Osaka, Japan*,

11:33am
Further Validation of the Strain-Life Weighted (SNW) Fen Method for Plant Realistic Strain and Temperature Waveforms
Technical Paper Publication: PVP2018-84879

Chris Currie, Andrew Morley, Daniel Leary, Marius Twite, Keith Wright, *Rolls-Royce Plc, Derby, UK*,
Norman Platts, *Amec Foster Wheeler, Warrington, UK*,

Session 2.2B (DA-12-1)
Fracture - I
Mezzanine, Karlin II 10:15am - 12:00pm

Session Developer/Chair: **Shunji Kataoka**,
JGC Corporation, Yokohama, Kanagwa, Japan
Session Co-Chair: **TJ Prewitt**,
DNV GL, Dublin, OH, USA

10:15am
Application of the T-Scaling Method to Predict Fracture Toughness Under Compressive Residual Stress in the Transition Temperature Region
Technical Paper Publication: PVP2018-84151

Toshiyuki Meshii, *University of Fukui, Fukui 910-8507, Japan*,
Kenichi Ishihara, *Kobelco Research Institute, Inc., Kobe, Hyogo, Japan*

10:41am
Improvement of J Estimation Schemes Based on Reference Stress for Linear Hardening Behavior
Technical Paper Publication: PVP2018-84410

Philippe Gilles, *GEP-INT, Paris, France*

11:07am
A review of Stress Intensity Factors at Pipe Tees and Branches
Technical Presentation: PVP2018-84900

Willem Vorster, *EDF Energy, Gloucester, Gloucestershire, UK*,
Alex Mann, *EDF Energy, Bury, Lancashire, UK*

11:33am
FEM Calculations of SIF and COA for Through Axial Cracks in Pipes in Geometrically Nonlinear Formulation
Technical Paper Publication: PVP2018-85033

Andrii Oryniak, *Solid Master LLC, Kiev, Ukraine*,
Igor Orynyak, *G.S. Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*

Session 2.2C (MF-6-2)
Materials and Technologies for Nuclear Power Plants - II
Mezzanine, Karlin III 10:15am - 12:00pm

Session Developer/Chair: **Weiju Ren**,
Oak Ridge National Laboratory, Oak Ridge, TN, USA
Session Co-Chair: **Randy K Nanstad**,
R&S Consultants LLC, Oak Ridge, TN, USA

10:15am
Review of Useful Correlations for Prediction of Irradiation Effects on Reactor Pressure Vessel Steels
Technical Paper Publication: PVP2018-84786

Randy K Nanstad, *R&S Consultants LLC, Oak Ridge, TN, USA*
William L. Server, *ATI-Consulting, Black Mountain, NC, USA*
G Robert Odette, Nathan Almirall, *University of California, Santa Barbara, CA, USA*
Mikhail A. Sokolov, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*

10:41am
Measurements of Stress During Thermal Shock in Clad Reactor Pressure Vessel Material Using Time-Resolved In-Situ Synchrotron X-Ray Diffraction
Technical Paper Publication: PVP2018-84676

Sam Oliver, Mahmoud Mostafavi, Chris Simpson, Andrew James, Martyn Pavier *University of Bristol, Bristol, UK*
Christina Reinhard, *Diamond Light Source, Didcot, Oxfordshire, UK*
David M Collins, *University of Birmingham, Birmingham, UK*

11:07am
Evaluation of Stress Corrosion Crack Growth in Low Alloy Steel Vessel Materials in the BWR Environment
Technical Paper Publication: PVP2018-84257

Sampath Ranganath, *XGEN Engineering, San Jose, CA, USA*
Robert G. Carter, *EPRI, Charlotte, NC, USA*
Rajeshwar Pathania, *EPRI, Palo Alto, CA, USA*
Stefan Ritter, Hans-Peter Seifert, *Paul Scherrer Institut (PSI), Villigen, Switzerland*

11:33am
Formulation of the Stress Corrosion Crack Growth Rates for the Practical Use in the Integrity Assessment of Nuclear Reactor Components
Technical Paper Publication: PVP2018-84213

Masato Koshiishi, Satoru Aoike, *Hitachi-GE Nuclear Energy, Ltd., Hitachi-shi, Ibaraki-ken, Japan*
Tsuneyuki Hashimoto, *Hitachi, Ltd., Hitachi-shi, Ibaraki-ken, Japan*
Yuya Hideki, *Chubu Electric Power, Ltd., Omaezaki-shi, Shizuoka-ken, Japan*

Session 2.2D (CS-11-5)
Extreme Pressure Equipment - II
Mezzanine, Palmovka 10:15am - 12:00pm

Session Developer/Chair: **Jinyang Zheng**, *Zhejiang University, Hangzhou, China*
Session Developer/Co-Chair: **Jianfeng Shi**, *Zhejiang University, Hangzhou, Zhejiang, China*

10:15am
Investigation on Standards on Hydrogen Cycle of Composite Tanks for Storage of High Pressure Hydrogen
Technical Paper Publication: PVP2018-84694

Yan-Nan Du, Zhenbang Wang, Yiwen Yuan, Xiaoying Tang, Xiaolong Xue *and* **Cheng Jun Jiang** *Shanghai Institute of Special Equipment Inspection and Technical Research (SSEI), Shanghai, Chin*,

10:50am
Comparison of Wall-temperatures of Two Types of Large Capacity Cylinders for Tube Trailers during CNG Loading Processes
Technical Paper Publication: PVP2018-84743

Guide Deng, *China Special Equipment Inspection and Research Institution, Beijing, China*
Yanhui Chen, *Taiyuan University of Technology, Taiyuan, Shanxi, China*
Guodong Jia, *Special Equipment Safety Supervision Bureau of AQSIQ, Beijing, Beijing, China*
Zhaojiang Gao *and* **Ke Bo**, *China Special Equipment Inspection and Research Institute, Beijing, China*

11:25am
Comparisons of Testing Methods for High-Pressure Hydrogen Storage Container Under the Law and Regulation System of UN and EU
Technical Paper Publication: PVP2018-84808

Bo Yang, JianPing Yao, Yiwen Yuan, Jielu Wang, Yaozhou Qian *and* **Xiaoying Tang**, *Shanghai Institute of Special Equipment Inspection and Technical Research (SSEI), Shanghai, China*

Session 2.2E (FSI-6-1)
Impact and Blast Loadings
Mezzanine, Rokoska 10:15am - 12:00pm

Session Developer/Chair: **David Gross**, *Dominion Engineering, Reston, VA, USA*
Session Developer/Co-Chair: **Matthew Edel**, *BakerRisk, San Antonio, TX, USA*
Session Co-Developer: **Chris Tipple**, *Structural Integrity Associates, Centennial, CO, USA*

10:15am
Drag Loads from Vapor Cloud Explosions
Technical Paper Publication: PVP2018-84307

Jihui Geng, William Lowry, *Baker Engineering and Risk Consultants, San Antonio, TX, USA*
Kelly Thomas, *BakerRisk, San Antonio, TX, USA*

10:40am
Failure Analysis of Vessel Cover Under Internal Pressure Impulse
Technical Paper Publication: PVP2018-84042

Sha Yang, Qi Dong, Liucheng Zhang, *Institute of Chemical Materials, China Academy of Engineering Physics, Mianyang, China*

11:05am
Dynamic Assessment of the Core Barrel During Loss of Coolant Accident
Technical Paper Publication: PVP2018-84762

Yaroslav Dubyk, Vladislav Filonov, Oleksii Ishchenko, Yuliia Filonova, *IPP-Centre, Kiev, Ukraine*
Igor Orynyak, *G.S. Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*

11:30am
Investigation on the Loading Characteristics in Proof Units
Technical Paper Publication: PVP2018-84043

Liucheng Zhang, Qi Dong, Sha Yang, *Institute of Chemical Materials, China Academy of Engineering Physics, Mianyang, China*

Session 2.2F (SE-12-1)
Advanced Seismic Evaluation and Code - I
Mezzanine, Hercovka 10:15am - 12:00pm

Session Developer: **Akira Maekawa**, *The Kansai Electric Power Co., Inc., Fukui, Japan*
Session Co-Developer: **Izumi Nakamura**, *National Research Institute of Earth Sciences/Disaster Prevention, Miki-shi, Hyogo 673-0515, Japan*
Session Chair: **Tomoyo Taniguchi**, *Tottori University, Tottori, Japan*
Session Co-Chair: **Akemi Nishida**, *Japan Atomic Energy Agency, Chiba, Japan*
Session Co-Developer: **Yinsheng Li,** *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*

10:15am
Application of JSME Seismic Code Case by Elastic-Plastic Response Analysis to Practical Piping System
Technical Paper Publication: PVP2018-84079

Akihito Otani, *IHI Corporation, Yokahoma, Japan*
Satoru Kai, Naoaki Kaneko, *IHI Corporation, Yokohama, Japan*
Tomoyoshi Watakabe, *Japan Atomic Energy Agency, Ibaraki, Japan*
Masanori Ando, *Japan Atomic Energy Agency, Shiraki 1, Japan*
Kazuyuki Tsukimori, *University of Fukui, Tsuruga, Japan*

10:41am
Simplified Seismic Response Analysis Method Using Reduced Model of Piping System
Technical Paper Publication: PVP2018-84428

Michiya Sakai, *CRIEPI, Abiko, Chiba, Japan*
Ryuya Shimazu, Shinichi Matsuura, *CRIEPI, Abiko-Shi, Chiba-ken, Japan*
Ichiro Tamura, *The Chugoku Electric Power Company, Hiroshima, Japan*

11:07am
Appropriate Damping on Seismic Design Analysis for Inelastic Response Assessment of Piping
Technical Paper Publication: PVP2018-84470

Tomoyoshi Watakabe, Masaki Morishita, *Japan Atomic Energy Agency, Ibaraki, Japan*

11:33am
Investigation on Method of Elasto-Plastic Analysis for Piping System Excited by Multi-Direction Input
Technical Paper Publication: PVP2018-84468

Nobuyuki Kojima, Takuro Kabaya, Masashi Arai, Satoru Hirouchi, Masatsugu Bando, *MHI Nuclear Systems and Solution Engineering Co., Ltd., Kobe, Japan*

Session 2.2G (CT-6-1)
Special Applications of Bolted Joints
Mezzanine, Tyrolka 10:15am - 12:00pm

Session Developer/Chair: **A. Fitzgerald Waterland, III**, *VSP Technologies, Prince George, VA, USA*
Session Co-Chair: **Jose Veiga**, *Teadit Industria e Comercio Ltda, Rio De Janeiro/RJ, Brazil*

10:15am
Stress Multiplier for Segmented Gaskets
Technical Paper Publication: PVP2018-84029

A. Fitzgerald Waterland, III, Jeffery Wilson, *VSP Technologies, Prince George, VA, USA*

10:41am
Use of UNS N07718 Bolting in ASME Pressure Vessel Applications in Wet Sour Service
Technical Paper Publication: PVP2018-84315

Cathleen Shargay, *Fluor Enterprises Inc, Aliso Viejo, CA, USA*
Leslie Antalffy, Kuntak Daru, *Fluor, Sugar Land, TX, USA*
Ramakrishnan Tiru, Anilkumar Panchal, *Reliance Industries Limited, Mumbai, India*

11:07am
Gasket Characteristics of RTJ Gaskets
Technical Presentation: PVP2018-85103

Manfred Schaaf, Frank Herkert, *AMTEC Advanced Measurement Messtechnischer Service GmbH, Lauffen am Neckar, Germany*

11:33am
Study Of Bolted Joint Connections Under Bending Moment And/Or Axial Loads With A New Methodology
Technical Presentation: PVP2018-84049

Ibai Coria, Iñigo Martin, Iker Heras, Mikel Abasolo, *University of the Basque Country (UPV/EHU), Bilbao, Vizcaya, Spain*,
Abdel-Hakim Bouzid, *Ecole Technologie Superieure, Montreal, QC, Canada*,

Session 2.2H (CS-37-1)
Improvement of Flaw Characterization Rules in Fitness-for-Service Codes - I
Lobby, Amsterdam 10:15am - 12:00pm

Session Developer/Chair: **Valery Lacroix**, *Tractebel Engineering, Brussels, Belgium*
Session Developer/Co-Chair: **Kunio Hasegawa**, *Japan Atomic Energy Agency (JAEA), Ibaraki-ken, Japan*

10:15am
Plastic Collapse Stresses for Pipes With Circumferential Twin Flaws Using Combination Rules
Technical Paper Publication: PVP2018-84019

Kunio Hasegawa and Yinsheng Li, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*
Valery Lacroix, *Tractebel Engineering, Brussels, Belgium*
Yun-Jae Kim, *Korea Univ, Seoul 136-701, Korea (Republic)*
Bohumir Strnadel, *Technical University of Ostrava, Ostrava-Poruba, Czech Republic*

10:41am
Rules for Flaw Interaction for Subsurface Flaws in Operating Pressurized Vessels: Technical Basis of Code Case N-877
Technical Paper Publication: PVP2018-84120

Valery Lacroix, Pierre Dulieu, *Tractebel Engineering, Brussels, Belgium*
Warren Bamford, Anees Udyawar, *Westinghouse Electric Co., Cranberry Township, PA, USA*
Kunio Hasegawa, *Japan Atomic Energy Agency (JAEA), Ibaraki-ken, Japan*
Sebastien Blasset, *New NP GmbH, Erlangen, Germany*
Ralf Tiete, *Areva, Erlangen, Germany*
Yinsheng Li, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*

11:07am
Proposal of New Combination Criterion for Pipe with Circumferential Multiple Cracks Based on Ductile Failure Simulation
Technical Paper Publication: PVP2018-84822

Myeong Woo Lee, Yun-Jae Kim, *Korea University, Seoul, Korea (Republic)*,
Kunio Hasegawa, *VSB-Technical University of Ostrava, Ostrava-Poruba, Czech Republic*,

11:33am
RSE-M / ASME XI / API 579 Comparison of Failure Assessment Diagrams (FAD)
Technical Paper Publication: PVP2018-84703

Claude Faidy, *CF Integrity Engineering, TASSIN, France*

Session 2.2I (MF-16-1)
Probabilistic Assessment of Failure
Lobby, Athens 10:15am - 12:00pm

Session Developer/Co-Chair: **Steven Xu**, *Kinectrics, Toronto, ON, Canada*
Session Co-Developer: **David Rudland**, *US NRC, Frederick, MD, USA*
Session Chair: **Blair Carroll**, *Canadian Nuclear Safety Commission, Ottawa, ON, Canada*

10:15am
Reversing the Chell Model to Predict Using Monte Carlo Simulations the Original Fracture Toughness of Ferritic Steels
Technical Paper Publication: PVP2018-84287

Derreck Van Gelderen, *Atkins Global, Bristol, Bristol, UK*
Julian D. Booker, *Univerdity of Bristol, Bristol, Bristol, UK*

10:41am
Numerical Study on the Creep Strain Characteristics for TMSR Reactor Coolant Piping under Thermal Loading
Technical Paper Publication: PVP2018-84333

Wei Gong, Mingqiang Xie, Yuan Fu, *Shanghai Shanghai Institute of Applied Physics, Shanghai, China*
Xiaochun Zhang, Xiao *Wang Shanghai Institute of Applied Physics, Chinese Academy of Sciences, Shanghai, China*,

11:07am
Evaluation of Risk from Carbon Macrosegregation in Large Pressure Retaining Forged Nuclear Components
Technical Paper Publication: PVP2018-84620

Ronald Gamble, *Sartrex Corporation, Mount Dora, FL, USA*
Timothy Hardin, *Electric Power Research Institute, Palo Alto, CA, USA*

11:33am
Investigation of the Fatigue Behavior of Austenitic Stainless Steels and their Welds for Reactor Internals under Combined LCF, HCF and VHCF Operational Loading Conditions
Technical Paper Publication: PVP2018-85028

Juergen Rudolph, *Framatome GMBH, Erlangen, Bavaria, Germany*
Xaver Schuler, *Materials Testing Institute (MPA) University of Stuttgart, Stuttgart, Baden-Württemberg, Germany*
Tim Schopf, *Materialprüfungsanstalt Universität Stuttgart, Stuttgart, Gibraltar*
Tilmann Beck, Marek Smaga, Tobias Daniel, *Institute of Materials Science and Engineering/TU Kaiserslautern, Kaiserslautern, Germany*
Birgit Buchholz, *NEW NP GMBH, Erlangen, Germany*

Session 2.2J (NDPD-1-2)
Emerging NDE Techniques and Applications - II
Lobby, Barcelona 10:15am - 12:00pm

Session Developer/Chair: **Anne Jüngert**, *MPA University of Stuttgart, Stuttgart, Germany*
Session Co-Chair: **Sandra Dugan**, *Swiss Federal Nuclear Safety Inspectorate ENSI, Brugg, AG, Switzerland*

10:15am
Advanced Signal Processing Techniques for Guided Wave Corrosion Monitoring System in Secondary Circuits of Nuclear Power Plants
Technical Paper Publication: PVP2018-84024

Andrei Gribok, Vivek Agarwal, *Idaho National Laboratory, Idaho Falls, ID, USA*

10:40am
Automatic Identification of Internal Defects in Tanks by Ultrasonic Waveform
Technical Paper Publication: PVP2018-85121

Qingchun Ma, Konghui Lin, Jinqiu Hu, Wenpei Zheng, *China University of Petroleum-Beijing, Beijing, China*

11:05am
Development of Degradation Management System for Bottom Plate Coating of Oil Storage Tank Using New Parameters
Technical Paper Publication: PVP2018-85000

Daisuke Ito, Shinji Okazaki, *Yohohama National University, Kanagawa, Japan*
Kouichi Sekino, *Kanagawa Institute of Industrial Science and Technology, Kanagawa, Japan*
Kazuyoshi Sekine, *High Pressure Institute of Japan, Tokyo, Japan*
Masaru Ishihara, *Japan Oil, Gas and Metals National Corporation, Tokyo, Japan*

Session 2.2K (OAC-3-2)
Monitoring, Diagnostic & Inspection - II
Lobby, Berlin 10:15am - 12:00pm

Session Developer: **Milan Brumovsky**, *UJV Rez, Rez, Czech Republic*
Session Chair: **Radim Kopriva**, *UJV Rez, a. s., Husinec, Czech Republic*
Session Co-Chair: **Milos Kytka**, *UJV Rez, Rez, Czech Republic*

10:15am
Development of High Temperature Semiconductor Strain Gages for Thermal Power Plant Applications
Technical Paper Publication: PVP2018-84137

Christopher A. Suprock, Joseph J. Christian, *Suprock Technologies LLC, Warren, NH, USA*
Stan T. Rosinski, *Electric Power Research Institute, Charlotte, NC, USA*

10:36am
Research on Flow Forecasting Technology of Underwater Production System Based on Multi-Sensor Data Fusion
Technical Presentation: PVP2018-84364

Qi Kang, Wei Wang, Haihao Wu, Jing Gong, *China University of Petroleum, Beijing, Beijing, China*

10:57am
A Study on the Magnetic Distribution of Nd-Fe-B Permanent Magnets in Pipeline In Line Inspection Tool
Technical Paper Publication: PVP2018-84529

Pan Song, Xiaoying Tang, Shaojun Wang, Bin Ren, Yantian Zuo, Jielu Wang, *Shanghai Insititute of Special Equipment Inspection and Technical Research, Shanghai, China*

11:18am
Use of PVDF Wires as Sensors for Non-Intrusive Pressure Measurement
Technical Paper Publication: PVP2018-84651

Richard Journaix, Loïc Ancian, Remi Salanon, *Vibratec, Ecully, France*

11:39am
Detection Of Creep Degradation On Collapsed Membrane Wall From P265GH Pressure Purpose Steel By Ultrasonic Testing
Technical Paper Publication: PVP2018-85159

Tomas Zavadil, *ATG (Advanced Technology Group), s.r.o., Prague 9, Czech Republic*

Session 2.2L (SPC-2-1)
Student Paper Symposium - PhD - I
Lobby, Brussels 10:15am - 12:00pm

Session Developer: **Yasumasa Shoji**, *YS Corporation LLC, Tokyo, Japan*
Session Co-Chair: **Fabrizio Paolacci**, *Roma Tre University, Roma, Italy*
Session Chair: **Russell Cipolla**, *Intertek AIM, Santa Clara, CA, USA*

10:15am
The Spherical Indentation Approach for Fracture Toughness Evaluation: A Study Based on the Energy Release Rate
Technical Paper Publication: PVP2018-84435

Tairui Zhang, Weiqiang Wang, Aiju Li, *Shandong University, Jinan, China*

10:41am
A Multidimensional and Multiscale Model for Pressure Analysis in a Reservoir-Pipe-Valve System
Technical Paper Publication: PVP2018-84591

Fengjie Zheng, Fuzheng Qu, Xueguan Song, *Dalian University of Technolygy, Dalian, China*

11:07am
Finite-Element Analysis of Crack Growth in Austenitic Stainless Steel Under Equibiaxial Loading
Technical Paper Publication: PVP2018-84156

Hager Dhahri, *IMSIA, ENSTA ParisTech, CNRS, CEA, EDF, University of Paris-Saclay, Gif Sur Yvette, France*
Cdric Gourdin, *CEA, Gif Sur Yvette, France*
Habibou Maitournam, *IMSIA, UMR 9219, CNRS, CEA, EDF, University of Paris-Saclay, Palaiseau, France*

11:33am
A Modified Microstructure-Based Creep Damage Model for Considering Prior Low Cycle Fatigue Damage Effects
Technical Paper Publication: PVP2018-84148

Wei Zhang, Xiaowei Wang, Jianming Gong, *Nanjing Tech University, Nanjing, Jiangsu, China*

Session 2.2M (MF-20-1)
Advanced Manufacturing and Materials Technology
Lobby, Sofia 10:15am - 12:00pm

Session Developer/Chair: **Anthony Horn**, *Wood, Warrington, UK*
Session Developer/Co-Chair: **Andrew Duncan**, *Savannah River National Laboratory, Aiken, SC, USA*

10:15am
Consideration on Tempering and PWHT Temperatures of C-Mn and Low Alloy Steels Used for the Fabrication of Pressure Vessels: Smart Tuning of Heat Treatment Parameters
Technical Paper Publication: PVP2018-84004

Sylvain Pillot, *Arcelormittal Global R&D, Le Creusot, France*
Mikihiro Sakata, *JGC, Yokohama, Japan*
Lionel Coudreuse, *Industeel ArcelorMittal, Site de la Loire, Rive de Gier, France*
Valery Ngomo, *Industeel Arcelormittal, Rive De Gier, France*

10:41am
A Study of the Material Properties and Performance of Hot Isostatically Pressed (HIP) Type 316L Stainless Steel Powders and HIP Processing Available From Today's International Supply Chain
Technical Paper Publication: PVP2018-84072

William Kyffin, *Nuclear AMRC, Rotherham, South Yorkshire, UK*
David Gandy, *Electric Power Research Institute, Charlotte, NC, USA*
Barry Burdett, *W B Burdett Associates, Truro, Cornwall, UK*

11:07am
The Effect of Specimen Thickness on Low Temperature Gaseous Carburization of 316L Austenitic Stainless Steel
Technical Paper Publication: PVP2018-84258

Yong Jiang, Pengpeng Zhang, Jianming Gong, *Nanjing TECH University, Nanjing, Jiangsu, China*

11:33am
Investigation of the Performance of Different Face-milling Inserts to Improve Rough Milling of SA508 Grade 3 Forgings
Technical Paper Publication: PVP2018-84337

Ozan Gurdal, Andrew Wright, Charles Carpenter, *Nuclear Advanced Manufacturing Research Centre, University of Sheffield, Sheffield, UK*
Michael Blackmore, *Sheffield Forgemasters International Limited, Sheffield, UK*

Session 2.2N (DA-2-2)
Design and Analysis of Piping and Components - II
Lower Lobby, Madrid 10:15am - 12:00pm

Session Developer/Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*
Session Co-Chair: **Bing Li**, *Kinectrics NSS, Kincardine, ON, Canada*

10:15am
Application of Finite Element in Accurate Calculations of Stresses in Expansion Joints
Technical Paper Publication: PVP2018-84320

Sudip Ganguly, *Bentley Systems, Inc., Anaheim, CA, USA*

10:41am
Modelling of Fatigue Due to Thermal Mixing by Using a Spectrum Method
Technical Paper Publication: PVP2018-84398

Antti Timperi, *VTT Technical Research Centre of Finland, Espoo, Finland*

11:07am
Establishing Fracture Mechanics Based Minimum Allowable Temperatures for Low Temperature Applications of ASME B31.3 Piping
Technical Paper Publication: PVP2018-84797

Seetha Ramudu Kummari, *The Equity Engineering Group, Inc., Copley, OH, USA*
Brian Macejko, Phillip E. Prueter, *The Equity Engineering Group, Inc., Shaker Heights, OH, USA*
Kraig Shipley, *The Equity Engineering Group Inc, Twinsburg, OH, USA*
Geoff Evans, *BP Exploration, Middlesex, UK*
Nijat Jamal, *BP Exploration Caspian Sea Limited, Baku, Azerbaijan*

11:33am
Efficient Solution for Cylindrical Shell Based on Short and Long (Enhanced Vlasov's) Solutions on Example of Concentrated Radial Force
Technical Paper Publication: PVP2018-85032

Igor Orynyak, *G.S. Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*,
Andrii Oryniak, *Solid Master LLC, Kiev, Ukraine*

Session 2.2O (DA-15-2)
Coke Drums: Bulges & Hot Spots - Operational Influences on Coke Drum Life Cycle & Analysis Methods
Lower Lobby, Congress Hall I 10:15am - 12:00pm

Session Developer: **Clay Rodery**, *C&S Technology, LLC, League City, TX, USA*
Session Chair: **Julian Bedoya**, *Stress Engineer Serv, Houston, TX, USA*
Session Co-Chair: **Tej Chadda**, *Amec Foster Wheeler, Houston, TX, USA*

10:15am
Performance of Bulges after Weld-Overlay Repairs
Technical Presentation: PVP2018-84736

Mahmod Samman, *Houston Engineering Solutions, LLC, Houston, TX, USA*
Gaurav Ajmera, *Reliance Industries Limited, Motikhavdi, Jamnagar, India*

10:41am
Correlating Coke Drum Profiles with Observed Surface Damage
Technical Paper Publication: PVP2018-84766

Egler Araque, Daryl Rutt, Darren Love, Stephen Park, Rick Clark, Jason Dawson, *CIA Inspection, Hannon, ON, Canada*

11:07am
Skirt, Bulges and Cone Challenging Weld Repairs
Technical Presentation: PVP2018-84893

Jorge Penso, *Shell Oil, Cypress, TX, USA*,
Jason Kaufman, *Shell Martinez Refinery, Martinez, CA, USA*

11:33am
Analysis of the Influence of the Cooling Patterns and the Shape of the Bulges on the Levels of Stress in the Cylindrical Section of Delayed Coke Drums
Technical Paper Publication: PVP2018-85009

Gabriel A. Vivas, Armando J. Moret, Roberto E. Bello, *PDVSA Intevep, Los Teques, Miranda, Venezuela*
Luis M. Melian, *PDVSA Petrocedeno, Jose, Anzoátegui, Venezuela*
Julian Bedoya, *Stress Engineer Serv, Houston, TX, USA*

Technical Tutorial 2.2Q (TW-2-4)
Fracture Mechanics Applications to Piping Part 2
Lower Lobby, Congress Hall III 10:15am - 12:00pm

Session Developer/Chair: **Maher Younan**,
American University in Cairo, New Cairo 11835, Egypt
Presented by: **Gery Wilkowski** and **Frederick (Bud) Brust,**
Engineering Mechanics Corporation of Columbus, Columbus, OH, USA

Block 2.3 Tuesday, July 17 2:15PM - 4:00PM

Session 2.3A (CS-3-5)
Environmental Fatigue Issues - V
Mezzanine, Karlin I 2:15pm - 4:00pm

Session Developer/Chair: **Seiji Asada**,
Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan
Session Co-Chair: **Thomas Metais**,
EDF China, Beijing, China

2:15pm
An Overview of EDF Full Components Testing: Experience And Feedback
Technical Presentation: PVP2018-84683

Gaëlle Leopold, *EDF R&D - Département Matériaux et Mécanique des Composants, Moret sur Loing, France*
Sam Cuvilliez, *EDF - DIPNN - Direction Technique, Lyon, France*
Thomas Metais, *EDF China, Beijing, China*

2:41pm
Nuclear Fatigue Codified Design Rules Development Status, Margins and Screening Criteria
Technical Paper Publication: PVP2018-84698

Claude Faidy, *CF Integrity Engineering, Tassin, France*

3:07pm
Environmental Assisted Fatigue and EDF 900 MWE PWRS Fleet: Towards an Exemption of Environmental Effects Consideration for Secondary Circuit Components
Technical Paper Publication: PVP2018-84301

Sam Cuvilliez, *EDF - DIPNN - Direction Technique, Lyon, France*
Gaëlle Leopold, *EDF R&D - Département Matériaux et Mécanique des Composants, Moret sur Loing, France*
Thomas Metais, *EDF China, Beijing, China*

3:33pm
Creep-Fatigue Damage Evaluation of Grade 91 Steel Using Interrupt Creep Fatigue Test
Technical Paper Publication: PVP2018-84561

Uijeong Ro, Jeong Hwan Kim, Hoomin Lee, Seok Jun Kang, Moon Ki Kim, *Sungkyunkwan University, Suwon, Korea (Republic)*

Session 2.3B (DA-12-2)
Fracture - II
Mezzanine, Karlin II 2:15pm - 4:00pm

Session Developer/Co-Chair: **Shane Finneran**,
DNV GL, Dublin, OH, USA
Session Chair: **Philippe Gilles**,
GEP-INT, Paris, France

2:15pm
Brittle Fracture Prediction Using Code_Aster: Review of Available Models and Focus on the GP Energy Approach
Technical Paper Publication: PVP2018-84096

Samuel Jules, Samuel Geniaut, Eric Lorentz, *EDF, Palaiseau, France*
Thomas Metais, *EDF China, Beijing, China*,

2:41pm
Experimental Results and Numerical Analyses of Tests Conducted on Large Alloy 600 Centre Cracked Tensile Specimens
Technical Paper Publication: PVP2018-84280

Patrick Le Delliou, *EDF, Moret Sur Loing Cedex, France*
Anna Dahl, *EDF, Moret-sur-Loing, France*
Christophe Sonnefraud, Willy Vincent, *EDF R&D, Moret-sur-Loing, France*

3:07pm
Dynamic Analysis and Evaluation of Control Rod Device Mechanism Missile Impact on Shielding Plate
Technical Paper Publication: PVP2018-84351

Xianhui Ye, Fu-Rui Xiong, Bin Zheng, Naibin Jiang, *Nuclear Power Institute of China, Chengdu, China*

3:33pm
Benchmark of Finite Elements and Extended-Finite Elements Methods for Stress Intensity Factors and Crack Propagation
Technical Paper Publication: PVP2018-84401

Remi Lacroix, *Esi-France, Lyon CEDEX 06, France*
Axelle Caron, Sandrine Dischert, *ESI Group, Lyon, France*
Hubert Deschanels, *Moïse Pignol, AREVA NP, Lyon, France*

Session 2.3C (MF-6-3)
Materials and Technologies for Nuclear Power Plants - III
Mezzanine, Karlin III 2:15pm - 4:00pm

Session Developer/Chair: **Weiju Ren**,
Oak Ridge National Laboratory, Oak Ridge, TN, USA
Session Co-Chair: **Randy K Nanstad**,
R&S Consultants LLC, Oak Ridge, TN, USA

2:15pm
Assessment of Creep Crack Growth Rates for Grade 91 Weld Joint at 550°C
Technical Paper Publication: PVP2018-84604

Woo Gon Kim, Hyeong-Yeon Lee, Eung Seon Kim, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic)*
Jae-Young Park, *KAERI, Daejeon, Korea (Republic)*
Seon Jin Kim, *Pukyong National University, Busan, Korea (Republic)*

2:41pm
Evaluation of Stress Rupture Factors for Grade 91 Weldments
Technical Paper Publication: PVP2018-84572

Kazuhiro Kimura, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*

3:07pm
Effects of Thermal Ageing on Microstructure and Hardness of Ni Cladding on Austenitic Stainless Steel by GTAW
Technical Paper Publication: PVP2018-84125

Kun Yu, Xianwu Shi, Zhijun Li, Chaowen Li, Shuangjian Chen, Xingtai Zhou, *Shanghai Institute of Applied Physics, Chinese Academy of Sciences, Shanghai, China*

3:33pm
Effect of Simulated Post-Weld Heat Treatment on The Mechanical Properties and Microstructure of P-No. 1 Carbon Steels
Technical Paper Publication: PVP2018-84605

Yongjoon Kang, Seung-Gun Lee, Gidong Kim, Sanghoon Lee, Sangwoo Song, *Korea Institute of Materials and Science, Changwon, Korea (Republic)*,
Sung-sik Kang, *Korea Institute of Nuclear Safety, Daejeon, Korea (Republic)*

Session 2.3D (CS-11-6)
Developments of Chinese Codes and Standards - II
Mezzanine, Palmovka 2:15pm - 4:00pm

Session Developer/Chair: **Guodong Jia**,
AQSIQ, Beijing, China
Session Developer/Co-Chair: **Guide Deng**,
China Special Equipment Inspection and Research Institution, Beijing, China

2:15pm
A Study on Damping Ratio in the Design Code of Vertical Vessels Supported by Skirt
Technical Paper Publication: PVP2018-84455

Wei Tan, Xiantao Fan, Yian Du, Zhanbin Jia, Liyan Liu, *Tianjin University, Tianjin, China*

2:41pm
Study on the Response Behavior of Large Steel Seamless Cylinder Pressure Relief Devices Under Different Fire Conditions
Technical Paper Publication: PVP2018-84457

Ke Bo, Baodi Zhao, Guide Deng, Fang Ji, *China Special Equipment Inspection and Research Institute, Beijing, China*,
Chunhui Ding, *Shenyang Special Equipment Inspection and Research Institute, Shenyang, China*,

3:07pm
Investigation on Fluid Induced Vibration of Heat Exchanger Beyond Pitch Ratio Range in Tema Standards and GB/T 151
Technical Paper Publication: PVP2018-84460

Wei Tan, Kai Guo, Zhanbin Jia, Yang Wang, Liyan Liu, *Tianjin University, Tianjin, China*

3:33pm
The Research on Automatic Defect Recongnition for Phased Array Ultrasonic Inspection of Polyolefin Butt Thermal-Fusion Joint
Technical Paper Publication: PVP2018-84497

Haijian Zhong, Weican Guo, Cunjian Miao, *Zhejiang Provincial Special Equipment Inspection and Research Institute, Hangzhou, China*
Jianfeng Shi, Dongsheng Hou, *Zhejiang University, Hangzhou, Zhejiang, China*

Session 2.3E (FSI-2-1)
Tube Arrays in Cross-Flow
Mezzanine, Rokoska 2:15pm - 4:00pm

Session Developer/Chair: **Njuki Mureithi**, *Polytechnique Montreal, Montreal, QC, Canada*
Session Co-Chair: **Masato Nishiguchi**, *Chiyoda Corporation, Yokohama-shi, Kanagawa-ken, Japan*

2:15pm
Fluid Structure Interaction Homogenization for Tube Bundles: Significant Dissipative Effects
Technical Paper Publication: PVP2018-84344

Gianluca Artini, Daniel Broc, *CEA Saclay, Gif-sur-Yvette, France*

2:41pm
Study on Flow Induced Vibration Analysis and Evaluation for Heat Transfer Tube of Steam Generator
Technical Paper Publication: PVP2018-84587

Xuan Huang, Huanhuan Qi, Fengchun Cai, Zhipeng Feng, Shuai Liu, *Nuclear Power Institute of China, Chengdu, China*

3:07pm
The Fluid Elastic Instability of Concentric Arrays of Tube Bundles Subjected on Cross Flow
Technical Paper Publication: PVP2018-84352

Liyan Liu, Wei Xu, Kai Guo, Zhanbin Jia, Yang Wang, Wei Tan, *Tianjin University, Tianjin, China*

3:33pm
A Quasi-steady In-Plane Fluidelastic Instability Analysis of a Rotated Triangular Tube Array in Two-Phase Cross Flow
Technical Paper Publication: PVP2018-85143

Stephen Olala, Njuki Mureithi, *Ecole Polytechnique Montreal, Montreal, QC, Canada*,

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Session 2.3F (SE-12-2)
Advanced Seismic Evaluation and Code - II
Mezzanine, Hercovka 2:15pm - 4:00pm

Session Developer: **Akira Maekawa**, *The Kansai Electric Power Co., Inc., Fukui, Japan*
Session Co-Developer: **Yinsheng Li**, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*
Session Co-Chair: **Michiya Sakai**, *CRIEPI, Abiko, Chiba, Japan*
Session Co-Developer/Chair: **Izumi Nakamura**, *National Research Institute of Earth Science/Disaster Prevention, Miki-shi, Hyogo 673-0515, Japan*

2:15pm
Seismic Test Result of Motor-Operated Butterfly Valve Actuators for Nuclear Power Plant
Technical Paper Publication: PVP2018-84219

Nobuo Kojima, Yukio Watanabe, Kazuyoshi Yonekura, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japan*
Yoshitaka Tsutsumi, *CHUBU Electric Power Co.,Inc., Nagoya, Japan*
Koji Nishino, *Toshiba, Yokohama, Japan*
Shin Kumagai, *Hitachi-GE Nuclear Energy, Ltd., Hitachi-shi, Japan*
Hiroyuki Kamino, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*

2:50pm
Seismic Test Analysis Evaluation of Motor-Operated Valve Actuators for Nuclear Power Plant
Technical Paper Publication: PVP2018-84223

Nobuo Kojima, Yukio Watanabe, Kazuyoshi Yonekura, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japan*
Yoshitaka Tsutsumi, *CHUBU Electric Power Co., Inc., Nagoya, Japan*
Koji Nishino, *Toshiba, Yokohama, Japan*
Shin Kumagai, *Hitachi-GE Nuclear Energy, Ltd., Hitachi-shi, Japan*
Hiroyuki Kamino, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*

3:25pm
Study on Ultimate State of Filament Winding FRP Pipes Under Bending Force
Technical Paper Publication: PVP2018-84417

Yuzo Shiogama, *Central Research Institute of Electric Power Industry, Abiko, Chiba-ken, Japan*
Nobuaki Kumagai, *Tohoku Electric Power Co., Inc., Sendai, Miyagi, Japan*
Yutaka Ando, *Tokyo Electric Power Company Holdings, Inc., Minato-ku, Tokyo, Japan*
Toshiyuki Kuribayashi, *Chubu Electric Power Co., Inc., Nagoya, Aichi, Japan*

Session 2.3G (CT-8-1)
Threaded Fasteners - I
Mezzanine, Tyrolka 2:15pm - 4:00pm

Session Developer: **Sayed Nassar**, *Oakland University, Rochester, MI, USA*
Session Chair: **Toshiyuk Sawa**, *Hiroshima University, Tokyo, Japan*
Session Co-Chair: **Giovanni Belingardi**, *Politecnico di Torino, Torino, Italy*

2:15pm
FEM Contact Stress Analysis at the Bearing Surfaces in Bolted Joints Under External Loadings
Technical Paper Publication: PVP2018-84086

Atsushi Shirakawa, *Honda R&D Co.,LTD, Haga-gun Haga-machi, Tochigi, Japan*
Toshiyuk Sawa, *Hiroshima University, Tokyo, Japan*
Tomohiro Naruse, *Hitachi Ltd, Tuchiura, Ibaraki, Japan*

2:41pm
Bearing Friction Torque in Threaded Fasteners with Non-Flat Underhead Contact
Technical Paper Publication: PVP2018-84015

Sayed Nassar, Marco Gerini Romagnoli, *Oakland University, Rochester, MI, USA*
Joon-Ha Lee, *Hyundai Motor, Seoul, Korea (Republic)*

3:07pm
Fatigue Performance of Preloaded Ultra High Strength Threaded Fasteners
Technical Paper Publication: PVP2018-84254

Sayed Nassar, *Oakland University, Rochester, MI, USA*,
Tianwu Li, *Oakland University, Auburn Hills, MI, USA*

3:33pm
On the Design of Contact Member Surface Shape of Bolted Joints to Minimize Clamping Load Loss
Technical Paper Publication: PVP2018-84387

Linbo Zhu, Yifei Hou, Jun Hong, *Xi'an Jiaotong University, Xi'an, Shaanxi, China*,
Abdel-Hakim Bouzid, *Ecole Technologie Superieure, Montreal, QC, Canada*

Session 2.3H (CS-37-2)
Improvement of Flaw Characterization Rules in Fitness-for-Service Codes - II
Lobby, Amsterdam 2:15pm - 4:00pm

Session Developer/Chair: **Valery Lacroix**, *Tractebel Engineering, Brussels, Belgium*
Session Developer/Co-Chair: **Kunio Hasegawa**, *Japan Atomic Energy Agency (JAEA), Ibaraki-ken, Japan*

2:15pm
Numerical Study on Longitudinal Distance Effect on Failure Stress of Non-Aligned Twin Cracked Pipe
Technical Paper Publication: PVP2018-84838

Thanh-Long Nguyen, Myeong Woo Lee, *Korea University, Seoul, Korea (Republic)*
Kunio Hasegawa, *Japan Atomic Energy Agency (JAEA), Ibaraki-ken, Japan*
Yun-Jae Kim, *Korea Univ, Seoul 136-701, Korea (Republic)*

2:41pm
Defect Interaction During Brittle Fracture of a Plate Containing Multiple Defects
Technical Presentation: PVP2018-84886

Rachid Chaouadi, *SCK.CEN, MOL, Belgium*
Robert Gerard, *Valery Lacroix, Tractebel Engineering, Brussels, Belgium*

3:07pm
Plastic Collapse Failure Stresses for Pipes with Inner and Outer Circumferential Flaws
Technical Paper Publication: PVP2018-84951

Kunio Hasegawa, Yinsheng Li,*Japan Atomic Energy Agency (JAEA), Ibaraki-ken, Japan*
Vratislav Mares, *Technical University of Ostrava, Ostrava-Poruba, Czech Republic*
Valery Lacroix, *Tractebel Engineering, Brussels, Belgium*

3:33pm
Alternative Characterization Rules for Multiple Surface Planar Flaws
Technical Paper Publication: PVP2018-84960

Pierre Dulieu, Valery Lacroix, *Tractebel Engineering, Brussels, Belgium*
Kunio Hasegawa, Yinsheng Li, *Japan Atomic Energy Agency (JAEA), Ibaraki-ken, Japan*
Bohumir Strnadel, *Technical University of Ostrava, Ostrava-Poruba, Czech Republic*

Session 2.3I (CS-28-1)
Uncertainty Characterization in Probabilistic Assessments of Structural Integrity
Lobby, Athens 2:15pm - 4:00pm

Session Developer: **Leonid Gutkin**, *Kinectrics Inc., Toronto, ON, Canada*
Session Chair: **Ryan Crane**, *ASME, New York, NY, USA*
Session Co-Chair: **Wolf Reinhardt**, *Candu Energy Inc, Mississauga, ON, Canada*

2:15pm
Pilot Study for Uncertainty Analysis in Probabilistic Fitness-For-Service Evaluations of Zr-2.5Nb Pressure Tubes: Identification of Influential Variables
Technical Paper Publication: PVP2018-85010

Christopher Manu, Suresh Datla, Leonid Gutkin, *Kinectrics Inc., Toronto, ON, Canada*

2:41pm
Pilot Study for Uncertainty Analysis in Probabilistic Fitness-For-Service Evaluations of Zr-2.5Nb Pressure Tubes: Uncertainty Characterization
Technical Paper Publication: PVP2018-85011

Leonid Gutkin, Suresh Datla, Christopher Manu, *Kinectrics Inc., Toronto, ON, Canada*

3:07pm
Uncertainty Analysis in Probabilistic Fitness-For-Service Evaluations of Zr-2.5Nb Pressure Tubes: Proposed Informative Annex to Canadian Nuclear Standard N285.8
Technical Presentation: PVP2018-85012

Leonid Gutkin, Christopher Manu, *Kinectrics Inc., Toronto, ON, Canada*

3:33pm
Verification of Probabilistic Fracture Mechanics Analysis Code through Benchmark Analyses
Technical Paper Publication: PVP2018-84963

Yinsheng Li, Masaki Koichi, Jinya Katsuyama, *Japan Atomic Energy Agency, Ibaraki, Japan*
Shumpei Uno, *Mizuho Information & Research Institute, Inc., Tokyo, Japan*
Terry Dickson, *Oak Ridge Consulting International, Oak Ridge, TN, USA*
Mark Kirk, *NRC, New Market, MD, USA*

Session 2.3J (NDPD-2-1)
NDE for Petrochemical and Power Plant Components - I
Lobby, Barcelona 2:15pm - 4:00pm

Session Developer/Chair: **Vivek Agarwal**, *Idaho National Laboratory, Idaho Falls, ID, USA*
Session Co-Chair: **Anne Jüngert**, *MPA University of Stuttgart, Stuttgart, Germany*

2:15pm
Failure Analysis of Duplex Stainless Steel in an Atmospheric Tower
Technical Paper Publication: PVP2018-84348

Chengsi Zheng, Gang Wang, Xiang Wu, Zhibin Ai, *Hefei General Machinery Research Institute Co. Ltd., Hefei, Anhui, China*

2:40pm
Case Study: Testing for Wall Loss as Due to Flow Accelerated Corrosion of Boiler Feed Water Pump Discharge Piping
Technical Presentation: PVP2018-84033

Lange Kimball, *Stress Engineering Services Inc., Houston, TX, USA*
Kuda Mutama, *Newmont Nevada Energy Investment, Elko, NV, USA*

3:05pm
Advanced NDE Techniques for Reliable Crack Inspection and Fitness-for-Service Assessments
Technical Paper Publication: PVP2018-84295

Joseph W Krynicki, Lujian Peng, *Exxon Mobil Research and Engineering, Spring, TX, USA*

3:30pm
Study on Low Frequency AC Excitation Magnetic Flux Leakage Testing for Defects with Different Depths
Technical Paper Publication: PVP2018-84479

Lu Xinyuan, Li Guanghai, *China Special Equipment Inspection And Research Institute, Beijing, China*
Chen Liangchao, Zhang Xiaozhu, *Beijing University of Chemical Technology, Beijing, China*
Chang Yu, *Beijing University of Technology, Beijing, China*

Session 2.3K (OAC-5-1)
Design, Testing, Qualification and Failure of Valves - I
Lobby, Berlin 2:15pm - 4:00pm

Session Developer/Chair: **L. Ike Ezekoye**, *Ezekoye Engineering Services LLC, Pittsburgh, PA, USA*
Session Co-Developer/Co-Chair: **Milan Brumovsky**, *UJV Rez a.s., Rez, Czech Republic*

2:15pm
System and Solenoid Valve Interaction Leading to Spurious Opening
Technical Paper Publication: PVP2018-84118

Alton Reich, *Streamline Automation LLC, Huntsville, AL, USA*

2:50pm
Prediction of Erosion Damage in a Choke Valve Working in Severe Slurry Conditions
Technical Paper Publication: PVP2018-84293

Stefano Malavasi, Gianandrea Vittorio Messa, Marco Negri, *Politecnico di Milano, Milano, Italy*

3:25pm
Qualification of Valve Actuators for Safety Related Nuclear Applications: Lessons Learned
Technical Paper Publication: PVP2018-85040

L. Ike Ezekoye, *Ezekoye Engineering Services LLC, Pittsburgh, PA, USA*
Ronald Farrell, *Flowserve Corporation, Raleigh, NC, USA*

Session 2.3L (SPC-2-2)
Student Paper Symposium - PhD - II
Lobby, Brussels 2:15pm - 4:00pm

Session Developer: **Mohamed Trabia**, *University of Nevada, Las Vegas, Las Vegas, NV, USA*
Session Co-Chair: **Noel P. O'Dowd**, *University of Limerick, Limerick, Ireland*
Session Chair: **Daniel Peters**, *Structural Integrity Associates, Edinboro, PA, USA*

2:15pm
Fatigue and Corrosion Fatigue Life Assessment with Application to Autofrettaged Parts
Technical Paper Publication: PVP2018-84536

Volodymyr Okorokov, Donald Mackenzie, Yevgen Gorash, *University of Strathclyde, Glasgow, UK*

2:50pm
Study Of Mode I-II Mixed Crack Propagation In Electrofusion Joint Of Polyethylene Pipe
Technical Paper Publication: PVP2018-84484

Yue Zhang, Jianfeng Shi, Jinyang Zheng, *Zhejiang University, Hangzhou, China*

3:25pm
Effect of Crack Orientation on Fracture Behaviour of Wire + Arc Additively Manufactured (WAAM) Nickel-Base Superalloy
Technical Paper Publication: PVP2018-84090

Cui Er Seow, *University of Bristol/National Structural Integrity Research Centre, Bristol, UK*
Harry Coules, *University of Bristol, Bristol, UK*
Raja Khan, *TWI Ltd, Cambridge, UK*

Session 2.3M (DA-17-1)
Composite Materials and Structures - I
Lobby, Sofia 2:15pm - 4:00pm

Session Developer/Chair: **Pierre Mertiny**, *University of Alberta, Edmonton, AB, Canada*
Session Developer/Co-Chair: **Mo Uddin**, *Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA*

2:15pm
Design of Imperfection-Insensitive Hierarchical Cylindrical Shells Enhanced by Hybrid Fibers
Technical Paper Publication: PVP2018-84030

Kuo Tian, Xiangtao Ma, Bo Wang, *Dalian University of Technology, Dalian, China*
Jiaxin Zhang, *Johns Hopkins University, Baltimore, MD, USA*

2:41pm
Modeling Automatic Detection of Critical Regions in Composite Pressure Vessel Subjected to High Pressure
Technical Paper Publication: PVP2018-84168

Michael Macri II, Andrew Littlefield, Joshua Root, Lucas Smith, *US Army RDECOM-ARDEC Benét Labs, Watervliet, NY, USA*

3:07pm
Design by Analysis of GFRP/CFRP Composite Pressure Vessels
Technical Paper Publication: PVP2018-84203

Martin Muscat, *University of Malta, Tal-Qroqq, Malta*
Duncan Camilleri, Brian Ellul, *University of Malta, Msida, Malta*

3:33pm
Design and Validation of a Filament Wound Composite Rocket Motor Case
Technical Paper Publication: PVP2018-84245

Emre Özaslan, Bülent Acar, Ali Yetgin, *Roketsan Inc., Ankara, Turkey*

Session 2.3N (DA-2-3)
Design and Analysis of Piping and Components - III
Lower Lobby, Madrid 2:15pm - 4:00pm

Session Co-Developer/Co-Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*
Session Chair: **Bing Li**, *Kinectrics NSS, Kincardine, ON, Canada*

2:15pm
Hydrogen Transfer Line Structural Analysis
Technical Paper Publication: PVP2018-84061

Larry P. Buchanan, Chris Bett, *National Resource Management, LLC, Knoxville, TN, USA*
Peter M. Rosenblad, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*

2:50pm
Investigation into Thermal Stress Characteristics of Pipe-In-Pipe Under High Temperature Condition
Technical Paper Publication: PVP2018-84578

Si-Hwa Jeong, Mingu Won, *Sungkyunkwan University, Suwon, Korea (Republic)*
Nam-Su Huh, *Seoul National University of Science and Technology, Seoul, Korea (Republic)*
Yun-Jae Kim, *Korea University, Seoul 136-701, Korea (Republic)*
J B Choi, *Sungkyunkwan University, Kyungi-do 440-746, Korea (Republic)*
Young-Jin Oh, *KEPCO Engineering and Construction, Gyeonggi-Do, Korea (Republic)*

3:25pm
Comparison of Predicted Cyclic Creep Damage from a Multi-Material Weldment FEA Model and the Traditional R5 Volume 2/3 Weldment Approach
Technical Paper Publication: PVP2018-85120

Feras Elagha, *WS Atkins, Bristol, UK*
David Tanner, David Knowles, *Atkins, Bristol, Avon, UK*

Session 2.3O (DA-15-3)
Coke Drum Repairs - Materials and Welding Aspects
Lower Lobby, Congress Hall I 2:15pm - 4:00pm

Session Developer: **Clay Rodery**, *C&S Technology, LLC, League City, TX, USA*
Session Co-Developer: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*
Session Chair: **Jorge Penso**, *Shell Oil, Cypress, TX, USA*
Session Co-Chair: **Julian Bedoya**, *Stress Engineer Serv, Houston, TX, USA*

2:15pm
Microstructural Characterization Of Base Material And Welded Joints Of Serviced And Non-Serviced Coke Drums
Technical Paper Publication: PVP2018-84859

Antonio Ramirez, Sebastian Romo, *Ohio State University, Columbus, OH, USA*
Jorge Penso, *Shell Oil, Cypress, TX, USA*
Darren Barborak, *AZZ/WSI, Suwanee, GA, USA*
Julian Bedoya, *Stress Engineer Serv, Houston, TX, USA*

2:41pm
Coke Drum Cone Cracking: Palliative Care Through Stochastic Elastic Plastic Fracture Mechanics
Technical Presentation: PVP2018-84711

Julian Bedoya, John Huang, *Stress Engineering Services, Houston, TX, USA*

3:07pm
Low-Cycle Fatigue Testing For Coke Drum External Repairs
Technical Presentation: PVP2018-84853

Sebastian Romo, Antonio Ramirez, *Ohio State University, Columbus, OH, USA*
Jorge Penso, *Shell Oil, Cypress, TX, USA*
Darren Barborak, *AZZ/WSI, Suwanee, GA, USA*
Julian Bedoya, *Stress Engineer Services, Houston, TX, USA*

3:33pm
A Proposal of Cladding Materials for Coke Drum Based on Fatigue Tests
Technical Paper Publication: PVP2018-84357

Hiroshi Nabeshima, Nobuhisa Kouno, Yasuhiko Shishido, Takushi Murakami, *Sumitomo Heavy Industries Process Equipment Co., Ltd., Saijo-city, Ehime, Japan*

Technical Tutorial 2.3Q (TW-2-5)
Advanced Fatigue Analysis Part 1
Lower Lobby, Congress Hall III 2:15pm - 4:00pm

Session Developer/Chair: **Maher Younan**, *American University in Cairo, New Cairo 11835, Egypt*
Presented by: **Kumarswamy Karpanan**, TechnipFMC, Houston, TX, USA

Block 2.4 Tuesday, July 17 4:15PM - 6:00PM

Session 2.4A (DA-3-1)
Fatigue Design and Analysis
Mezzanine, Karlin I 4:15pm - 6:00pm

Session Developer/Chair: **Laurent De Baglion**, *AREVA, Paris La Défense Cedex, France*
Session Co-Chair: **Alexander Bosch**, *Technische Universität Darmstadt, Darmstadt, Germany*

4:15pm
Analysis of Small Caliber Gun Barrels under Internal Pressure Fatigue Loading
Technical Presentation: PVP2018-84131

Adam Foltz, *US Army ARDEC, Picatinny Arsenal, NJ, USA*

4:41pm
Numerical Fatigue Life Evaluation With Experimental Results for Type III Accumulators
Technical Paper Publication: PVP2018-84188

Sang-Won Kim, *Institute of Industrial Science, The University of Tokyo, Tokyo, Japan*
Nobuhiro Yoshikawa, *University of Tokyo, Tokyo, Japan*
Hiroshi Kobayashi, *Toshiro Fujisawa, Japan Petroleum Energy Center, Tokyo, Japan*
Takeru Sano, *The High Pressure Gas Safety Institute of Japan, Machida-shi, Tokyo, Japan*

5:07pm
Fatigue Life of Welded Joints of AISI 347 Stainless Steel Under Thermomechanical and Variable Amplitude Loading
Technical Paper Publication: PVP2018-84705

Alexander Bosch, *Technische Universität Darmstadt, Darmstadt, Germany*
Sophie Schackert, Christoph Schweizer, *Fraunhofer IWM, Freiburg, Germany*
Michael Vormwald, *TU Darmstadt, Darmstadt, Germany*

5:33pm
Numerical Study on the Startup and Shutdown Performance for the High Pressure Inner Casing of the Solar Steam Turbine
Technical Paper Publication: PVP2018-84418

Peng Wang, *Shanghai Electric Power Generation Equipment Co., Ltd., Turbine Plant, Shanghai, China*
Gang Chen, *Shanghai Electric Power Generation Equipment Co.,Ltd., Shanghai, China*
Wenfu Li, *Shanghai Turbine Works Co. Ltd., Shanghai, China*

Session 2.4B (DA-12-3)
Fracture - III
Mezzanine, Karlin II 4:15pm - 6:00pm

Session Developer/Chair: **Shane Finneran**, *DNV GL, Dublin, OH, USA*
Session Co-Chair: **Philippe Gilles**, *GEP-INT, Paris, France*

4:15pm
Influence of Weld Residual Stresses on Ductile Crack Behavior on AISI Type 316LN Stainless Steel Weld Joint
Technical Paper Publication: PVP2018-84693

Sai Deepak Namburu, Lakshmana Rao Chebolu, Raghu Prakash, *Indian Institute of Technology, Madras, Chennai, Tamil Nadu, India*
Athimoola Krishnan Subramanian, *Indira Gandhi Center for Atomic Research, Chennai, Tamil Nadu, India*
Sasikala Gomathy, *Indira Gandhi Center for Atomic Research, Chennai, Tamil Nadu, India*

4:41pm
Proposed Methodology Changes to Determine Minimum Design Metal Temperature of ASME/API Impact Tested Materials Based On Fracture Mechanics
Technical Paper Publication: PVP2018-84795

Seetha Ramudu Kummari, *The Equity Engineering Group, Inc., Copley, OH, USA*
Brian Macejko, Phillip E. Prueter, *The Equity Engineering Group, Inc., Shaker Heights, OH, USA*

5:07pm
Dimensional Changes of Graphite Flakes and Fracture in Tensile Tests of Gray Cast Iron
Technical Paper Publication: PVP2018-85124

Naoya Tada, Takeshi Uemori, *Okayama University, Okayama, Japan*

5:33pm
Prediction of Fracture Toughness Temperature Dependence Over a Wide Temperature Range Using Simplified and Direct Scaling Method
Technical Paper Publication: PVP2018-84172

Takashi Inoue, *University of Fukui, Fukui-city, Japan*
Toshiyuki Meshii, *University of Fukui, Fukui 910-8507, Japan*

Session 2.4C (MF-6-4)
Materials and Technologies for Nuclear Power Plants - IV
Mezzanine, Karlin III 4:15pm - 6:00pm

Session Developer/Chair: **Weiju Ren**,
Oak Ridge National Laboratory, Oak Ridge, TN, USA
Session Co-Chair: **Randy K Nanstad**,
R&S Consultants LLC, Oak Ridge, TN, USA

4:15pm
A Study on the Pressure–Temperature Limit Curve with High Cooling Rate (for the Reactor) Using Finite Element Method
Technical Paper Publication: PVP2018-84850

Yerin Choi, Moon Ki Kim, Min-Kyu Kim, Jae-Hee Kim, Tae-Young Ryu, *Sungkyunkwan University, Suwon, Korea (Republic)*
J B Choi, *Sungkyunkwan University, Kyungi-do 440-746, Korea (Republic)*
Jun Seog Yang, *Korea Hydro & Nuclear Power Co., Ltd., Yuseong-Gu, Daejeon, 00, Korea (Republic)*

4:41pm
Margins Assessment of Pressure-Temperature Limit Curves for a RPV
Technical Paper Publication: PVP2018-85145

Feng Lv, Gengyu Zhou, *Suzhou Nuclear Power Research Institute, Suzhou, Jiangsu, China*
Haiyang Qian, *GE Power, Avon, CT, USA*

5:07pm
JRQ (A533B Cl.1) Steel Heat Treated at 450°C, 500°C and 550°C: SEM, TEM, DRX and EBSD Studies
Technical Paper Publication: PVP2018-84916

Aida Liliana Medina Almazan, *Instituto Nacional de Investigaciones Nucleares, Ocoyoacac, Mexico*,
Lizandra Sarahí Ovando-Ramirez, *Instituto Nacional de Investigaciones Nucleares, Lerma/Mexico, Mexico*,
Rogelio Hernandez Callejas, *Instituto Nacional de Investigaciones Nucleares, Ocoyoacac, Edo. Mexico, Mexico*,
Gonzalo Galicia Aguilar, *Instituto de Ingeniería/ Universidad Veracruzana, Boca del Rio, Veracruz, Mexico*

5:33pm
Initial Characterization of RPV Materials Harvested from the Decommissioned Zion Unit 1 Nuclear Power Plant
Technical Presentation: PVP2018-84509

Thomas M. Rosseel, Mikhail A. Sokolov, Xiang Chen, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Randy K Nanstad, *R&S Consultants LLC, Oak Ridge, TN, USA*

Session 2.4D (CS-11-7)
Example of Engineering Failure Analysis in China - II
Mezzanine, Palmovka 4:15pm - 6:00pm

Session Developer/Chair: **Xuedong Chen**,
Hefei General Machinery Research Institute, Hefei, Anhui, China
Session Developer/Co-Chair: **Zhichao Fan**,
Hefei General Machinery Research Institute, Hefei, Anhui, China

4:15pm
Research and Application of Ultrasonic Guided Wave with L(0,2) Mode for Elbow Tube Defect Inspection
Technical Paper Publication: PVP2018-84548

Ju Ding, ShuHong Liu, ChenHuai Tang, Jielu Wang, Bin Ren, Bo Yang, Yan-Nan Du, *Shanghai Institute of Special Equipment Inspection and Technical Research, Shanghai, China*
Min Zhang, *Texas A&M University, Texas, TX, USA*

4:50pm
Research on Reheat Cracking Criterion of CGHAZ in 2.25Cr1Mo0.25V Steel
Technical Paper Publication: PVP2018-84583

Shuang Zhou, Changjun Liu, Jianping Tan, Haoyu Zhang, *East China University of Science and Technology, Shanghai, China*

5:25pm
Engineering Application of Miniature Specimen Sampling Method on FFS Assessment of Corrosive Pits of In-Service Pressure Pipeline
Technical Paper Publication: PVP2018-84873

Yuqing Yang, Ting Zhang, Yichang Huang, Jielu Wang, *Shanghai Institute of Special Equipment Inspection and Technical Research (SSEI), Shanghai, China*
Xin Du, Hu Hui, *East China University Of Science and Technology, Shanghai, China*

Session 2.4E (FSI-2-2)
Fuel and Multi-Span Structure Flow-Induced Vibration
Mezzanine, Rokoska 4:15pm - 6:00pm

Session Developer: **Njuki Mureithi**,
Polytechnique Montreal, Montreal, QC, Canada
Session Chair: **Kensuke Hara**,
Tokyo Institute of Technoloby, Tokyo, Japan
Session Co-Chair: **Mustapha Benaouicha**,
Segula Engineering France, Querqueville, France

4:15pm
Study on the Influence of Clamping Failure on the Flow Induced Vibration and Wear of Fuel Rod
Technical Paper Publication: PVP2018-84326

Huanhuan Qi, Zhipeng Feng, Fu-Rui Xiong, Naibin Jiang, Qian Huang, Xuan Huang, *Nuclear Power Institute of China, Chengdu, China*

4:41pm
Development of Structural Integrity Assessment Method for Flow-Induced Vibration of Reactor Internals in PWR
Technical Paper Publication: PVP2018-84473

Hirokazu Sugiura, *Mitsubishi Heavy Industries, Ltd, Kobe, Japan*
Shigeyuki Watanabe, *Mitsubishi Heavy Industries, Ltd., Tokyo, Japan*
Akihisa Iwasaki, *MHI, Takasago, Japan*
Hideyuki Morita, Hideyuki Sakata, *Mitsubishi Heavy Industries, Ltd., Hyogo-pref, Japan*
Yoshito Nishikawa, *The Kansai Electric Power Co., Inc., Osaka, Japan*

5:07pm
Comparison of Tube-Tube Collision Frequency with and without the Use of Impingement Plate

Technical Paper Publication: PVP2018-84729

Jiri Buzik, Tomá Létal, Pavel Loák, Martin Nad, Marek Pernica, *Brno University of Technology, Brno, Czech Republic*

5:33pm
Numerical Simulation on Flow Induced Vibration and Fretting Wear of Steam Generator
Technical Paper Publication: PVP2018-84347

Wei Tan, Kai Guo, Xiantao Fan, Yipeng Wang, Guorui Zhu, Liyan Liu, *Tianjin University, Tianjin, China*

5:25pm
The Fracture Limit of Steel-Frame Members under Dynamic Repeated Loads through the Shaking Table Test
Technical Paper Publication: PVP2018-84830

Kensuke Shiomi, Yusuke Wada, *IHI Corporation, Yokohama, Japan*

Session 2.4F (SE-12-3)
Advanced Seismic Evaluation and Code - III
Mezzanine, Hercovka 4:15pm - 6:00pm

Session Developer: **Akira Maekawa**, *The Kansai Electric Power Co., Inc., Fukui, Japan*
Session Co-Developer: **Yinsheng Li**, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*
Session Developer/Co-Chair: **Izumi Nakamura**, *National Res Institute of Earth Sciences/Disaster Prevention*, Miki-shi, Hyogo 673-0515, Japan
Session Chair: **Fabrizio Paolacci**, Roma Tre University, Roma, Italy
Session Co-Chair: **Nobuo Kojima**, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japan*

4:15pm
Evaluating Large Aboveground Storage Tanks Subject to Seismic Loading Part I: Closed-Form Solutions and Equivalent Static Analysis
Technical Paper Publication: PVP2018-84836

Phillip E. Prueter, *The Equity Engineering Group, Inc., Shaker Heights, OH, USA*
Seetha Ramudu Kummari, *The Equity Engineering Group, Inc., Copley, OH, USA*

4:50pm
Evaluating Large Aboveground Storage Tanks Subject to Seismic Loading Part II: Explicit Dynamic Analysis with Liquid Sloshing Effects
Technical Paper Publication: PVP2018-84837

Seetha Ramudu Kummari, *The Equity Engineering Group, Inc., Copley, OH, USA*
Phillip E. Prueter, *Michael F. P. Bifano, The Equity Engineering Group, Inc., Shaker Heights, OH, USA*

Session 2.4G (CT-8-2)
Threaded Fasteners - II
Mezzanine, Tyrolka 4:15pm - 6:00pm

Session Developer/Chair: **Sayed Nassar**, *Oakland University, Rochester, MI, USA*
Session Co-Chair: **Luca Goglio**, *Politecnico di Torino, Torino, Italy*

4:15pm
Analytical Modeling of Self-Loosening of Bolted Joints
Technical Paper Publication: PVP2018-84016

Valentin Fort, Abdel-Hakim Bouzid, *Ecole Technologie Superieure, Montreal, QC, Canada*
Michel Gratton, *Institut National des Sciences Appliquées Centre Val de Loire, Blois, France*

4:41pm
A Normalized Stress of Pull-Out Action on Bolted Joints Under Eccentric Load
Technical Paper Publication: PVP2018-84179

Makoto Imura, *Hitachi Co. Ltd., Hitachinaka, Japan*
Takayuki Koyama, Motonobu Iizuka, Takayuki Suzuki, *Hitachi co. Ltd., Hitachi, Japan*

5:07pm
A Comparative Study on Mechanical Behavior of Pipe-Socket Threaded Joints with Taper-Taper Threads and Taper-Parallel Threads Combinations by Finite Element Analysis and Experiments
Technical Paper Publication: PVP2018-84657

Satoshi Nagata, *Toyo Engineering Corporation, Narashino, Chiba, Japan*
Shinichi Fujita, *Japan Pipe Fittings Association, Tokyo, Japan*
Toshiyuk Sawa, *Hiroshima University, Tokyo, Japan*

5:33pm
Effect of Autoclave Process Variables on Film Adhesive Bond with Polycarbonate Coupons
Technical Paper Publication: PVP2018-84917

Shraddha Jagatap, Sayed Nassar, *Oakland University, Rochester, MI, USA*

5:25pm
Difference in Susceptibility to 475°C Embrittlement of Duplex Stainless Steel Base Metal and Weld Metal
Technical Paper Publication: PVP2018-84361

Mikihiro Sakata, Tomoaki Kiso, *JGC, Yokohama, Japan*
Yasuhiro Sato, Masayuki Tanaka, *TASETO, Fujisawa, Japan*

Session 2.4H (MF-5-1)
Fitness for Service and Failure Assessment - I
Lobby, Amsterdam 4:15pm - 6:00pm

Session Developer: **Marvin Cohn**,
Intertek, Santa Clara, CA, USA
Session Co-Developers: **Carl Jaske**,
HSI Group, Inc., Columbus, OH, USA
Bruce Wiersma,
Savannah River National Laboratory, Aiken, SC, USA
Zhigang Wei,
Tenneco, Ann Arbor, MI, USA
Haiyang Qian,
GE Power, Avon, CT, USA
Session Chair: **Francis Ku**,
Structural Integrity Associates, San Jose, CA, USA
Session Co-Chair: **Michiel Brongers**,
DNV GL USA, Inc., Dublin, OH, USA

4:15pm
Creep Strength Evaluation of a New and a Used Grade 91 Welded Joints by Using a Miniature Specimen
Technical Paper Publication: PVP2018-84010

Takashi Ogata, *Chiba Institute of Technology, Chiba, Japan*

4:50pm
Comparison of Fracture Stress Prediction in Thin Walled Vessels with Flaws Using BS 7910 Analysis Method and Test Data
Technical Presentation: PVP2018-84824

Mahendra Rana, *Consultant, Niantic, CT, USA*
Kang Xu, *Praxair, Tonawanda, NY, USA*

Session 2.4I (MF-4-1)
FA3 RPV Positive Carbon Segregation Issue - I
Lobby, Athens 4:15pm - 6:00pm

Session Co-Developer/ Co-Chair: **Peter James**,
Wood, Warrington, Cheshire, UK
Session Co-Developer: **Elisabeth Keim**,
AREVA, Erlangen, Germany,
Dominique Moinereau,
Electricite De France, Moret Sur Loing F-77818, France,
Tomas Nicak,
Framatome GmbH, Erlangen, Germany
Session Co-Developer/Chair: **Stephane Marie**,
AREVA NP, Paris La Defense, France

4:15pm
Flamanville EPR RPV'S Heads Carbon Segregation: Vessel Heads Manufacturing
Technical Paper Publication: PVP2018-84492

Benoit Lefever, *AREVA NP, Courbevoie, France*
Thierry Berger, *AREVA NP, Chalon Sur Saone, France*
Isabelle Bobin Vastra, *AREVA NP, Le Creusot, France*
Stephane Marie, *AREVA NP, Paris La Defense, France*

4:41pm
Flamanville EPR RPV'S Heads Carbon Segregation: Characterisation of the Segregation in the Heads
Technical Paper Publication: PVP2018-84495

Stephane Marie, *AREVA NP, Paris La Defense, France*,
Philippe Fichot, *AREVA NP, Chalon sur Saône, France*,
Olivier Calonne, *AREVA NP, Le Creusot, France*,
Mathieu Segond, *AREVA NP, Paris la Defense, France*,
Yvon Desnoyers, *Geovariances, Avon, France*,
Mejido Hajjaj, Cecile Miller, *EDF, Saint Denis, France*

5:07pm
Flamanville EPR RPV'S Heads Carbon Segregation: Tests Program Definition to Characterize the Mechanical Properties of the High Carbon Segregation
Technical Paper Publication: PVP2018-84329

Stephane Marie, *AREVA NP, Paris La Defense, France*
Jérôme Demarecaux, Philippe Fichot, *AREVA NP, Chalon sur Saône, France*
Elisabeth Keim, *AREVA, Erlangen, Germany*
Johannes May, *AREVA NP, Erlangen, Germany*
Rachid Chaouadi, *SCK-CEN, Mol, Belgium*
Marlies Lambrecht, *SCK-CEN, Mol, Belgium*
Peter Birkett, *AMEC FW, Warrington, UK*
Mejido Hajjaj, *Cecile Miller, EDF, Saint Denis, France*

5:33pm
Flamanville EPR RPV'S Heads Carbon Segregation: Impact of the High Carbon Segregation on the Mechanical Properties of the RPV Steel
Technical Paper Publication: PVP2018-84330

Stephane Marie, *AREVA NP, Paris La Defense, France*
Jérôme Demarecaux, Philippe Fichot, *AREVA NP, Chalon sur Saône, France*
Mejido Hajjaj, *Cecile Miller, EDF, Saint Denis, France*

Session 2.4J (NDPD-2-2)
NDE for Petrochemical and Power Plant Components - II
Lobby, Barcelona 4:15pm - 6:00pm

Session Developer/Chair: **Vivek Agarwal**, *Idaho National Laboratory, Idaho Falls, ID, USA*
Session Co-Chair: **Sandra Dugan**, *Swiss Federal Nuclear Safety Inspectorate ENSI, Brugg, AG, Switzerland*

4:15pm
The Phased Array Ultrasonic Inner Inspection for the Butt Weld On the Head of High-Pressure Vessel
Technical Paper Publication: PVP2018-84504

Cunjian Miao, *Zhejiang Provincial Special Equipment Inspection and Research Institute, Hangzhou, China*,
Qi He, *Zhejiang University, Hangzhou, Zhejiang, China*,
Xingji Du, Weican Guo, Zhangwei Ling, Huiting Xu,
Zhejiang Provincial Special Equipment Inspection and Research Institute, Hangzhou, China

4:40pm
Monitoring of CMC-Jacketed Pipes for High-Temperature Applications
Technical Paper Publication: PVP2018-85023

Anne Jüngert, Min Huang, Andreas Klenk, *MPA University of Stuttgart, Stuttgart, Germany*,
Maximilian Friedrich, *IMWF University of Stuttgart, Stuttgart, Germany*,
Stefan Weihe, *Materials Testing Institute of Stuttgart, Stuttgart, Germany*

5:05pm
Calculation of Inspection Intervals for an Ammonia Storage Tank Based on Design Modifications, RBI, Commissioning Inspection, and FEA
Technical Paper Publication: PVP2018-84742

Thomas Prewitt, Shane Finneran, Juan Carlos Ruiz-Rico, *DNV GL, Dublin, OH, USA*

Session 2.4K (OAC-5-2)
Design, Testing, Qualification and Failure of Valves - II
Lobby, Berlin 4:15pm - 6:00pm

Session Developer/Co-Chair: **L. Ike Ezekoye**, *Ezekoye Engineering Services LLC, Pittsburgh, PA, USA*
Session Co-Developer/Chair: **Milan Brumovsky**, *UJV Rez a.s., Rez Czech Republic*

4:15pm
Discussion on Rules of Inspection and Type Test for Imported Pressure Piping Valves in China
Technical Paper Publication: PVP2018-84208

Luyun Zhou, *Shanghai Institute of Special Equipment Inspection and Technology Research, Shanghai, China*
Minghai Fu, Weipu Xu, *SSEI, Shanghai, China*

4:50pm
Piston-Lift Check Valve Flow Verification Using CFD
Technical Paper Publication: PVP2018-84672

Matthew Laney, Ronald Farrell, *Flowserve Corporation, Raleigh, NC, USA*

5:25pm
A Case Study: Balanced Globe Valves Failure, Root Cause, and Recovery
Technical Paper Publication: PVP2018-84757

Ronald Farrell, Matthew Laney, *Flowserve Corporation, Raleigh, NC, USA*,
Preston Vock, Andrew Garcia, *Westinghouse, Cranberry Township, PA, USA*,

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Session 2.4L (FSI-5-1)
Int'l Symposium on Emerging Technologies: Engineering Applications
Lobby, Brussels 4:15pm - 6:00pm

Session Developer/Chair: **Kazuaki Inaba**,
Tokyo Institute of Technology, Tokyo, Japan
Session Developer/Co-Chair: **Hirofumi Iyama**,
National Institute of Technology, Kumamoto College, Yatsushiro, Kumamoto, Japan
Session Co-Developers: **Christina Giannopapa**,
Eindhoven University of Technology,Eindhoven, Netherlands
Toshiaki Watanabe,
National Fisheries University, Shimonoseki 759-6595, Japan
Lambros Kaiktsis,
National Technical University of Athens, Zografou, Greece
Stefano Malavasi,
Politecnico Di Milano University, Milano, Italy
George Papadakis,
Imperial College London, London, UK

4:15pm
Importance of Accounting for Finite Particle Size in CFD-Based Erosion Prediction
Technical Paper Publication: PVP2018-84248

Gianandrea Vittorio Messa, Yongbo Wang, *Politecnico di Milano, Milano, MI, Italy*

4:41pm
Influence of Pressure Vessel Shape on Explosive Forming
Technical Paper Publication: PVP2018-84476

Hirofumi Iyama, Masatoshi Nishi, *National Institute of Technology, Kumamoto College, Yatsushiro, Kumamoto, Japan*,
Yoshikazu Higa, *National Institute of Technology, Okinawa College, Nago, Okinawa, Japan*

5:07pm
Application of the CEL Approach to Consider FSI for the Assessment of Leak Tightness for Elastomeric Seals
Technical Paper Publication: PVP2018-84792

Yevgen Gorash, *University of Strathclyde, Glasgow, Scotland, UK*
Alan Bickley, *Weir Advanced Research Centre, Glasgow, UK*
Francisco Gozalo, *Weir Minerals, South Salt Lake, UT, USA*

5:33pm
A Study for Theoretical Modeling of Cavitation Inducement from the Solid-Fluid Interface with Fluid-Structure Interaction
Technical Paper Publication: PVP2018-84811

Tomohisa Kojima, *Meiji University, Kanagawa, Japan*
Kazuaki Inaba, Yuto Takada, *Tokyo Institute of Technology, Tokyo, Japan*

Session 2.4M (DA-17-2)
Composite Materials and Structures - II
Lobby, Sofia 4:15pm - 6:00pm

Session Developer/Chair: **Pierre Mertiny**,
University of Alberta, Edmonton, AB, Canada
Session Developer/Co-Chair: **Mo Uddin**,
Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA

4:15pm
Design and Application of an Equator Flexible Supported Acrylic Spherical Vessel for Neutrino Detector
Technical Paper Publication: PVP2018-84128

Fan Zhou, Yang Du, *China University of Petroleum, Qingdao, China*
Zhiping Chen, *Zhejiang University, Hangzhou, China*
Shaojing Hou, Yuekun Heng, *Institute of High Energy Physics Chinese Academy of Sciences, Beijing, China*

4:41pm
Modeling the Interfacial De-Bonding Behavior Between Steel Wire and Adhesive
Technical Paper Publication: PVP2018-84379

Jun Shi, *Wuhan Institute of Technology, Wuhan, China*
Jianfeng Shi, Xinyu Nie, Yue Zhang, *Zhejiang University, Hangzhou, Zhejiang, China*
Guangzhong Li, Hubei Xingxin *Technology Co.,Ltd, Ezhou, China*
Hanxin Chen, Yibin He, Qingjun Wang, *Wuhan Institute of Technology, Wuhan, China*

5:07pm
Damage Behavior of Filament-Wound Composite Cylinder Under Impact by Flat-Ended Impactor
Technical Paper Publication: PVP2018-84485

Qiaoguo Wu, Xuedong Chen, Zhichao Fan, Yong Jiang, Xiaoqiang Zhang, Defu Nie, *Hefei General Machinery Research Institute, Hefei, China*

5:33pm
An Introduction to the New ASME Standards on Non-metallic Pressure Piping Systems
Technical Paper Publication: PVP2018-84458

Charles Henley, *Kiewit Engineering Group Inc., Lenexa, KS, USA*
Jeffrey Eisenman, *Maverick Applied Science, Inc, Palmetto, FL, USA*

Session 2.4N (DA-2-4)
Design and Analysis of Piping and Components - IV
Lower Lobby, Madrid 4:15pm - 6:00pm

Session Developer/Chair: **Chakrapani Basavaraju**, *US Nuclear Regulatory Commission, North Potomac, MD, USA*
Session Co-Chair: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*

4:15pm
Application of Genetic Algorithm on Optimal Pipeline Route Considering Complex Terrains and Obstacles
Technical Paper Publication: PVP2018-84272

Bingyuan Hong, Xiaoping Li, Yu Li, Jingjing Gao, Yanhong Zhou, Baocheng Wei, Siqi Zhang, Jing Gong, *China University of Petroleum-Beijing, Beijing, China*

4:41pm
Layout Optimization for Progressive Development of Stellated Natural Gas Gathering Network
Technical Paper Publication: PVP2018-84524

Bingyuan Hong, Xiaoping Li, Yu Li, Jingjing Gao, Yanhong Zhou, Baocheng Wei, Siqi Zhang, Jing Gong, *China University of Petroleum-Beijing, Beijing, China*

5:07pm
Performance of Depressurization Devices to Dynamic Loads Generated by Arcing in Liquid Filled Transformers
Technical Paper Publication: PVP2018-84691

Ashwin Padmanaban Iyer, Anne Goj, Omar Ahmed, *Transformer Protector Corporation, Humble, TX, USA*

5:33pm
Dynamic Fracture Behavior of 316L Brazed Joint: Study With Experimental and Finite Element Methods
Technical Paper Publication: PVP2018-84133

Weiya Zhang, *China University of Petroleum (East China), Qingdao, China*
Wenchun Jiang, *College of Chemical Engineering, China University of Petroleum(East China), Qingdao, China*
Bin Yang, Ming Song, *China University of Petroleum (East China), Qingdao, China*
Xiangnan Zhai, *Tianhua Research Institute of Chemical Machinery and Automation, Lanzhou, China*

Session 2.40 (DA-15-4)
Closing Session: What's Next for the Industry?
Lower Lobby, Congress Hall I 4:15pm - 6:00pm

Session Developer/Chair: **Clay Rodery**, *C&S Technology, LLC, League City, TX, USA*
Session Co-Developer: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*
Session Co-Chair: **Jaan Taagepera**, *Chevron ETC, Richmond, CA, USA*

Technical Tutorial 2.4Q (TW-2-6)
Advanced Fatigue Analysis Part 2
Lower Lobby, Congress Hall III 4:15pm - 6:00pm

Session Developer/Chair: **Maher Younan**,
American University in Cairo, New Cairo 11835, Egypt
Presented by: **Kumarswamy Karpanan**,
TechnipFMC, Houston, TX, USA

Block 3.1 Wednesday, July 18 8:15AM - 10:00AM

Session 3.1A (DA-3-2)
Development of New Design Fatigue Curves in Japan
Mezzanine, Karlin I 8:15am - 10:00am

Session Developer/Chair: **Seiji Asada**,
Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan
Session Co-Chair: **Masahiro Takanashi**,
IHI Corporation, Isogo-ku 235-8501, Japan

8:15am
Development of New Design Fatigue Curves in Japan - Proposal of a New Fatigue Evaluation Method
Technical Paper Publication: PVP2018-84432

Seiji Asada, *Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan*
Akihiko Hirano, *Hitachi-GE Nuclear Energy, Ltd., Hitachi, Japan*
Toshiyuki Saito, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japa n*
Yasukazu Takada, *The Kansai Electric Power Co., Inc., Osaka, Japan*
Hideo Kobayashi, *Tokyo Institute of Technology, Tokyo, Japan*

8:41am
Development of New Design Fatigue Curves in Japan: Discussion of Best-Fit Curves Based on Fatigue Test Data with Small-Scale Test Specimen
Technical Paper Publication: PVP2018-84052

Yun Wang, Hisamitsu Hatoh, *Hitachi, Ltd., Hitachi, Ibaraki, Japan*
Masato Yamamoto, *CRIEPI, Yokosuka, Japan*
Motoki Nakane, Akihiko Hirano, *Hitachi-GE Nuclear Energy, Ltd., Hitachi, Japan*
Kentaro Hayashi, *The Kansai Electric Power Co., Inc., Osaka, Japan*

9:07am
Development of New Design Fatigue Curves in Japan - Discussion of Best-Fit Curves Based on Large-Scale Fatigue Tests of Carbon and Low-Alloy Steel Plates
Technical Paper Publication: PVP2018-84456

Masahiro Takanashi, *IHI Corporation, Isogo-ku 235-8501, Japan*
Hiroshi Ueda, *IHI Corporation, Yokohama 235, Japan*
Toshiyuki Saito, Takuya Ogawa, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japan*
Kentaro Hayashi, *The Kansai Electric Power Co., Inc., Osaka, Japan*

9:33am
Development of New Design Fatigue Curves in Japan - Discussion of Best Fit Curves Based on Fatigue Test Data with Large Scale Piping
Technical Paper Publication: PVP2018-84436

Masaru Bodai, *MHI Solution Technologies, Co., Ltd., Takasago, Hyogo, Japan*
Yuichi Fukuta, *Mitsubishi Heavy Industries (MHI), LTD, Takasago, Hyogo, Japan*
Seiji Asada, *Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan*
Kentaro Hayashi, *The Kansai Electric Power Co., Inc., Osaka, Japan*

Session 3.1B (CS-22-1)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - I
Mezzanine, Karlin II 8:15am - 10:00am

Session Developer: **William L. Server**,
ATI-Consulting, Black Mountain, NC, USA
Session Co-Developer/Chair: **Masato Yamamoto**,
CRIEPI, Yokosuka, Japan
Session Co-Chair: **Tomohiro Kobayashi**,
CRIEPI, Yokosuka, Kanagawa, Japan

8:15am
Assessment of Master Curve Material Inhomogeneity Using Small Data Sets
Technical Paper Publication: PVP2018-84297

Kim Wallin, *VTT Nuclear Safety, Espoo, Finland*

8:41am
Fracture Toughness Evaluation of Heat-Affected Zone under Weld Overlay Cladding in Reactor Pressure Vessel Steel
Technical Paper Publication: PVP2018-84535

Yoosung Ha, Tohru Tobita, Hisashi Takamizawa, Satoshi Hanawa, Yutaka Nishiyama, *Japan Atomic Energy Agency, Tokai-Mura, Ibaraki-Ken, Japan*

9:07am
Study on Applicability of Master Curve Methodology Using Miniature C(T) Specimen to a Reactor Pressure Vessel Steel with Low Upper Shelf Energy
Technical Paper Publication: PVP2018-84994

Kentaro Yoshimoto, Takatoshi Hirota, Hiroyuki Sakamoto, Masato Oshikiri, *Mitsubishi Heavy Industries, Ltd., Takasago, Japan*
Kazuya Tsutsumi, Takeshi Murakami, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*

9:33am
Crack Resistance Curve Measurement with Miniaturized CT Specimen
Technical Paper Publication: PVP2018-84690

Rachid Chaouadi, Marlies Lambrecht, *SCK-CEN, MOL, Belgium*,
Robert Gerard, *Tractebel-Engie, Brussels, Belgium*

Session 3.1C (MF-6-5)
Materials and Technologies for Nuclear Power Plants - V
Mezzanine, Karlin III 8:15am - 10:00am

Session Developer/Chair: **Weiju Ren**,
Oak Ridge National Laboratory, Oak Ridge, TN, USA
Session Co-Chair: **Randy K Nanstad**,
R&S Consultants LLC, Oak Ridge, TN, USA

8:15am
Estimation of Stress-Displacement Curve of Multiple Notched Stainless Steel Pipe Under Combined Load of Axial Force and Bending
Technical Paper Publication: PVP2018-84523

Ryosuke Suzuki, Masaaki Matsubara, Kento Arai, Kosuke Takano, Tsukasa Hagiwara, *Gunma University, Kiryu, Gunma, Japan*

8:41am
Derivation of Transverse Tensile Properties of Alloy 690 Steam Generator Tubes Using Ring-Tensile Specimen and Finite Element Analysis
Technical Paper Publication: PVP2018-84828

Jongmin Kim, Min-Chul Kim, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic)*

9:07am
Analytical Determination of Stress Indices and Stress Intensification Factor for an Extruded Nozzle of Super Pipe
Technical Paper Publication: PVP2018-85144

Feng Lv, Gengyu Zhou, *Suzhou Nuclear Power Research Institute, Suzhou, Jiangsu, China*
Haiyang Qian, *GE Power, Avon, CT, USA*

9:33am
Effect of the Ferrite Number in the Degree of Sensitization and Detection of a Zone of Dissolution in the Interphase Delta Ferrite-Austenite in 304 Stainless Steel.
Technical Presentation: PVP2018-84829

Carlos R. Arganis-Juárez, *Instituto Nacional De Investigaciones Nucleares, Ocoyoacac, Mexico*
Audi Vazquez, *Instituto Nacional de Investigaciones Nucleares, La Marquesa, Mexico*
Rafael Colas, *Universidad Autonoma de Nuevo Leon, San Nicololas de los garzas, Nuevo Leon, Mexico*

Session 3.1D (CS-11-8)
Failure Analysis of Engineering Structure - II
Mezzanine, Palmovka 8:15am - 10:00am

Session Developer/Chair: **Yinghua Liu**,
Tsinghua University, Beijing, China
Session Developer/Co-Chair: **Jun Shen**,
Tsinghua University, Beijing, China

8:15am
Buckling Instability Analysis and Stiffeners Optimization Design for Large Vacuum Spherical Tanks
Technical Paper Publication: PVP2018-84954

Yongsheng Xu, Liang Sun, Zhirong Yang, Hongchao Suo, *China Special Equipment Inspection Institute, Beijing, China*
Guide Deng, *China Special Equipment Inspection and Research Institution, Beijing, China*

8:41am
Application of Failure Mode and Effect Analysis on Centifugal Pumps of Atmospheric and Vacuum Distillation Unit
Technical Paper Publication: PVP2018-85008

Xiang Li, Cheng Dai, Feng Gao, Huadong Wang, Zhimin Sun, *China Special Equipment Inspection & Research Institute, Beijing, Beijing, China*

9:07am
Corrosion Inhibition Effect of Mixed Inhibitors - Cinnamaldehyde and Vanilline on by Molecular Dynamic Simulation
Technical Presentation: PVP2018-85117

Wang Zhen, He Shijun, Hu Jun, *Northwest University, Xi'an, China*

9:33am
Experimental Study on Mechanical Properties and Microstructure of 2.25Cr1Mo0.25V Steels by the Influence of Heat Treatment and Welding
Technical Paper Publication: PVP2018-84437

Qing Li, Guangxu Cheng, Mu Qin, Zaoxiao Zhang, *Xi'An Jiaotong University, Xi'An, China*

Session 3.1E (FSI-2-3)
Flutter, VIV and General FSI
Mezzanine, Rokoska 8:15am - 10:00am

Session Developer: **Njuki Mureithi**, *Polytechnique Montreal, Montreal, QC, Canada*
Session Co-Chair: **Gianluca Artini**, *CEA Saclay, Gif-sur-Yvette, France*
Session Chair: **Daniel Broc**, *CEA Saclay, Gif-sur-Yvette, France*

8:15am
Experiences in Developing a Practical Algorithm of Identification and Attenuation of Pressure Pulsation and Piping Vibration in Gas Reciprocating Compressor Plants and Other Systems
Technical Paper Publication: PVP2018-84565

Maciej Rydlewicz, Wojciech Rydlewicz, *Centrum Systemow Softdesk, Lodz, Poland*

8:41am
Dynamics of a Free Heaving and Prescribed Pitching Hydrofoil in a Turbulent Flow, with a Fluid Structure Interaction Approach
Technical Paper Publication: Pvp2018-84636

Paul Brousseau, *Mustapha Benaouicha, Segula Engineering France, Querqueville, Normandie, France*
Sylvain Guillou, *University of Caen Normandy (UNICAEN), Cherbourg-Octeville, France*

9:07am
Fluid-Structure Interaction Approach for Numerical Investigation of a Flexible Hydrofoil Deformations in Turbulent Fluid Flow
Technical Paper Publication: PVP2018-84637

Mustapha Benaouicha, *Segula Engineering France, Querqueville, France*
Sylvain Guillou, Alina Santa Cruz, *University of Caen Normandy (UNICAEN), Cherbourg-Octeville, France*
Hamdi Trigui, *Segula Engineering France, Querqueville, France*

9:33am
Development of an Efficient Stability Analysis Method for a Plate in a Uniform Flow by Using Differential Algebraic Equations
Technical Paper Publication: PVP2018-84680

Kensuke Hara, *Tokyo Institute of Technology, Tokyo, Japan*

Session 3.1F (SE-4-1)
Structural Dynamics - I
Mezzanine, Hercovka 8:15am - 10:00am

Session Developer: **Katsuhisa Fujita**, *Osaka City University, Osaka, Japan*
Session Co-Developer/Chair: **Kiyoshi Aida**, *Mitsubishi Hitachi Power Systems, Ltd., Kure-Shi, Japan*
Session Co-Chair: **Keisuke Minagawa**, *Saitama Institute of Technology, Saitama, Japan*

8:15am
Fast Reactor Cores: Seismic Excitation in the Vertical Direction – Numerical Methods
Technical Paper Publication: PVP2018-84098

Daniel Broc, Gianluca Artini, *CEA Saclay, Gif-sur-Yvette, France*
Jerome Cardolaccia, *Commissariat Lenergie Atomique Et Aux Nergies Alternatives, Gif-sur-Yvette, France*,
Laurent Martin, *CEA, St Paul lez Durance, France*

8:41am
Fast Reactor Core Seismic Experiment and Analysis under Strong Excitation
Technical Paper Publication: PVP2018-84466

Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*
Akihisa Iwasaki, *MHI, Takasago, Japan*
Kazuteru Kawamura, *Mitsubishi Heavy Industries, Ltd, Hyogo, Japan*
Shinichiro Matsubara, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*
Hidenori Harada, *Mitsubishi FBR Systems, Inc., Tokyo, Japan*

9:07am
Fast Reactor Core Seismic Experiment of Full Scale Single Model of Control Rod
Technical Paper Publication: PVP2018-84471

Akihisa Iwasaki, *MHI, Takasago, Japan*
Shinichiro Matsubara, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*
Kazuteru Kawamura, *Mitsubishi Heavy Industries, Ltd, Hyogo, Japan*
Hidenori Harada, *Mitsubishi FBR Systems, Inc., Tokyo, Japan*
Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*

9:33am
Fast Reactor Core Seismic Analysis for Verification of Assessment Model of Control Rod
Technical Paper Publication: PVP2018-84474

Akihisa Iwasaki, *MHI, Takasago, Japan*
Shinichiro Matsubara, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*
Kazuteru Kawamura, *Mitsubishi Heavy Industries, Ltd, Hyogo, Japan*
Hidenori Harada, *Mitsubishi FBR Systems, Inc., Tokyo, Japan*
Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*

Session 3.1G (DA-10-4)
Bolted Joint Progress - International Liaison - I
Mezzanine, Tyrolka 8:15am - 10:00am

Session Developer/Chair: **Warren Brown**, *Integrity Engineering Solutions, Dunsborough, WA, Australia*
Session Developer/Co-Chair: **Clay Rodery**, *C&S Technology, LLC, League City, TX, USA*

8:15am
Activity and Future Development on Researches of BFC in JPVRC
Technical Presentation: PVP2018-84854

Toshiyuki Sawa, *Hiroshima University, Tokyo, Japan*

8:50am
Update on Pressure Boundary Bolted Joint Activity from the USA
Technical Presentation: PVP2018-84862

Clay Rodery, *C&S Technology, LLC, League City, TX, USA*

9:25am
Update from Europe and France on Bolted Joints
Technical Presentation: PVP2018-84871

Hubert Lejeune, *Cetim, Nantes 44000, France*

Session 3.1H (MF-5-2)
Fitness for Service and Failure Assessment - II
Lobby, Amsterdam 8:15am - 10:00am

Session Developer: **Marvin Cohn**,
Intertek, Santa Clara, CA, USA
Session Co-Developers: **Carl Jaske**,
HSI GROUP, INC., Columbus, OH, USA
Bruce Wiersma,
Savannah River National Laboratory, Aiken, SC, USA
Zhigang Wei,
Tenneco, Ann Arbor, MI, USA
Session Chair: **Jinyang Zheng**,
Zhejiang University, Hangzhou, China
Session Co-Chair: **Michiel Brongers**,
DNV GL USA, Inc., Dublin, OH, USA

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8:15am
Degradation of the Steel Liner Plate of Containment Buildings
Technical Presentation: PVP2018-84962

Hun Cha, Yonglak Paek, Sangyun Kim, Euisik Yoon, *Korea Institute of Nuclear Safety, Daejeon, Korea (Republic)*

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8:41am
Assessment of Weld Quality Using Control Chart and Frequency Domain Analysis
Technical Paper Publication: PVP2018-85091

Dinu Thekkuden, Abdel-Hamid Ismail Mourad, John Christy, Amir Idrisi, UAE University, Al Ain 15551, UAE

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9:07am
Stress Intensity Factors for Circular-Arc Cracks in Plates
Technical Paper Publication: PVP2018-84502

Do-Jun Shim, Shu Tang, *Structural Integrity Associates, Inc., San Jose, CA, USA*
Tae-Jin Kim, Nam-Su Huh, *Seoul National University of Science and Technology, Seoul, Korea (Republic)*

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9:33am
Weight Function Based Stress Intensity Factor Solution for Nozzle Corner Cracks
Technical Presentation: PVP2018-85072

Do-Jun Shim, Dilip Dedhia, Wilson Wong, *Structural Integrity Associates, Inc., San Jose, CA, USA*

Session 3.1I (MF-4-2)
FA3 RPV Positive Carbon Segregation Issue - II
Lobby, Athens 8:15am - 10:00am

Session Developer/Chair: **Dominique Moinereau**,
Electricite De France, Moret Sur Loing F-77818, France
Session Co-Developers: **Elisabeth Keim**,
AREVA, Erlangen, Germany,
Peter James,
Wood, Warrington, Cheshire, UK,
Tomas Nicak,
Framatome GmbH, Erlangen, Germany
Session Developer/Co-Chair: **Stephane Marie**,
AREVA NP, Paris La Defense, France

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8:15am
FA3 RPV Carbon Segregation Issue. Representativeness And Transferability Of Sacrificial Parts
Technical Paper Publication: PVP2018-84487

André Lefrancois, Benoit Lefever, *AREVA NP, Courbevoie, France*
Thierry Berger, *AREVA NP, Chalon Sur Saone, France*
Stephane Marie, *AREVA NP, Paris La Defense, France*

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8:41am
Thermo-Mechanical Justification of the FA3 Cover and Bottom Heads Under Normal, Abnormal And Accidental Loading Situations
Technical Paper Publication: PVP2018-84553

Stephane Chapuliot, *AREVA-NP, Paris La Défense, France*
Mickael Sportisse, Julien Hardouin, *FRAMATOME, Paris La Défense, France*
Stephane Vidard, *EDF/SEPTEN, Villeurbanne, France*

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9:07am
Assessment of the Fitness for Service of the Flamanville EPR Reactor Pressure Vessel Closure Head and Bottom Head Domes Containing a Segregation Zone Characterized by a High Carbon Content
Technical Paper Publication: PVP2018-84132

Isabelle Delvallee-Nunio, Olivier Loiseau, Daniel Monhardt, Audrey Buiron, Franck Dubois, *IRSN, Fontenay-aux-Roses, France*

9:33am
Flamanville EPR RPV'S Heads Carbon Segregation: Conlusions and Feedback Integration
Technical Presentation: PVP2018-84668

Bruno Marchal, Stephane Marie, *AREVA NP, Paris la Defense, France*

Session 3.1J (CS-23-1)
Hydrogen Flakes Assessment in the RPV's
Lobby, Barcelona 8:15am - 10:00am

Session Developer/Chair: **Valery Lacroix**, *Tractebel Engineering, Brussels, Belgium*
Session Developer/Co-Chair: **Pierre Dulieu**, *Tractebel, Brussels, Belgium*

8:15am
Mechanical Behaviour of a Forged Ferritic Steel Shell Containing Numerous Hydrogen Flakes
Technical Paper Publication: PVP2018-84087

Clementine Jacquemoud, *CEA, Gif Sur Yvette, France*
Isabelle Delvallee-Nunio, *IRSN, Fontenay-aux-Roses, France*

8:41am
Experimental and Numerical Investigations on the Failure Behavior of Pressurized Components Containing Crack Fields
Technical Paper Publication: PVP2018-84155

Patrick Gauder, Xaver Schuler, *Materials Testing Institute (MPA) University of Stuttgart, Stuttgart, Baden-Württemberg, Germany*,
Michael Seidenfuss, *IMWF, University of Stuttgart, Stuttgart, Germany*

9:07am
Towards a Process for the Assessment of Mixed Mode I+II Fracture Toughness
Technical Paper Publication: PVP2018-84575

Afaf Bouydo, *Tractebel Engie, Woluwé Saint Lambert, Belgium*
Valery Lacroix, *Tractebel Engineering, Brussels, Belgium*
Rachid Chaouadi, *SCK.CEN, Mol, Belgium*
Vratislav Mares, *Technical University of Ostrava, Ostrava-Poruba, Czech Republic*

9:33am
Numerical Investigations on the Interaction of Cracks in Quasi-Laminar Crack Fields
Technical Paper Publication: PVP2018-84688

Christian Swacek, Michael Seidenfuss, *IMWF, University of Stuttgart, Stuttgart, Germany*,
Xaver Schuler, *Materials Testing Institute (MPA) University of Stuttgart, Stuttgart, Baden-Württemberg, Germany*,

Session 3.1K (OAC-4-1)
Radioactive Materials (RAM) Storage and Transport - I
Lobby, Berlin 8:15am - 10:00am

Session Developer: **Mike Weber**, *Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany*
Session Chair: **Matthias Jaunich**, *Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany*
Session Co-Chair: **Zenghu Han**, *Argonne National Laboratory, Lemont, IL, USA*

8:15am
Application of Leakage Rates Measured on Scaled Cask or Component Models to the Package Containment Safety Assessment
Technical Paper Publication: PVP2018-84089

Annette Rolle, Viktor Ballheimer, Tino Neumeyer, Frank Wille, *Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany*

8:41am
Numerical Approach to Determine the Correct Puncture Bar Length for the IAEA Puncture Bar Drop Test
Technical Paper Publication: PVP2018-84614

Mike Weber, Viktor Ballheimer, Frank Wille, Uwe Zencker, *Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany*

9:07am
Results and Correlations from Analyses of the ENSA ENUN 32P Cask Transport Tests
Technical Paper Publication: PVP2018-84763

Elena Kalinina, Natalie Gordon, Douglas Ammerman, William Uncapher, Sylvia Saltzstein, Catherine Wright, *Sandia National Laboratories, Albuquerque, NM, USA*

9:33am
Temperature Prediction of a TN-32 Used Nuclear Fuel Canister Subjected to Vacuum Drying Conditions
Technical Paper Publication: PVP2018-84844

Megan Higley, Mustafa Hadj-Ncer, Miles Greiner, *University of Nevada, Reno, Reno, NV, USA*

9:33am
Experimental Study on the Effect of High Pressure Dissolved Gas on Wax Deposition
Technical Presentation: PVP2018-84365

Qianli Ma, **Wei Wang**, **Chuanshuo Wang, Jing Gong**, China University of Petroleum-Beijing, Beijing, China,

Session 3.1L (HPT-6-1)
Design and Evaluation of HPHT in Subsea Applications
Lobby, Brussels 8:15am - 10:00am

Session Developer/Chair: **Young-Hoon Han**, *Cameron International (A Schlumberger Company), Houston, TX, USA*
Session Developer/Co-Chair: **Kumarswamy Karpanan**, *TechnipFMC, Houston, TX, USA*

8:15am
Subsea Tree Connector Capacity Chart Per the Elastic-Plastic Analysis Methodology
Technical Paper Publication: PVP2018-84849

Ali Sepehri, Stuart Harbert, Joe Wilhelmi, *OneSubsea, A Schlumberger Company, Houston, TX, USA*

8:41am
Effect of Helix Angle on the Bending Capacity of a 5 Inch API Standard Flange
Technical Paper Publication: PVP2018-85162

Young-Hoon Han, Blake Shirley, Jason Pivowar, *Cameron International (A Schlumberger Company), Houston, TX, USA*

9:07am
Discussion of the Background of the Design Margins in API 17 TR8 HPHT Design Referencing ASME VIII Division 3
Technical Paper Publication: PVP2018-85131

Daniel Peters, *Structural Integrity Associates, Edinboro, PA, USA*
Man Pham, *Anadarko Petroleum, The Woodlands, TX, USA*

Session 3.1M (MF-14-1)
Composite Systems for Pressure Vessels and Piping - I
Lobby, Sofia 8:15am - 10:00am

Session Developer/Chair: **Mo Uddin**, *Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA*
Session Developer/Co-Chair: **Pierre Mertiny**, *University of Alberta, Edmonton, AB, Canada*

8:15am
Determination of Safety Factors for Repair of Buried Nuclear Safety Related Metallic Pipe Using Carbon Fiber Reinforced Polymer
Technical Paper Publication: PVP2018-84788

Michael Marohl, *Sargent & Lundy LLC, Chicago, IL, USA*
Rasko Ojdrovic, *Simpson Gumpertz & Heger, Waltham, MA, USA*

8:50am
Perspectives on Safety Margin Associated with Internal Repair Of Buried Class 2 and 3 Safety Related Piping Using Carbon Fiber Reinforced Polymer Composites
Technical Paper Publication: PVP2018-84972

Mo Uddin, *Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA*
Prabhat Krishnaswamy, *Engineering Mechanics Corporation of Columbus, Columbus, OH, USA*
Chakrapani Basavaraju, *US Nuclear Regulatory Commission, North Potomac, MD, USA*
Kamal Manoly, *US Nuclear Regulatory Commission, Rockville, MD, USA*

9:25am
Optimization of Curing Conditions and Nanofiller Incorporation for Production of High Performance Laminated Kevlar/Epoxy Nanocomposites
Technical Paper Publication: PVP2018-85067

Abdel-Hamid Ismail Mourad, Mouza Al Mansoori, Lamia AlMarzooqi, Farah Genena, Nizamudeen Cherupurakal, *UAE University, Al Ain 15551, UAE*

Session 3.1N (DA-14-1)
Evaluation and Countermeasure for BDBE - I
Lower Lobby, Madrid 8:15am - 10:00am

Session Developer: **Naoto Kasahara**, *Univ Of Tokyo, Tokyo 113 8656, Tokyo, Japan*
Session Co-Developer/Chair: **Bing Li**, *Kinectrics NSS, Kincardine, ON, Canada*
Session Co-Chair: **Tatsuhiro Yamazaki**, *Japan Nuclear Safety Institute, Tokyo, Japan*

8:15am
Proposal of the Local Failure Evaluation Method with Stress Parameters
Technical Paper Publication: PVP2018-84222

Takashi Sakaguchi, Mizuki Yoshida, *The University of Tokyo, Tokyo, Japan*
Takuya Sato, *Jgc Corporation, Yokohama, Japan*
Naoto Kasahara, *University Of Tokyo, Tokyo 113 8656, Tokyo, Japan*

8:41am
Contribution to Safety Enhancement for BDBE in Structure and Material Fields
Technical Paper Publication: PVP2018-84353

Naoto Kasahara, Takuya Sato, *The University of Tokyo, Tokyo, Japan*
Andrei Blahoianu, *Independent Nuclear Engineering Consultant, Ottawa, ON, Canada*

9:07am
Improved Model Tests to Investigate the Failure Modes of Pipes Under Beyond Design Basis Earthquakes
Technical Paper Publication: PVP2018-84424

Izumi Nakamura, *National Res Institute of Earth Sciences/ Disaster Prevention, Miki-shi, Hyogo 673-0515, Japan*
Naoto Kasahara, *University Of Tokyo, Tokyo 113 8656, Tokyo, Japan*

9:33am
Formula for Estimation of Effective Applied Moment at Cracked Section Considering Compliance Change and its Application under Dynamic Loading Conditions
Technical Paper Publication: PVP2018-84877

Yeji Kim, *Korea University, Seoul, Korea (Republic)*
Young-Jin Oh, *KEPCO Engineering and Construction, Gyeonggi-Do, Korea (Republic)*
Yun-Jae Kim, *Korea University, Seoul 136-701, Korea (Republic)*
Il Soon Hwang, *Seoul National University, Seoul, Korea (Republic)*

Technical Tutorial 3.1Q (TW-2-1)
Auto-Refrigeration & Brittle Fracture Prevention Part 1
Lower Lobby, Congress Hall III 8:15am - 10:00am

Session Developer/Chair: **Maher Younan**, *American University in Cairo, New Cairo 11835, Egypt*
Presented by: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*

Block 3.2 Wednesday, July 18 10:15AM - 12:00PM

Session 3.2A (MF-17-1)
Fatigue Performance of Welded Joints
Mezzanine, Karlin I 10:15am - 12:00pm

Session Developer/Chair: **Do-Jun Shim**,
Structural Integrity Associates, Inc., San Jose, CA, USA
Session Co-Chair: **Yinsheng Li**,
Japan Atomic Energy Agency, Ibaraki-Ken, Japan
Session Co-Developers: **Mo Uddin**,
Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA
David Rudland,
US NRC, Frederick, MD, USA
Matthew Kerr,
Naval Nuclear Laboratory - Knolls, Niskayuna, NY, USA

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10:15am
Low Cycle Fatigue Behavior of Alloy 800H Base Metal and Weldments at 700°C
Technical Paper Publication: PVP2018-84069

Seon Jin Kim, Rando Tungga Dewa, *Pukyong National University, Busan, Korea (Republic)*
Woo Gon Kim, Eung Seon Kim, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic)*

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10:50am
Effects of Socket Weld Field Condition on Vibration Fatigue Behavior of Carbon Steel Piping
Technical Paper Publication: PVP2018-84585

Chang-Young Oh, Dong-Woo Kim, Sanghoon Lee, Sangwoo Song, Namkyu Kim, *Korea Institute of Materials Science, Changwon, Korea (Republic)*,

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11:25am
Crack Growth Prediction for Cracked Dissimilar Metal Weld Joint in Pipe Under Large Seismic Cyclic Loading
Technical Paper Publication: PVP2018-85022

Yoshihito Yamaguchi, *Japan Atomic Energy Agency, Tokai-Mura, Japan*
Jinya Katsuyama, *Japan Atomic Energy Agency, Ibaraki, Japan*
Yinsheng Li, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*

Session 3.2B (CS-22-2)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - II
Mezzanine, Karlin II 10:15am - 12:00pm

Session Developer: **Masato Yamamoto**,
CRIEPI, Yokosuka, Japan
Session Co-Developer: **William L. Server**,
ATI-Consulting, Black Mountain, NC, USA
Session Chair: **Rachid Chaouadi**,
SCK.CEN, MOL, Belgium
Session Co-Chair: **Kentaro Yoshimoto**,
Mitsubishi Heavy Industries, Ltd., Takasago, Japan

•

10:15am
Master Curve Testing on Reconstituted Surveillance Charpy Specimens
Technical Paper Publication: PVP2018-84749

Ferenc Gillemot, Marta Horvath, Akos Horvath, Ildiko Szenthe, Attila Kovacs, *Hungarian Academy of Sciences Centre for Energy Research, Budapest, Hungary*

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10:41am
Master Curve Fracture Toughness Characterization of Eurofer97 Using Miniature Multi-Notch Bend Bar Specimens for Fusion Applications
Technical Paper Publication: PVP2018-85065

Xiang Chen, Mikhail A. Sokolov, Yutai Katoh, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Michael Rieth, *Karlsruhe Institute of Technology, Karlsruhe, Germany*
Logan N. Clowers, *The University of Tennessee, Knoxville, TN, USA*

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11:07am
Interlaboratory Study for Small Punch Testing Preliminary Results
Technical Paper Publication: PVP2018-84142

Milan Brumovsky, *UJV Rez, Rez, Czech Republic*
Radim Kopriva, *UJV Rez, a.s., Husinec, Czech Republic*

11:33am
Derivation of Mechanical Properties of Reactor Pressure Vessels in Korea Standard Nuclear Power Plants Using Small Punch Test Technique
Technical Presentation: PVP2018-84573

Seokmin Hong, Ki-Deuk Min, Jongmin Kim, Min-Chul Kim, Bongsang Lee, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic)*

Session 3.2C (MF-2-1) Hydrogen-Assisted Fatigue of Austenitic Stainless Steel
Mezzanine, Karlin III 10:15am - 12:00pm

Session Developer: **Chris San Marchi**, *Sandia National Laboratories, Livermore, CA, USA*
Session Chair: **Joseph Ronevich**, *Sandia National Laboratory, Livermore, CA, USA*
Session Co-Chair: **Laurent Briottet**, *French Alternative Energies and Atomic Energy Commission (CEA), Grenoble, France*

10:15am
Influence of Hydrogen on Tensile and Fatigue Life Properties of 304/308 Austenitic Stainless Steels Butt Welded Joints
Technical Paper Publication: PVP2018-84781

Saburo Okazaki, Hisao Matsunaga, Masami Nakamura, Shigeru Hamada, Saburo Matsuoka, *Kyushu University, Fukuoka, Japan*

10:41am
Effect of High Pressure Gaseous Hydrogen on Fatigue Properties of SUS304 and SUS316 Austenitic Stainless Steel
Technical Paper Publication: PVP2018-84267

Takashi Iijima, Bai An, Hirotoshi Enoki, *National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Ibaraki, Japan*
Junichiro Yamabe, *Kyushu University, Fukuoka, Japan*

11:07am
Fatigue Life Properties of Circumferentially-Notched Bar of Austenitic Stainless Steel with Various Stress Concentration Factors
Technical Paper Publication: PVP2018-84420

Naoaki Nagaishi, *Industrial Technology Center of SAGA, Saga, Japan*
Michio Yoshikawa, Saburo Okazaki, Hisao Matsunaga, Junichiro Yamabe, Saburo Matsuoka, *Kyushu University, Fukuoka, Japan*

11:33am
Global Harmonization of Fatigue Life Testing in Gaseous Hydrogen
Technical Paper Publication: PVP2018-84898

Chris San Marchi, *Sandia National Laboratories, Livermore, CA, USA*
Junichiro Yamabe, Saburo Matsuoka, *Kyushu University, Fukuoka, Japan*
Martina Schwarz, *Materials Testing Institute of Stuttgart, Stuttgart, Germany*
Hisao Matsunaga, *Kyushu University, Fukuoka, Japan*
Stefan Zickler, *Materialprüfungsanstalt Universität Stuttgart, 70569, Germany*
Hideo Kobayashi, *Tokyo Institute of Technology, Tokyo, Japan*

Session 3.2D (CS-9-1)
ASME Section XI Code Activities - I
Mezzanine, Palmovka 10:15am - 12:00pm

Session Developer/Chair: **Russell Cipolla**, *Intertek AIM, Santa Clara, CA, USA*
Session Co-Chair: **Ryan Crane**, *ASME, New York, NY, USA*

10:15am
Fatigue Crack Growth in Low Alloy Steels Under Tension-Compression Loading in Air
Technical Paper Publication: PVP2018-84467

Kisaburo Azuma, *Nuclear Regulation Authority, Japan, Tokyo, Japan*
Yasuhiro Yamazaki, *Chiba University, Chiba-shi, Chiba, Japan*

10:41am
Stress Intensity Factor Coefficients for Circumferential OD Surface Flaws in Cylinders for Appendix A of ASME Section XI
Technical Paper Publication: PVP2018-84381

Darrell Lee, *BWX Technologies, Barberton, OH, USA*,
Russell Cipolla, Michael Liu, *Intertek AIM, Santa Clara, CA, USA*,

11:07am
Investigation Of Calculating Stress Intensity Factor At Surface Point And Its Inclusion In Engineering Standards
Technical Paper Publication: PVP2018-85093

Steven Xu, *Kinectrics, Toronto, ON, Canada*
Greg Thorwald, *Quest Integrity Group, Boulder, CO, USA*
Patrick Le Delliou, *EDF - Electricite De France, Moret Sur Loing Cedex, France*
Russell Cipolla, *Intertek AIM, Santa Clara, CA, USA*

11:33am
Limit Load Solution of Non-Aligned Multiple Flaws
Technical Paper Publication: PVP2018-84809

Fuminori Iwamatsu, *Hitachi, Ltd., Ibaraki, Japan*
Katsumasa Miyazaki, *Hitachi Research Lab, Hitachi Ltd, Ibaraki-Ken 319-1292, Japan*
Koichi Saito, *Hitachi-GE Nuclear Energy, Ltd., Hitachi, Japan*

Session 3.2E (FSI-2-4)
Acoustics and Piping Vibrations
Mezzanine, Rokoska 10:15am - 12:00pm

Session Developer: **Njuki Mureithi**, *Polytechnique Montreal, Montreal, QC, Canada*
Session Co-Chair: **Fu-Rui Xiong**, *Nuclear Power Institute of China, Chengdu, China*
Session Chair: **Maciej Rydlewicz**, *Centrum Systemow Softdesk, Lodz, Poland*

10:15am
Simulation of Acoustic-Structure Interaction by Using Finite Element Analysis in Reactor Pressure Vessel of PWR
Technical Paper Publication: PVP2018-84496

Koji Maeta, Keisuke Matsuyama, Hideyuki Morita, *Mitsubishi Heavy Industries, Ltd, Takasago, Hogo, Japan*
Hirokazu Sugiura, *Mitsubishi Heavy Industries, Ltd, Kobe, Japan*
Shigeyuki Watanabe, *Mitsubishi Heavy Industries, Ltd., Tokyo, Japan*
Akihisa Iwasaki, *MHI, Takasago, Japan*,
Yoshito Nishikawa, *The Kansai Electric Power Co., Inc., Osaka, Japan*

10:50am
Prediction of Elbow Flow Dynamics Using Correlated Wall Pressure Data
Technical Paper Publication: PVP2018-84712

André Baramili, Loïc Ancian, *Vibratec, Ecully, Rhône-Alpes, France*
Ludovic Chatellier, Laurent David, *University of Poitiers, Poitiers, Vienne, France*

11:25am
Fluid Structure Coupling Analysis on Flow Induced Vibration in Tee Junction Pipes
Technical Paper Publication: PVP2018-85135

Takahiro Ishigami, Masato Nishiguchi, *Chiyoda Corporation, Yokohama-Shi, Japan*
Hisao Izuchi, Munenori Maekawa, *Chiyoda Corporation, Yokohama, Kanagawa Pref., Japan*

Session 3.2F (SE-4-2)
Structural Dynamics - II
Mezzanine, Hercovka 10:15am - 12:00pm

Session Developer: **Katsuhisa Fujita**, *Osaka City University, Osaka, Japan*
Session Co-Developer/Chair: **Kiyoshi Aida**, *Mitsubishi Hitachi Power Systems, Ltd., Kure-Shi, Japan*
Session Co-Chair: **Keisuke Minagawa**, *Saitama Institute of Technology, Saitama, Japan*

10:15am
Dynamic Analysis and Design Methods for Combustion Turbine Exhaust Silencers Employing Acoustical Baffles
Technical Paper Publication: PVP2018-84160

Agron Gjinolli, Jason Dorgan, *Babcock & Wilcox Universal Inc., Stoughton, WI, USA*,
Elden Ray, *Babcock & Wilcox Universal Inc., Warrenton, VA, USA*

10:36am
Approximate Formulas for Cylindrical Shell Free Vibration Based on Vlasov's and Enhanced Vlasov's Semi-Momentless Theory
Technical Paper Publication: PVP2018-84932

Igor Orynyak, *G.S. Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Yaroslav Dubyk, *IPP-Centre, Kiev, Ukraine*

10:57am
Study on the Predictive Evaluation Method of Nonlinear Sloshing Wave Height of Cylindrical Tanks (Part1: Shaking table test results and verification results of analytical method for nonlinear sloshing)
Technical Paper Publication: PVP2018-84416

Hideyuki Morita, Tomoshige Takata, Hideki Madokoro, Hiromi Sago, *Mitsubishi Heavy Industries, Ltd., Takasago, Hyogo-ken, Japan*
Hisatomo Murakami, *Mitsubishi Heavy Industries, Ltd., Kobe, Hyogo-ken, Japan*
Shinobu Yokoi, *Mitsubishi FBR Systems, Inc., Tokyo, Japan*
Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*

11:18am
Study on the Predictive Evaluation Method of Nonlinear Sloshing Wave Height of Cylindrical Tanks (Part 2: Proposal and examination of applicability of the predictive evaluation method)
Technical Paper Publication: PVP2018-84419

Hiromi Sago, Hideyuki Morita, Tomoshige Takata, Hideki Madokoro, *Mitsubishi Heavy Industries, Ltd., Takasago, Hyogo-ken, Japan*
Hisatomo Murakami, *Mitsubishi Heavy Industries, Ltd., Kobe, Hyogo-ken, Japan*
Shinobu Yokoi, *Mitsubishi FBR Systems, Inc., Tokyo, Japan*
Tomohiko Yamamoto, *JAEA, Higashi-Ibaraki, Japan*

11:39am
Seismic Response of a Cylindrical Water Storage Tank of Nuclear Power Plant Under Large Seismic Motion
Technical Paper Publication: PVP2018-84896

Shinichi Matsuura, *CRIEPI, Abiko-shi, Chiba-ken, Japan*
Ichiro Tamura, *The Chugoku Electric Power Company, Hiroshima, Japan*

Session 3.2G (DA-10-5)
Bolted Joint Progress - International Liaison - II
Mezzanine, Tyrolka 10:15am - 12:00pm

Session Developer/Chair: **Warren Brown**, *Integrity Engineering Solutions, Dunsborough, WA, Australia*
Session Developer/Co-Chair: **Clay Rodery**, *C&S Technology, LLC, League City, TX, USA*

10:15am
Update on Pressure Boundary Bolted Joint Activity from Brazil
Technical Presentation: PVP2018-84887

Jose Veiga, *Teadit Industria e Comercio Ltda, Rio De Janeiro/RJ, Brazil*

10:50am
An Update on Pressure Boundary Bolted Joint Activities in Australia
Technical Presentation: PVP2018-85006

Warren Brown, *Integrity Engineering Solutions, Dunsborough, WA, Australia*

11:25am
International Liaison on Bolted Flanged Joints - Updates from Europe & Germany
Technical Presentation: PVP2018-85105

Manfred Schaaf, *AMTEC Advanced Measurement Messtechnischer Service GmbH, Lauffen am Neckar, Germany*

Session 3.2H (CS-6-1)
API 579/ASME Code Fitness-For-Service Activities
Lobby, Amsterdam 10:15am - 12:00pm

Session Developer/Chair: **Phillip E. Prueter**, *The Equity Engineering Group, Inc., Shaker Heights, OH, USA*
Session Co-Chair: **Seetha Ramudu Kummari**, *The Equity Engineering Group, Inc., Copley, OH, USA*

10:15am
Initial Developments for LBB Application to HTHA Sensitive Non-Stress Relieved Carbon Steel Girth Welds in Refinery Plants
Technical Paper Publication: PVP2018-84669

Gery Wilkowski, Yunior Hioe, Elizabeth Kurth, Ed Punch, Mo Uddin, Frederick (Bud) Brust, *Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA*
Kenneth Bagnoli, Greg Pioszak, *Exxon Mobil Research and Engineering, Spring, TX, USA*

10:41am
A Residual Stress Profile Estimation Method for Narrow Groove Girth Welds
Technical Paper Publication: PVP2018-84858

Shaopin Song, Pingsha Dong, *University of Michigan, Ann Arbor, MI, USA*

11:07am
A Comprehensive Structural Strain Method Incorporating Strain-Hardening Effects: From LCF to Ratcheting Evaluations
Technical Paper Publication: PVP2018-84860

Xianjun Pei, Pingsha Dong, Shaopin Song, *University of Michigan, Ann Arbor, MI, USA*
David Osage, *The Equity Engineering Group, Inc., Beachwood, OH, USA*

11:33am
New Fatigue Screening Criteria for the Fitness-for-Service Assessment of In-Service Process Piping Vibrations
Technical Paper Publication: PVP2018-84847

Michael F. P. Bifano, Anthony J. Feller, *The Equity Engineering Group, Inc, Shaker Heights, OH, USA*
Lyle Breaux, *Stress Engineering Services, Metairie, LA, USA*
Richard Brodzinski, *BP, Naperville, IL, USA*

Session 3.2I (MF-4-3)
European Programs In Structural Integrity - I
Lobby, Athens 10:15am - 12:00pm

Session Developer: **Dominique Moinereau**, *Electricite De France, Moret Sur LoingF-77818, France*
Session Co-Developer: **Elisabeth Keim**, *AREVA, Erlangen, Germany,*
Stephane Marie, *AREVA NP, Paris La Defense, France*
Session Co-Developer/Chair: **Peter James**, *Wood, Warrington, Cheshire, UK*
Session Developer/Co-Chair: **Tomas Nicak**, *Framatome GmbH, Erlangen, Germany*

10:15am
Advanced Structural Integrity Assessment Tools for Safe Long Term Operation (ATLAS+)
Technical Paper Publication: PVP2018-84554

Kim Wallin, *VTT Nuclear Safety, Espoo, Finland*
Dominique Moinereau, *Electricite De France, Moret Sur Loing F-77818, France*
Mike Smith, *University of Manchester, Manchester, UK*
Stephane Marie, *AREVA NP, Paris La Defense, France*
Peter Dillström, *KIWA Inspecta Technology, Stockholm, Sweden*
Elisabeth Keim, *AREVA, Erlangen, Germany*
Szabolcs Szavai, *Bay Zoltan Nonprofit Ltd. for Applied Research, Miskolc, Hungary*
Sebastian Lindqvist, *VTT, Espoo, Finland*

10:41am
ATLAS+: Design of Large Scale Fracture Mechanics Tests on a Ferritic Pipe
Technical Paper Publication: PVP2018-84628

Tomas Nicak, *Framatome GmbH, Erlangen, Germany*
Patrick Le Delliou, *EDF - Electricite De France, Moret Sur Loing Cedex, France*
Anna DahlL, *EDF, Moret-sur-Loing, France*
Tobias Bolinder, *Inspecta Technology AB, Stockholm, Sweden*
Elisabeth Keim, *AREVA, Erlangen, Germany*
Kim Wallin, *VTT Nuclear Safety, Espoo, Finland*
Alexander Eriksson, *Kiwa Inspecta, Stockholm, Sweden*

11:07am
Weld Residual Stress Activities within the ATLAS+ Project
Technical Paper Publication: PVP2018-84633

Mike Smith, *University of Manchester, Manchester, UK*

11:33am
The Experimental Work in Support to ATLAS+ Project
Technical Paper Publication: PVP2018-84697

Dominique Moinereau, Patrick Le Delliou, Anna Dahl, *EDF, Moret-sur-Loing, France*
Yann Kayser, *CEA, Saclay, France*
Szabolcs Szavai, *Bay Zoltan Nonprofit Ltd. for Applied Research, Miskolc, Hungary*
Levente Tatar, **MTA EK, Budapest, Hungary**
Tobias Bolinder, *KIWA Inspecta, Stockholm, Sweden*
Marta Serrano, *CIEMAT, Madrid, Spain*
Jacques Besson, *ARMINES Centre des Matériaux, Evry, France*
Tomas Nicak, *Framatome GmbH, Erlangen, Germany*
Stephane Marie, *Framatome, Paris La Défense, France*
Kim Wallin, *VTT Nuclear Safety, Espoo, Finland*

Session 3.2J (CT-9-1)
New and Emerging Methods of Analysis and Applications
Lobby, Barcelona 10:15am - 12:00pm

Session Developer/Chair: **Young Ho Park**, *New Mexico State University, Las Cruces, NM, USA*
Session Developer/Co-Chair: **John Vande Voorde**, *OCAS Nv, Zelzate, Belgium*

10:15am
Prediction of the Leakage Threshold for Hertzian Contact Seals: A Cellular Automata Model
Technical Paper Publication: PVP2018-84404

John Vande Voorde, *OCAS Nv, Zelzate, Belgium*
Jeroen Van Wittenberghe, *OCAS, Ghent, Belgium*

10:41am
Study Of Oil&Gas Pipeline Real-Time Inspection and Monitoring Systems Based on Wireless Sensor Networks Technology
Technical Presentation: PVP2018-84528

Hong-Bo Zhang, Qiang Liu, Qiang Bai, Nan Ding, Yang Yang, Sheng-Yin Song, *Neng Lv, Tubular Goods Research Institute of CNPC, Xi'an, China*

11:07am
Stress and Damage Analysis of Fiber-Reinforced Composite Pipe
Technical Paper Publication: PVP2018-84673

Isaiah Ramos, Young Ho Park, *New Mexico State University, Las Cruces, NM, USA*
Jordan Ulibarri-Sanchez, *NMSU, Las Cruces, NM, USA*

11:33am
A Crystal Plasticity Based Model and 3-D Microstructure Representation of High-Strength Steel Alloys
Technical Paper Publication: PVP2018-85137

Khaled H. Khafagy, Tarek M. Hatem, *The British University in Egypt, Cairo, Egypt*

Session 3.2K (OAC-4-2)
Radioactive Materials (RAM) Storage and Transport - II
Lobby, Berlin 10:15am - 12:00pm

Session Developer/Chair: **Mike Weber**, *Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany*
Session Co-Chair: **Mustafa Hadj-Nacer**, *University of Nevada, Reno, Reno, NV, USA*

10:15am
Comparison of Thermal Test Using Slice Model and Half-Scale Model of Shipping Package
Technical Paper Publication: PVP2018-84260

Kyoung-Sik Bang, Seung-Hwan Yu, Ju-Chan Lee, Woo-Seok Choi, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic)*

10:41am
Investigation of the Time and Temperature Dependent Behavior of Metal Seals in Radioactive Waste Containers
Technical Paper Publication: PVP2018-84584

Tobias Grelle, Dietmar Wolff, Ulrich Probst, Matthias Jaunich, Holger Völzke, *BAM Bundesanstalt für Materialforschung und -prüfung, Berlin, Germany*

11:07am
A Compact Type B Packaging Design for De-inventory of Cs/Sr Capsules
Technical Presentation: PVP2018-85133

Zenghu Han, *Argonne National Laboratory, Lemont, IL, USA*,
Jie Li, Dimitrios Kontogeorgakos, Yung Liu, *Argonne National Laboratory, Argonne, IL, USA*,
James Shuler, *Department of Energy, Washington, D.C., DC, USA*

11:33am
Optimal Design of Spent Fuel Containment Impact Limiter by Response Surface Method
Technical Paper Publication: PVP2018-84429

Haijun Hu, Qiqi Tong, Yun Li, Sheng Wang, *Xi'an Jiaotong University, Xi'an, Shaanxi, China*
Fei Fan, Hai Ye, Peizhen Sheng, Jiancang Li, *Lanzhou Lanshi Energy Equipment Institute Co., Ltd., Lanzhou, Gansu, China*,

Session 3.2L (HPT-6-2)
Subsea Fatigue, Fracture and Vibration
Lobby, Brussels 10:15am - 12:00pm

Session Developer/Chair: **Kumarswamy Karpanan**, *TechnipFMC, Houston, TX, USA*
Session Developer/Co-Chair: **Chris Tipple**, *Structural Integrity Associates, Centennial, CO, USA*
Kannan Subramanian, *Stress Engineering Services, Metairie, LA, USA*

10:15am
Fracture Mechanics Fatigue Evaluation of a Flowline Clamp Connector Using Finite Element Modeling of a Crack
Technical Paper Publication: PVP2018-85164

Curtis Sifford, Ali Shirani, *OneSubsea A Schlumberger Company, Houston, TX, USA*

10:41am
Shock and Vibration Qualification Using FEA for a Pressure Vessel in a Drilling Tool
Technical Presentation: PVP2018-84941

Nagarajan Balasubramanian, *Schlumberger, Houston, TX, USA*

11:07am
Weld Rod Fatigue Analysis Using Effective Notch Stress Method
Technical Paper Publication: PVP2018-84122

Kumarswamy Karpanan, Allison Weber Kirk, Gerald Hershman, *TechnipFMC, Houston, TX, USA*

11:33am
Advanced High Strength Martensitic Stainless Steels for High Pressure Equipment
Technical Paper Publication: PVP2018-84546

Jean-Marc Lardon, Thibault Poulain, *Aubert-Duval, Les Ancizes, France*

Session 3.2M (MF-14-2)
Composite Systems for Pressure Vessels and Piping - II
Lobby, Sofia 10:15am - 12:00pm

Session Developer/Chair: **Mo Uddin**,
Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA
Session Developer/Co-Chair: **Pierre Mertiny**,
University of Alberta, Edmonton, AB, Canada

10:15am
Winding: Autofrettage Study on Reinforced Thermoplastics Vessel Based on ANSYS ACP
Technical Paper Publication: PVP2018-84085

Jinhao Huang, Cheng-Hong Duan, *College of Mechanical Engineering, Beijing University of Chemical Technology, Beijing, China*,
Liang Wu, *China Land Engineering Technology Limited Liability Company, Xian, China*
Xiangpeng Luo, *Beijing University of Chemical Technology, Beijing, China*

10:41am
Study on Fatigue Characteristics of CFRP
Technical Paper Publication: PVP2018-85081

Tatsumi Takehana, Toshihiro Yamada, Takeru Sano, Katsuyuki Kimura, Tetsuji Miyashita, Yuta Shiga, *The High Pressure Gas Safety Institute of Japan, Machida-shi, Tokyo, Japan*
Nobuhiro Yoshikawa, *University of Tokyo, Tokyo, Japan*, *Hiroshi Kobayashi, Japan Petroleum Energy Center, Tokyo, Japan*

11:07am
Study on Stress Rupture Characteristics of CFRP
Technical Paper Publication: PVP2018-85082

Takeru Sano, Tatsumi Takehana, Toshihiro Yamada, Tetsuji Miyashita, Yuta Shiga, *The High Pressure Gas Safety Institute of Japan, Machida-shi, Tokyo, Japan*
Nobuhiro Yoshikawa, *University of Tokyo, Tokyo, Japan*
Hiroshi Kobayashi, *Japan Petroleum Energy Center, Tokyo, Japan*

11:33am
Bolted Flange Joint Made of Glass Fibre Reinforced Polymer (GFRP) for Pipelines
Technical Paper Publication: PVP2018-84593

Muhsin Aljuboury, Md Jahir Rizvi, Stephen Grove, Richard Cullen, *Plymouth University, Plymouth, Devon, UK*

Session 3.2N (DA-14-2)
Evaluation and Countermeasure for BDBE - II
Lower Lobby, Madrid 10:15am - 12:00pm

Session Developer: **Bing Li**,
Kinectrics NSS, Kincardine, ON, Canada
Session Co-Developer/Chair: **Naoto Kasahara**,
Univ Of Tokyo, Tokyo 113 8656, Tokyo, Japan
Session Co-Chair: **Yun-Jae Kim**,
Korea Univ, Seoul 136-701, Korea (Republic)

10:15am
Effect of 3-D Initial Imperfections on the Deformation Behaviors of Head Plates Subjected to Convex Side Pressure
Technical Paper Publication: PVP2018-84533

Hiroki Yada, Kazuyuki Tsukimori, *Japan Atomic Energy Agency, Fukui, Japan*
Masanori Ando, *Japan Atomic Energy Agency, Shiraki 1, Japan*
Masakazu Ichimiya, Yoshinari Anoda, *Fukui University, Fukui-Ken, Japan*

10:36am
Evaluation of Deformation and Failure Behaviors of Nuclear Components Using a Simulated Specimen Under Excessive Seismic Loads
Technical Paper Publication: PVP2018-84576

Jin Weon Kim, *Chosun University, Gwangju, Korea (Republic)*
Ik Hyun Song, *Chosun University, Gwangju, Korea (Republic)*
Hyeong Do Kweon, *Korea Hydro & Nuclear Power Co., LTD, Daejeon, Korea (Republic)*
Jong-sung Kim, *Sejong University, Seoul, Korea (Republic)*
Yun-Jae Kim, *Korea University, Seoul 136-701, Korea (Republic)*

10:57am
Comparison of Various Cyclic Hardening Models for Notched C(T) Specimen Simulation Under Cyclic Loading
Technical Paper Publication: PVP2018-84579

Jong-Min Lee, *Korea University, Seoul, Korea (Republic)*
Hune-Tae Kim, *Korea University, Seongbuk-Gu, Seoul, Korea (Republic)*
Yun-Jae Kim, *Korea University, Seoul 136-701, Korea (Republic)*
Jin Weon Kim, *Chosun University, Kwangju, Korea (Republic)*

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11:18am
Applicability of Nonlinear Kinematic Hardening Models to Low Cycle Fatigue Simulation of C(T) Specimen
Technical Paper Publication: PVP2018-84653

Hune-Tae Kim, *Korea University, Seongbuk-Gu, Seoul, Korea (Republic)*
Gyo-Geun Youn, Jong-Min Lee, *Korea University, Seoul, Korea (Republic)*
Yun-Jae Kim, *Korea University, Seoul 136-701, Korea (Republic)*
Jin Weon Kim, *Chosun University, Gwangju, Korea (Republic)*

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11:39am
Evaluation of Gas Accumulation in RCIC System Discharge Piping of BWR Nuclear Power Plant
Technical Paper Publication: PVP2018-84256

Chao Jen Li, Zhen-Yu Hung, *Pei-Hsun Huang, Industrial Technology Research Institute, Hsinchu, Taiwan*

Session 3.20 (CT-8-3)
Adhesive Joining
Lower Lobby, Congress Hall I 10:15am - 12:00pm

Session Developer/Chair: **Giovanni Belingardi**, *Politecnico di Torino, Torino, Italy*
Session Co-Chair: **Valentina Brunella**, *Department of Chemistry, University of Turin, Torino, Italy*

10:15am
Ultrasonic Very High Cycle Fatigue (VHCF) Tests on a High Strength Epoxy Adhesive
Technical Presentation: PVP2018-84677

Andrea Tridello, Davide S. Paolino, Luca Goglio, Giorgio Chiandussi, Massimo Rossetto, *Politecnico di Torino, Torino, Italy*

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10:41am
Experimental Assessment of the Dynamic Behavior of a Thermoplastic Hot Melt Adhesive
Technical Paper Publication: PVP2018-84725

Raffaele Ciardiello, Andrea Tridello, Luca Goglio, Giovanni Belingardi, *Politecnico di Torino, Torino, Italy*

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11:07am
Experimental and Numerical Analysis of a Pristine and a Nano-Modified Thermoplastic Adhesive
Technical Paper Publication: PVP2018-84728

Carlo Boursier Niutta, Raffaele Ciardiello, Giovanni Belingardi, *Politecnico di Torino, Torino, Italy*
Alessandro Scattina, *Politecnico Di Torino - Department of Mechanical and Aerospace Engineering, Torino, Italy*

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11:33am
Effect of Autoclave Cure Time and Surface Preparation on Film Adhesive Bond in Lightweight Material Joints
Technical Paper Publication: PVP2018-84009

Isotta Morfini, Sayed Nassar, *Oakland University, Rochester, MI, USA*
Luca Goglio, Giovanni Belingardi, *Politecnico di Torino, Torino, Italy*

Technical Tutorial 3.2Q (TW-2-2)
Auto-Refrigeration & Brittle Fracture Prevention Part 2
Lower Lobby, Congress Hall III 10:15am - 12:00pm

Session Developer/Chair: **Maher Younan**, *American University in Cairo, New Cairo 11835, Egypt*
Presented by: **Kannan Subramanian**, *Stress Engineering Services, Metairie, LA, USA*

Block 3.3 Wednesday, July 18 2:15PM - 4:00PM

Session 3.3A (MF-17-2)
Impact of Microstructure on Mechanical Properties
Mezzanine, Karlin I 2:15pm - 4:00pm

Session Developer/Chair: **Mo Uddin**, *Engineering Mechanics Corporation of Columbus, Upper Arlington, OH, USA*
Session Co-Developer: **Matthew Kerr,** *Naval Nuclear Laboratory - Knolls, Niskayuna, NY, USA*
David Rudland, *US NRC, Frederick, MD, USA*
Session Developer/Co-Chair: **Do-Jun Shim**, *Structural Integrity Associates, Inc., San Jose, CA, USA*

•

2:15pm
Effect of Weld Strength Mismatch and Weld Width on the Fracture Toughness Determined from SENB Specimens
Technical Paper Publication: PVP2018-84194

Philippa Moore, Natalia Garban, Philippe Bastid, *TWI Ltd, Cambridge, Cambs, UK*
Kevin Hughes, *Brunel University London, Cambridge, Cambs, UK*

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2:50pm
Characterization of Dissimilar Welded Joints Between Austenitic and Duplex Stainless Steel Grades for Liquid Tank Applications
Technical Paper Publication: PVP2018-84997

Graziano Ubertalli, Monica Ferraris, Paolo Matteis, Davide Di Saverio, *Politecnico di Torino, Torino, Italy*

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3:25pm
The Thermo-Mechanical Behaviour of the Alloy 600 and Alloy 82 Materials
Technical Paper Publication: PVP2018-84592

Vasileios Akrivos, *The University of Manchester, Manchester, UK*
Mike Smith, *University of Manchester, Manchester, UK*

Session 3.3B (CS-22-3)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - III
Mezzanine, Karlin II 2:15pm - 4:00pm

Session Developer/Chair: **Robert G. Carter**, *EPRI, Charlotte, NC, USA*
Session Co-Chair: **Xiang Chen**, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Session Co-Developers: **Masato Yamamoto**, *CRIEPI, Yokosuka, Japan*
William L. Server, *ATI-Consulting, Black Mountain, NC, USA*

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2:15pm
Use of Mini-CT Specimens for Fracture Toughness Characterization of Low Upper-Shelf Linde 80 Weld Before And After Irradiation
Technical Paper Publication: PVP2018-84804

Mikhail A. Sokolov, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*

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2:41pm
Trial Study of the Master Curve Fracture Toughness Evaluation by Mini-C(T) Specimens for Low Upper Shelf Weld Metal Linde-80
Technical Paper Publication: PVP2018-84906

Masato Yamamoto, *CRIEPI, Yokosuka, Japan*

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3:07pm
Fracture Toughness Characterization of Low Upper-Shelf Linde 80 Weld Using Mini-Ct Specimens
Technical Paper Publication: PVP2018-84967

Michael R. Ickes, *Westinghouse, Pittsburgh, PA, USA*
J. Brian Hall, *Westinghouse, Churchill, PA, USA*
Robert G. Carter, *EPRI, Charlotte, NC, USA*

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3:33pm
Inter-laboratory Results and Analyses of Mini-C(T) Specimen Testing of an Irradiated Linde 80 Weld Metal
Technical Paper Publication: PVP2018-84950

William Server, *ATI Consulting, Black Mountain, NC, USA*
Mikhail A. Sokolov, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Masato Yamamoto, *CRIEPI, Yokosuka, Japan*
Robert G. Carter, *EPRI, Charlotte, NC, USA*

Session 3.3C (MF-2-2)
Materials Evaluation Methods for Hydrogen Service
Mezzanine, Karlin III 2:15pm - 4:00pm

Session Developer/Chair: **Chris San Marchi,** *Sandia National Laboratories, Livermore, CA, USA*
Session Co-Developer: **May Martin**, *National Institute of Standards and Technology, Boulder, CO, USA*
Session Co-Chair: **Takashi Iijima**, *AIST, Tsukuba, Japan*

2:15pm
Methods of Material Testing in High-Pressure Hydrogen Environment and Evaluation of Hydrogen Compatibility of Metallic Materials: Current Status in Japan
Technical Paper Publication: PVP2018-84112

Hideo Kobayashi, *Tokyo Institute of Technology, Tokyo, Japan*
Hiroshi Kobayashi, *Japan Petroleum Energy Center, Tokyo, Japan*
Takeru Sano, *The High Pressure Gas Safety Institute of Japan, Machida-shi, Tokyo, Japan*
Takashi Maeda, *JRCM, Tokyo, Japan*
Hiroaki Tamura, *JARI, Tokyo, Japan*
Ayumu Ishizuka, *JAMA, Tochigi, Japan*
Mitsuo Kimura, Nobuhiro Yoshikawa, *University of Tokyo, Tokyo, Japan*
Takashi Iijima, *AIST, Tsukuba, Japan*
Junichiro Yamabe, Saburo Matsuoka, Hisao Matsunaga, *Kyushu University, Fukuoka, Japan*

2:41pm
Influence of 70 MPa Hydrogen Gas on SUS 630 from 77 K To 373 K by Simple Testing Method
Technical Paper Publication: PVP2018-84462

Toshio Ogata, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*

3:07pm
Imaging Hydrogen in Stainless Steel Alloys by Kelvin Probe Force Microscopy
Technical Paper Publication: PVP2018-84755

Joy McNamara, Andrew Duncan, Michael Morgan, Paul Korinko, *Savannah River National Laboratory, Aiken, SC, USA*

3:33pm
Simple Mechanical Testing Method to Evaluate Influence of High Pressure Hydrogen Gas
Technical Paper Publication: PVP2018-84187

Toshio Ogata, *National Institute for Materials Science, Tsukuba, Ibaraki, Japan*

Session 3.3D (CS-9-2)
ASME Section XI Code Activities - II
Mezzanine, Palmovka 2:15pm - 4:00pm

Session Developer/Chair: **Russell Cipolla**, *Intertek AIM, Santa Clara, CA, USA*
Session Co-Chair: **Ryan Crane**, *ASME, New York, NY, USA*

2:15pm
Three Approaches to Quantification of NDE Uncertainty and a Detailed Exposition of the Expert Panel Approach using the Sheffield Elicitation Framework
Technical Paper Publication: PVP2018-84771

Jeffrey Fong, N. Alan Heckert, James J. Filliben, *National Institute of Standards & Technology, Gaithersburg, MD, USA*
Steven Doctor, *Pacific Northwest National Laboratory, Richland, WA, USA*

2:41pm
Definition of Fatigue Crack Growth Thresholds for Ferritic Steels in Fitness-for-Service Codes
Technical Paper Publication: PVP2018-84940

Kunio Hasegawa, *VSB-Technical University of Ostrava, Ostrava-Poruba, Czech Republic*
Bohumir Strnadel, *Technical University of Ostrava, Ostrava-Poruba, Czech Republic*

3:07pm
Fatigue Crack Growth for Ferritic Steel Under Negative Stress Ratio
Technical Paper Publication: PVP2018-84961

Yoshihito Yamaguchi, *Japan Atomic Energy Agency, Tokai-Mura, Japan*,
Kunio Hasegawa, Yinsheng Li, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*

3:33pm
Revision to Stress Intensity Factor Equations for ASME Section XI Appendix C-4000, Determination of Failure Mode
Technical Paper Publication: PVP2018-85051

Kiminobu Hojo, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*
Steven Xu, *Kinectrics, Toronto, ON, Canada*

Session 3.3E (FSI-2-5)
FIV of Multi-span Structures
Mezzanine, Rokoska 2:15pm - 4:00pm

Session Developer: **Njuki Mureithi**, *Polytechnique Montreal, Montreal, QC, Canada*
Session Chair: **André Baramili**, *Vibratec, Ecully, Rhône-Alpes, France*
Session Co-Chair: **Liyan Liu**, *Tianjin University, Tianjin, China*

2:15pm
Study on the Simplified Method of Special Supporting Structure for Steam Generator Tubes
Technical Paper Publication: PVP2018-84349

Wei Tan, Songyuan Jiang, Zhao Li, Zhanbin Jia, Liyan Liu, *Tianjin University, Tianjin, China*

2:50pm
Vibration and Stability Analysis of Pipe Conveying Fluid Using Dynamic Stiffness Matrix and Numerical Methods
Technical Paper Publication: PVP2018-84408

Mohamed Aboulella, *PGESCo | Power Generation Engineering and Services Company, Cairo, Egypt*,
Tamer Ahmed El-Sayed, Said Hamed Farghaly, *Faculty of Engineering El-Mataria, Helwan University, Cairo, Egypt*

3:25pm
A Simplified Approach to Estimate Flow-Induced Vibrations on an Elbowed Piping System
Technical Paper Publication: PVP2018-84717

André Baramili, Loïc Ancian, *Vibratec, Ecully, Rhône-Alpes, France*,
Ludovic Chatellier, Laurent David, *University of Poitiers, Poitiers, Vienne, France*,

Session 3.3F (SE-1-1)
Earthquake Resistance and Seismic Margin
Mezzanine, Hercovka 2:15pm - 4:00pm

Session Developer/Chair: **Tomoyo Taniguchi**, *Tottori University, Tottori, Japan*
Session Developers/Co-Chair: **Akira Maekawa**, *The Kansai Electric Power Co., Inc., Fukui, Japan*
Izumi Nakamura, *National Research Institute of Earth Sciences/Disaster Prevention, Miki-shi, Hyogo 673-0515, Japan*

2:15pm
The Simulation of Strong Ground Motion Using Empirical Green Function and Stochastic Method for Southern Taiwan Area
Technical Paper Publication: PVP2018-84670

Tsung-Jen Teng, Pei-Ting Chen, *National Center for Research on Earthquake Engineering, Taipei, Taiwan*
Ting-Wei Chang, Yuan-Sen Yang, Wen-I Liao, *National Taipei University of Technology, Taipei, Taiwan*
Chien-Kuo Chiu, *National Taiwan University of Science and Technology, Taipei, Taiwan*

2:50pm
Estimation Accuracy of Absolute Maximum Elasto-Plastic Displacements of MDOF Oscillators Based on a Modal Combination Rule With Post-Yielding Modal Properties and Linear Response Spectrum Values
Technical Paper Publication: PVP2018-84237

Tomoyo Taniguchi, Yusuke Ono, Kyosuke Mukaibo, *Tottori University, Tottori, Japan*
Yoshihiko Toda, *JIP Techno-Science, Osaka, Osaka, Japan*

3:25pm
Applicability of the Simplified Analysis and Relevant Calculations to Evaluating Uplift Displacement of Unanchored Tanks
Technical Paper Publication: PVP2018-84239

Tomoyo Taniguchi, *Tottori University, Tottori, Japan*
Yuichi Yoshida, *Kawasaki Heavy Industries, Ltd., Kobe, Hyogo, Japan*
Ken Hatayama, *National Research Institute of Fire and Disaster, Chofu, Tokyo, Japan*

Session 3.3G (DA-10-1)
Bolted Joint Codes and Standards
Mezzanine, Tyrolka 2:15pm - 4:00pm

Session Co-Developer/
Co-Chair: **Warren Brown**,
Integrity Engineering Solutions, Dunsborough, WA, Australia
Session Co-Developer/Chair: **Clay Rodery**,
C&S Technology, LLC, League City, TX, USA

2:15pm
ASME PCC-1:2018—-What is New and Different?
Technical Paper Publication: PVP2018-84902

Clay Rodery, *C&S Technology, LLC, League City, TX, USA*
Warren Brown, *Integrity Engineering Solutions, Dunsborough, WA, Australia*

2:41pm
Comparison of Different Bolt Elongation Load Control Methods
Technical Paper Publication: PVP2018-85004

Warren Brown, Tze-Yew Lim, *Integrity Engineering Solutions, Dunsborough, WA, Australia*
Graeme Brown, *Bureau Veritas, Canningvale, Western Australia, Australia*

3:07pm
Stud Bolt Thread Engagement & Implications of Applying New Construction Requirements in Post Construction Scenarios
Technical Paper Publication: PVP2018-84864

Clay Rodery, *C&S Technology, LLC, League City, TX, USA*

3:33pm
Update on Allowable Limits for Corroded Pressure Boundary Bolted Joints
Technical Paper Publication: PVP2018-85005

Warren Brown, *Stewart Long, Integrity Engineering Solutions, Dunsborough, WA, Australia*

Session 3.3H (CS-38-1)
Quality Assurance, Nondestructive Testing, and NDE Personnel Certification
Lobby, Amsterdam 2:15pm - 4:00pm

Session Developer/Chair: **Tomas Zavadil**,
ATG (Advanced Technology Group), s.r.o., Prague 9, Czech Republic
Session Developer/Co-Chair: **Richard Barnes**,
Anric, Etobicoke, ON, Canada
Session Co-Chair: **Michael Turnbow**,
Tennessee Valley Authority, Hixson, TN, USA

2:15pm
A Treatise on Weld Evaluation
Technical Paper Publication: PVP2018-84109

Dipak Chandiramani, *Independent Consultant, Mumbai, Maharashtra, India*
Sadasivan Narayana, *Materials Evaluation Services(M) Pvt. Ltd., Mumbai, India*

2:41pm
Inter-Laboratory Proficiency Testing of NDT Labs According to ISO 17043 as a Tool for Continuous Improvement Principle According to ISO 9001
Technical Paper Publication: PVP2018-85160

Tomas Zavadil, *ATG (Advanced Technology Group), S.R.O., Prague 9, Czech Republic*

3:07pm
ASME ANDE-01 - A Completely New Approach For NDT Personnel Qualification
Technical Paper Publication: PVP2018-85161

Tomas Zavadil, *ATG (Advanced Technology Group), S.R.O., Prague 9, Czech Republic*
Michael Turnbow, *Tennessee Valley Authority, Hixson, TN, USA*

3:33pm
Recent Developments in API Codes and Standards on Fugitive Emissions
Technical Presentation: PVP2018-85096

Gobind Khiani, *Fluor Inc, Calgary, AB, Canada*
Duane Brown, *API, Washington DC, WA, USA*

Session 3.3I (MF-4-4)
European Programs In Structural Integrity - II
Lobby, Athens 2:15pm - 4:00pm

Session Developer: **Dominique Moinereau**, *Electricite De France, Moret Sur Loing F-77818, France*
Session Co-Developers: **Peter James**, *Wood, Warrington, Cheshire, UK*, **Stephane Marie**, *AREVA NP, Paris La Defense, France*
Session Co-Developer/Chair: **Tomas Nicak**, *Framatome GmbH, Erlangen, Germany*
Session Developer/Co-Chair: **Elisabeth Keim**, *AREVA, Erlangen, Germany*

2:15pm
Compact Crack Arrest Tests for the Validation of a Finite Element Material Model of the Reactor Pressure Vessel Steel of the Nuclear Power Plant KKG
Technical Paper Publication: PVP2018-84068

Uwe Mayer, *MPA University of Stuttgart, Stuttgart, Germany*
Alexander Mutz, *Kernkraftwerk Gösgen-Däniken AG, Däniken, Switzerland*
Tomas Nicak, *Framatome GmbH, Erlangen, Germany*

2:50pm
Presentation of DEFI-PROSAFE Project: Probabilistic Methodology to Assess Margin in Deterministic RPV Integrity Assessment and Proposed Benchmark
Technical Paper Publication: PVP2018-84615

Ralf Tiete, *Areva, Erlangen, Germany*
Sebastien Blasset, Richard Trewin, *New NP GmbH, Erlangen, Germany*
Vladislav Pistora, *UJV Rez, a.s., Husinec-Rez, Czech Republic*
Markus Niffenegger, *Paul Scherrer Institute, Villingen, Switzerland*
Miroslav Posta, *UJV, Husinec, Czech Republic*
Guian Qian, *Paul Scherrer Institute, Villigen-Psi, Switzerland*

3:25pm
Fracture Toughness Predictive Models within the SOTERIA EU Project
Technical Paper Publication: PVP2018-85074

Peter James, *Wood, Warrington, Cheshire, UK*
Marc Berveiller, *EDF, Paris, France*

Session 3.3J (CT-14-1)
Computational FEA for Limit Load, Elastic-Plastic Analysis and Creep
Lobby, Barcelona 2:15pm - 4:00pm

Session Developer: **Reza Adibi-Asl**, *Kinectrics NSS, Toronto, ON, Canada*
Session Co-Chair: **Wolf Reinhardt**, *Candu Energy Inc, Mississauga, ON, Canada*
Session Chair: **Don Metzger**, *SNC, ON, Canada*

2:15pm
Analytical Evaluation of Residual Stresses in the Transition Zone of Expanded Tube-to-Tubesheet Joints
Technical Paper Publication: PVP2018-84044

Abdel-Hakim Bouzid, *Ecole Technologie Superieure, Montreal, QC, Canada*
Mohammadhossein Pourreza, *ETS, Montreal, QC, Canada*

2:41pm
Ratchet Boundary for Superimposed Biaxial Membrane Stress States
Technical Paper Publication: PVP2018-85150

Wolf Reinhardt, *Candu Energy Inc, Mississauga, ON, Canada*

3:07pm
Limit Load Analysis of Torispherical Head with Thermal Hotspot Damage
Technical Paper Publication: PVP2018-84990

Soheil Nakhodchi, Amir Mehrizi, *K.N.Toosi University of Technology, Tehran, Iran*
Reza Adibi-Asl, *Kinectrics NSS, Toronto, ON, Canada*

3:33pm
SCC Propagation Analyses in a Welded Joint Under Various Assumed Residual Stresses and Anisotropic SCC Propagation Law
Technical Paper Publication: PVP2018-84238

Hiroshi Okada, Manabu Kikuchi, Masahiro Ono, Yasunori Yusa, *Tokyo University of Science, Noda, Japan*
Masayuki Kamaya, *Inst Of Nuclear Safety System, Mikata-gun Fukui 919-1205, Japan*

Session 3.3K (OAC-4-3)
Radioactive Materials (RAM) Storage and Transport - III
Lobby, Berlin 2:15pm - 4:00pm

Session Developer/Chair: **Zenghu Han**,
Argonne National Laboratory, Lemont, IL, USA
Session Co-Chair: **Mike Weber**,
Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany

2:15pm
Temperature-Jump Measurement at Stainless Steel and Helium Interface: Application to Used Nuclear Fuel Vacuum Drying Process
Technical Paper Publication: PVP2018-84848

Cody Zampella, Mustafa Hadj-Nacer, *University of Nevada-Reno, Reno, NV, USA*
Miles Greiner, *University of Nevada-Reno, Reno, NV, USA*

2:50pm
Long-Term Performance of Elastomer seals - From Aging Tests to Lifetime Estimations
Technical Paper Publication: PVP2018-84631

Matthias Jaunich, Anja Koemmling, Jutta Horn, Holger Völzke, Dietmar Wolff, *Bundesanstalt für Materialforschung und-pruefung (BAM), Berlin, Germany*

3:25pm
Experimental Investigation of the Burning Behaviour of Transport Package Impact Limiters and Simulation of Fire Spread Impact on the Cask
Technical Paper Publication: PVP2018-84714

Marina Erenberg, Claus Bletzer, Martin Feldkamp, André Musolff, Marko Nehrig, Frank Wille, *Bundesanstalt für Materialforschung und-prüfung (BAM), Berlin, Germany*

Session 3.3L (HPT-6-6)
HPHT Equipment Design for Oil and Gas Applications
Lobby, Brussels 2:15pm - 4:00pm

Session Developer/Chair: **Jim Kaculi**,
Dril-Quip, Inc., Houston, TX, USA
Session Co-Chair: **Daniel Peters**,
Structural Integrity Associates, Edinboro, PA, USA

2:15pm
HPHT Equipment Design Guidelines. Evolution of Analysis, Testing, Standards, and Regulatory Requirements
Keynote Presentation: PVP2018-85165

Jim Kaculi, *Dril-Quip, Inc., Houston, TX, USA*

Session 3.3N (DA-9-1)
Piping and Equipment Dynamics
Lower Lobby, Madrid 2:15pm - 4:00pm

Session Developer/Chair: **Pieter van Beek**,
TNO, Delft, Netherlands
Session Developer/Co-Chair: **Michael Porter**,
Porter McGuffie, Inc., Lawrence, KS, USA

2:15pm
Finite Element Analysis of a Pressure Vessel Subjected to an Internal Blast Load
Technical Paper Publication: PVP2018-84012

Imad Barsoum, *PI Abu Dhabi, Abu Dhabi, UAE*
Lawal Sadiq, *The Petroleum Institute, Abu Dhabi, UAE*

2:50pm
Cooperative Design and Optimization of Reactor Coolant System Piping Supports Under Static and Dynamical Load Conditions
Technical Paper Publication: PVP2018-84026

Fu-Rui Xiong, Bin Lan, *Nuclear Power Institute of China, Chengdu, China*

3:25pm
Piping Evaluation of Flow Induced Vibrations Using Harmonic Loads
Technical Paper Publication: PVP2018-84028

Anestis Papadopoulos, Mohamed Aboulella, *PGESCo | Power Generation Engineering and Services Company, Cairo, Egypt*

Wednesday, July 18 5:00PM - 10:00PM

HONORS & AWARDS GALA AND DINNER
5:00PM – 10:00PM
Congress Hall I + II + III

Block 4.1 Thursday, July 19 8:15AM - 10:00AM

Session 4.1A (MF-18-1)
Creep Deformation and Crack Growth
Mezzanine, Karlin I 8:15am - 10:00am

Session Developer: **Catrin Mair Davies**, *Imperial College London, London, UK*
Session Co-Developer/Chair: **Rita Kirchhofer**, *Exponent, Menlo Park, CA, USA*
Session Co-Chair: **Catrin Davies**, *Imperial College London, London, UK*

8:15am
Long Term Creep Life Prediction of New and Service Exposed P91 Steel
Technical Paper Publication: PVP2018-84314

Muneeb Ejaz, Norhaida Ab Razak, Catrin Mair Davies, *Imperial College London, London, UK*
Andrew Morris, *EDF Energy / Coal, Gas and Renewables, West Burton, UK*
Scott Lockyer, *Uniper, Nottingham, UK*

8:41am
Load Line Displacement Partitioning in Creep Crack Growth Analyses
Technical Paper Publication: PVP2018-84303

Michael D Jones, Catrin Mair Davies, *Imperial College London, London, UK*
Kamran Nikbin, *ICL, London, UK*

9:07am
Analysis of Creep Crack Growth Behavior of the Brazed Joint Using Continuum Damage Mechanics Approach
Technical Paper Publication: PVP2018-85126

Yu-Cai Zhang, *China University of Petroleum, Qingdao, China*
Wenchun Jiang, *College of Chemical Engineering, China University of Petroleum(East China), Qingdao, China*
Shantung Tu, Xian-Cheng Zhang, Guoyan Zhou, *East China University of Science and Technology Shanghai,China, China*

9:33am
Creep Deformation Analyses for Grade 91 Steels Considering Heat-to-Heat Variation
Technical Paper Publication: PVP2018-85058

Haruhisa Shigeyama, *Central Research Institute of Electric Power Industry, Yokosuka, Japan*
Yukio Takahashi, *Central Res Inst Elec Pwr Ind, Yokosuka, 240-0196, Japan*
John Siefert, Jonathan Parker, *Electric Power Research Institute, Charlotte, NC, USA*

Session 4.1B (CS-22-4)
Master Curve Fracture Toughness and Other Small Specimen Mechanical Properties - IV
Mezzanine, Karlin II 8:15am - 10:00am

Session Developer/Chair: **William L. Server**, *ATI-Consulting, Black Mountain, NC, USA*
Session Co-Developer: **Masato Yamamoto**, *CRIEPI, Yokosuka, Japan*
Session Co-Chair: **Yoosung Ha**, *Japan Atomic Energy Agency, Tokai-Mura,Ibaraki-Ken, Japan*

8:15am
Evaluation of Through Wall Fracture Toughness Distribution of IAEA Reference Material JRQ by Mini-C(T) Specimens and the Master Curve Method
Technical Paper Publication: PVP2018-84889

Masato Yamamoto, *CRIEPI, Yokosuka, Japan*
Tomohiro Kobayashi, *Central Research Institute of Electric Power Industry, Komae, Tokyo, Japan*

8:41am
Comparison of Standard Charpy and Master Curve Approach in WWER RPV Integrity Evaluation
Technical Presentation: PVP2018-84143

Milan Brumovsky, *UJV Rez, Rez, Czech Republic*

9:07am
A Perspective of the Small Punch Test Application to the Evaluation of Hydrogen Embrittlement in Steels: Effect of Punch Rate on Fracture Properties
Technical Paper Publication: PVP2018-84066

Borja Arroyo, Jose A. Álvarez, Federico Gutiérrez-Solana,Roberto Lacalle, *University of Cantabria, Santander, Spain*
Jenifer Sainz, *Fundación Centro Tecnologico de Componentes, Santander, Cantabria, Spain*,

9:33am
Estimation of the Reference Temperature, T0, by Means of the Small Punch Testing Technique
Technical Paper Publication: PVP2018-84250

David Andrés, Roberto Lacalle, Sergio Cicero, Jose A. Álvarez, Manuel Pinzón, *University of Cantabria, Santander, Spain*

Session 4.1C (MF-2-3)
Hydrogen Embrittlement and Prevention
Mezzanine, Karlin III 8:15am - 10:00am

Session Developer: **Chris San Marchi**, *Sandia National Laboratories, Livermore, CA, USA*
Session Chair: **Hisao Matsunaga**, *Kyushu University, Fukuoka, Japan*
Session Co-Chair: **Eun-Ju Song**, *Sandia National Laboratories, Livermore, CA, USA*

8:15am
Temperature Dependence of Fatigue Crack Growth in Low-Alloy Steel Under Gaseous Hydrogen
Technical Paper Publication: PVP2018-84438

Osamu Takakuwa, Saburo Matsuoka, Saburo Okazaki, Michio Yoshikawa, Junichiro Yamabe, Hisao Matsunaga, *Kyushu University, Fukuoka, Japan*

8:41am
Evaluation of the Compatibility of High-Strength Aluminum Alloy 7075-T6 to High-Pressure Gaseous Hydrogen Environment
Technical Paper Publication: PVP2018-84321

Yuhei Ogawa, Hisao Matsunaga, Saburo Matsuoka, *Kyushu University, Fukuoka, Japan*
Dain Kim, *The University of Tokyo, Tokyo, Japan*,

9:07am
Transient Hydrogen Diffusion/Elastoplastic Coupling Analysis for Predicting Fatigue Crack Growth Acceleration of Low-Carbon Steel in Gaseous Hydrogen
Technical Paper Publication: PVP2018-84390

Kaito Kawahara, Masaki Fujikawa, *University of the Ryukyus, Okinawa, Japan*
Junichiro Yamabe, *Kyushu University, Fukuoka, Japan*

9:33am
Influence of Microstructure on Hydrogen Performance of Pressure Vessel Steels
Technical Presentation: PVP2018-84777

May Martin, Matthew Connolly, Peter Bradley, Andrew Slifka, *National Institute of Standards and Technology, Boulder, CO, USA*

Session 4.1D (CS-7-1)
Recent Developments in ASME Codes and Standards - I
Mezzanine, Palmovka 8:15am - 10:00am

Session Developer/Chair: **T.-L. (Sam) Sham**, *Argonne National Laboratory, Lemont, IL, USA*
Session Co-Chair: **Mark Messner**, *Argonne National Laboratory, Lemont, IL, USA*

8:15am
A Basis for Applying Elastic Perfectly-Plastic Design Methods to Cyclic Softening Materials
Technical Paper Publication: PVP2018-84103

Mark Messner, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*
Yanli Wang, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*
Bob Jetter, *R.I. Jetter Consulting, Pebble Beach, CA, USA*

8:41am
2025 Nuclear Code: The Vision for the Future of ASME Nuclear Codes and Standards
Technical Paper Publication: PVP2018-84031

Dale Matthews, *Framatome, Lynchburg, VA, USA*
Ralph Hill, *Hill Engineering Solutions, Las Vegas, NV, USA*
Charles Bruny, *Independent Author, Georgetown, KY, USA*

9:07am
A Unified Inelastic Constitutive Model for the Average Engineering Response of Grade 91 Steel
Technical Paper Publication: PVP2018-84104

Mark Messner, V. Tung Phan, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*

9:33am
The Role of Material Modeling on Strain Range Estimation for Elevated Temperature Cyclic Life Evaluation
Technical Paper Publication: PVP2018-84100

Mark Messner, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*
Bob Jetter, *R.I. Jetter Consulting, Pebble Beach, CA, USA*
Yanli Wang, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*

Session 4.1E (CS-12-1)
Recent Developments in European Codes and Standards - I
Mezzanine, Rokoska 8:15am - 10:00am

Session Co-Developer/Co-Chair: **John Sharples**, *AMEC Foster Wheeler, Warrington, Cheshire, UK*
Session Co-Developer: **Claude Faidy,** *CF Integrity Engineering, Tassin, France*
Session Co-Developer/Chair: **Jinhua Shi**, *Amec Foster Wheeler, Gloucester, UK*

8:15am
Building the UK ABWR: Developments in Structural Integrity Safety Cases for Highest Reliability Components in the UK
Technical Paper Publication: PVP2018-84038

Tim Jelfs, Angus Beveridge, *Horizon Nuclear Power, Gloucester, UK*
James O'Neill, *Frazer-Nash Consultancy Ltd, Gloucester, UK*,

8:41am
"NTD ASI, Section IV: Evaluation of Residual Lifetime of Components and Piping in WWER Type NPPs"
Technical Paper Publication: PVP2018-84139

Milan Brumovsky, *UJV Rez, Rez, Czech Republic*

9:07am
RCC-M Code: Main Evolutions from the 2016 to 2018 Editions
Technical Paper Publication: PVP2018-84409

Manuela Triay, Benoit Lefever, Julien Quere, Jean-Luc Gobert, *AREVA NP, Courbevoie, France*
Eric Meister, *Septen/EDF, Villeurbanne, France*
Sylvain Puybouffat, *Emmanuel Chantelat, EDF/Ceidre, Saint-Denis, France*
Julien Cadith, *EDF/Ceidre, Saint-Denis, France*,

9:33am
Overview of Recent Activities Undertaken by the UK Forum for Engineering Structural Integrity (FESI)
Technical Paper Publication: PVP2018-84681

John Sharples, Brian Daniels, *AMEC Foster Wheeler, Warrington, Cheshire, UK*
Brian Tomkins, *FESI, Warrington, Cheshire, UK*
Peter Flewitt, *University of Bristol, Bristol, UK*
Stephen Garwood, *Imperial College London, London, UK*

Session 4.1F (SE-8-1)
Seismic Evaluation of Systems, Structures and Components - I
Mezzanine, Hercovka 8:15am - 10:00am

Session Developer/Chair: **Akihito Otani**, *IHI Corporation, Yokahoma, Japan*
Session Developer/Co-Chair: **Akemi Nishida**, *Japan Atomic Energy Agency, Chiba, Japan*

8:15am
Verification of Mainframe Computer Structure Finite Element Model Under Vibration and Seismic Tests
Technical Paper Publication: PVP2018-84200

Budy Notohardjono, Shawn Canfield, Suraush Khambati, Richard Ecker, *IBM Corp, Poughkeepsie, NY, USA*

8:50am
Measurement of Natural Frequencies of the Fluid-Elastic-Coupled Shell Plate Vibration of a Large-Sized Cylindrical Steel Tank by Microtremor Observation
Technical Paper Publication: PVP2018-84547

Ken Hatayama, *National Research Institute of Fire and Disaster, Chofu, Tokyo, Japan*
Shinsaku Zama, *Yokohama National University, Yokohama, Kanagawa, Japan*
Shoichi Yoshida, *Yokohama National University (Retired), Yokohama, Kanagawa, Japan*

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9:25am
Categorization of Dynamic Loading into Force-Controlled Loading and Displacement-Controlled Loading
Technical Paper Publication: PVP2018-85098

Ichiro Tamura, *The Chugoku Electric Power Company, Hiroshima, Japan*,
Shinichi Matsuura, Ryuya Shimazu, *Criepi, Abiko-Shi, Chiba-Ken, Japan*,
Koji Kimura, *Tokyo Institute Of Technology, Tokyo, Tokyo, Japan*

Session 4.1G (DA-10-2)
Dr Bill Koves Memorial Session on Advanced Bolted Joint Design and Analysis
Mezzanine, Tyrolka 8:15am - 10:00am

Session Developer/Chair: **Warren Brown**, *Integrity Engineering Solutions, Dunsborough, WA, Australia*
Session Developer/Co-Chair: **Gysbert Van Zyl**, *Sabic, Jubail, Saudi Arabia*

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8:15am
ASME B16.20 Jacketed Gaskets Performance Testing
Technical Paper Publication: PVP2018-84907

Jose Veiga, Carlos D. Girão, *Teadit Indústria e Comércio Ltda, Rio de Janeiro, RJ, Brazil*
Joel Baulch, *Teadit North America, Pasadena, TX, USA*
Scott Hamilton, *Hex Technology, Austin, TX, USA*

8:41am
Case Studies on the Use of Thermal-Mechanical Finite Element Analysis to Evaluate Weld Ring Gasket and Diaphragm Seal Designs
Technical Paper Publication: PVP2018-84910

Phillip E. Prueter, Robert C. Davis, *The Equity Engineering Group, Inc., Shaker Heights, OH, USA*
Clay Rodery, *C&S Technology, LLC, League City, TX, USA*
Stephen McJones, *BP, Rancho Palos Verdes, CA, USA*
Richard Brodzinski, *BP, Naperville, IL, USA*
Josh Havekost, *Daniel E. Feddeler, BP, Whiting, IN, USA*

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9:07am
Gasket Catastrophic Failure Modes
Technical Paper Publication: PVP2018-85002

Warren Brown, Nathan Knight, *Integrity Engineering Solutions, Dunsborough, WA, Australia*

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9:33am
Three-Dimensional Numerical Analysis for Bolted Flange Joints Considering Effect of Creep
Technical Paper Publication: PVP2018-85111

Lewen Bi, Lanzhu Zhang, *East China University of Science and Technology, Shanghai, China*

Session 4.1H (CS-14-1)
Repair, Replacement and Mitigation Activities
Lobby, Amsterdam 8:15am - 10:00am

Session Developer/Chair: **Steven McCracken**, *EPRI, Harrisburg, NC, USA*
Session Co-Chair: **Hiroyuki Kobayashi**, *The Japan Atomic Company, Tokyo 101-0053, Japan*

8:15am
Study on Promoting Use of Repair, Replacement and Mitigation Techniques in Maintenance Activities of Nuclear Power Plants
Technical Paper Publication: PVP2018-84512

Koji Dozaki, *The Japan Atomic Power Co, Tokyo, Japan*
Takayuki Aoki, *Tohoku University, Sendai, Japan*
Koji Koyama, *Mitsubishi Heavy Industries, Ltd, Kobe, Japan*
Masanori Kanno, *The University of Tokyo, Tokyo, Japan*
Ryoichi Saeki, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japan*

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8:41am
Temporary Acceptance of Leaking Brazed Joints
Technical Paper Publication: PVP2018-84779

Jim O'Sullivan, *Procon 1, LLC, Fort Myers Beach, FL, USA*
Kevin Hacker, *Dominion Energy, Glen Allen, VA, USA*

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9:07am
New Code Case for Pin Brazing Non-Structural Attachment Tabs for Buried Pipe Cathodic Protection
Technical Paper Publication: PVP2018-84897

Steven McCracken, *EPRI, Harrisburg, NC, USA*
Nicholas Mohr, *EPRI, Palo Alto, CA, USA*

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9:33am
Development of Improved Equations for Weld Heat Input and Dilution Control - Part 2
Technical Paper Publication: PVP2018-85154

Jonathan Tatman, *EPRI, Charlotte, NC, USA*

Session 4.1I (MF-32-1)
Structural Integrity for Spent Fuel Canisters
Lobby, Athens 8:15am - 10:00am

Session Developer/Chair: **Yun-Jae Kim**,
Korea University, Seoul 136-701, Korea (Republic)
Session Co-Developer: **Andrew Duncan**,
Savannah River National Laboratory, Aiken, SC, USA
Session Developer/Co-Chair: **Poh-Sang Lam**,
Savannah River National Lab, Aiken, SC, USA

8:15am
FE Welding Residual Stress Analysis and Validation for Spent Nuclear Fuel Canisiters
Technical Paper Publication: PVP2018-84857

Jae-Min Gim, Ji-Soo Kim, Yun-Jae Kim, *Korea University, Seoul, Korea (Republic)*
Poh-Sang Lam, *Savannah River National Lab, Aiken, SC, USA*

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8:41am
Progress Report on Stress Intensity Factor and J-integral Estimation for Spent Nuclear Fuel Canisters under Mechanical Loading
Technical Paper Publication: PVP2018-84966

Su Kim, Jae-Min Gim, Yun-Jae Kim, *Korea University, Seoul, Korea (Republic)*
Poh-Sang Lam, *Savannah River National Lab, Aiken, SC, USA*

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9:07am
Engineering J Estimation Equations for Spent Fuel Canisters Under Combined Mechanical and Welding Residual Stresses
Technical Paper Publication: PVP2018-85076

Hyunjae Lee, Jae-Yoon Jeong, Yun-Jae Kim, *Korea University, Seoul, Korea (Republic)*
Poh-Sang Lam, *Savannah River National Lab, Aiken, SC, USA*

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9:33am
Crack Growth Rate Testing of Bolt-Load Compact Tension Specimens Under Chloride-Induced Stress Corrosion Cracking Conditions in Spent Nuclear Fuel Canisters
Technical Paper Publication: PVP2018-84753

Andrew Duncan, Poh-Sang Lam, Robert Sindelar, Kathryn Metzger, *Savannah River, National Laboratory, Aiken, SC, USA*

Session 4.1J (CT-12-1)
Computational Applications in Fatigue, Fracture and Damage Mechanics
Lobby, Barcelona 8:15am - 10:00am

Session Developer/Chair: **Reza Adibi-Asl**, *Kinectrics NSS, Toronto, ON, Canada*
Session Developer/ Co-Chair: **Wolf Reinhardt**, *Candu Energy Inc, Mississauga, ON, Canada*

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8:15am
Formulation of Three-Dimensional J-Integral for Finite Strain Elastic-Plastic Fracture Problems Under Any Load Histories (Monotonic and Cyclic Loads)
Technical Paper Publication: PVP2018-84241

Koichiro Arai, Hiroshi Okada, Yasunori Yusa, *Tokyo University of Science, Noda, Chiba-ken, Japan*

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8:41am
Blind Prediction of the Response of an Additively Manufactured Tensile Test Coupon Loaded to Failure
Technical Paper Publication: PVP2018-84246

Lindsay N Gilkey, John Bignell, Remi Dingreville, Scott Sanborn, *Sandia National Laboratories, Albuquerque, NM, USA*
Christopher Jones, *Kansas State University, Manhattan, KS, USA*

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9:07am
Comparison of New Proposal for Simplified Elastic-Plastic Analysis and Code Case N-779
Technical Paper Publication: PVP2018-85146

Wolf Reinhardt, *Candu Energy Inc, Mississauga, ON, Canada*
Sampath Ranganath, *XGEN Engineering, San Jose, CA, USA*

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9:33am
A Methodology for Constructing Complex 3D Cracked Body Finite Element Models Efficiently
Technical Paper Publication: PVP2018-84908

Willem Vorster, *EDF Energy, Gloucester, Gloucestershire, UK*
Alex Mann, *EDF Energy, Bury, Lancs, UK*

Session 4.1K (OAC-8-1)
Aging and Life Management and Extension - I
Lobby, Berlin 8:15am - 10:00am

Session Developer/Chair: **Georges Bezdikian**, *Georges Bezdikian Consulting, Le Vesinet, France*
Session Co-Developer: **Garry Young**, *Entergy Services Inc, Russellville, AR, USA*
Session Co-Chair: **Joseph Cluever**, *LPI, Inc., Richland, WA, USA*

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8:15am
Long-Term Operation of BWR RPV and its Internals
Technical Paper Publication: PVP2018-84541

Otso Cronvall, *VTT Technical Research Centre of Finland Ltd (VTT), Espoo, Finland*

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9:07am
Estimation of Weibull Life Distributions from Expert Categorical Estimates of Failure Probabilities
Technical Paper Publication: PVP2018-84831

Joseph Cluever, *LPI, Inc., Richland, WA, USA*,
Thomas C. Esselman, *LPI, Inc., Amesbury, MA, USA*,
Sam Harvey, *Electric Power Research Institute, Charlotte, NC, USA*

Session 4.1L (HPT-1-1)
Design and Analysis of Pre-Service Equipment
Lobby, Brussels 8:15am - 10:00am

Session Developer/Chair: **Kumarswamy Karpanan**, *TechnipFMC, Houston, TX, USA*
Session Developer/Co-Chair: **Chris Tipple**, *Structural Integrity Associates, Centennial, CO, USA*

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8:15am
High Pressure Composite Vessel with Integrated Optical Fiber Sensors. Monitoring of Manufacturing Process and Operation
Technical Paper Publication: PVP2018-85157

Pawel Gasior, Radoslaw Rybczynski, Jerzy Kaleta, *Wroclaw University of Science and Technology, Wroclaw, Poland*
Stephane Villalonga, Fabien Nony, Christophe Magnier, *Commissariat à L'Énergie Atomique et aux Energies Alternatives, CEA Le Ripault, Monts, France*

8:41am
Proposal of New Upper Limit of Hydrostatic Test Pressure in KT-3 of ASME Section VIII Division 3
Technical Paper Publication: PVP2018-84271

Susumu Terada, *Kobe Steel, Ltd., Takasago, Hyogo, Japan*

9:07am
Modelling and Measuring Residual Stress in Autofrettaged Hollow Cylinders through the Initial Strain Distribution Method
Technical Presentation: PVP2018-84625

Matteo Loffredo, Bernardo Disma Monelli, Marco Beghini, *University of Pisa, Pisa, Italy*
Andrea Bagattini, *Baker Hughes, a GE Company, Florence, Firenze, Italy*

9:33am
Screening criteria for ASME VIII-2 and -3 Local Strain Limit Damage
Technical Presentation: PVP2018-84397

Kumarswamy Karpanan, *TechnipFMC, Houston, TX, USA*
Daniel Peters, *Structural Integrity Associates, Edinboro, PA, USA*
Imad Barsoum, *PI Abu Dhabi, Abu Dhabi, UAE*

Session 4.1M (MF-11-1)
Pipeline Integrity - I
Lobby, Sofia 8:15am - 10:00am

Session Developer/Chair: **Xiankui Zhu**, *EWI - Structural Integrity, Columbus, OH, USA*
Session Co-Chair: **Dong-Yeob Park**, *Canmetmaterials, Natural Resources Canada, Calgary, AB, Canada*

8:15am
Relationship of Fracture Behaviours Between Full-Scale Pipe Bending and Small-Scale Toughness Tests
Technical Paper Publication: PVP2018-84138

Dong-Yeob Park, Jie Liang, Jean-Philippe Gravel, *Canmetmaterials, Natural Resources Canada, Calgary, AB, Canada*
Hisakazu Tajika, Takahiro Sakimoto, Satoshi Igi, *JFE Steel Corporation, Chiba, Chiba, Japan*
James Gianetto, Government of Canada-Natural *Resources, Hamilton, ON, Canada*
Joe Kondo, *JFE Steel Corporation, Tokyo, Japan*

8:41am
Limit Strain of X70 Pipes with a Semi-Elliptical Crack Based on Initiation and Ductile Tearing Criteria
Technical Paper Publication: PVP2018-84641

Ju-Yeon Kang, Youn-Young Jang, Nam-Su Huh, *Seoul National University of Science and Technology, Seoul, Korea (Republic)*,
Ki-Seok Kim, Woo-Yeon Cho, *POSCO, Incheon, Korea (Republic)*

9:07am
Strain Capacity Investigation on Grade X70 High Strain Line Pipe with Girth Weld
Technical Paper Publication: PVP2018-85059

Hisakazu Tajika, Takahiro Sakimoto, Tsunehisa Handa, Satoshi Igi, Rinsei Ikeda, *JFE Steel Corporation, Chiba, Chiba, Japan*
Joe Kondo, *JFE Steel Corporation, Tokyo, Japan*

9:33am
Numerical Calculation of Fatigue Crack Growth for the Structures of Elbow and Tee Pipe
Technical Paper Publication: PVP2018-85061

Peng Tang, Jiacheng Luo, Pengzhou Li, Lei Sun, Juan Luo, *Nuclear Power Institute of China, Chengdu, China*

Session 4.1N (DA-7-1)
Thermal Stresses and Elevated Temperature Design - I
Lower Lobby, Madrid 8:15am - 10:00am

Session Developer: **Albert Segall**,
Penn State Univ, University Park, PA, USA
Session Co-Developer: **San Iyer,**
Indian Institute of Technology, Delhi, India
Session Co-Developer/Chair: **Tasnim Hassan**,
NC State University, Raleigh, NC, USA
Session Co-Chair: **Maryam Torfeh**,
Amirkabir University, Tehran, Tehran, Iran

8:15am
Visualization of Thermal Fatigue Damage Distribution with Elastic-Plastic FEA
Technical Paper Publication: PVP2018-84095

Junya Miura, Terutaka Fujioka, Yasuhiro Shindo, *Toyo University, Saitama, Japan*

8:50am
Assembly of Bolted Flanged and Support Joints for Use in Elevated Temperature Exhaust Systems
Technical Paper Publication: PVP2018-84159

Jason Dorgan, Agron Gjinolli, *Babcock & Wilcox Universal Inc., Stoughton, WI, USA*

9:25am
Creep Evaluation for a PWR Reactor Pressure Vessel Lower Head under Severe Accident Considering Sustained Internal Pressure
Technical Paper Publication: PVP2018-84375

Yongjian Gao, Ming Cao, Yinbiao He, *Shanghai Nuclear Engineering Research & Design Institute, Shanghai, China*

Session 4.1O (EPRI-1-1)
EPRI Workshop on Continuum Damage Modeling
Session 1 - Keynote Presentation
Lower Lobby, Congress Hall I 8:15am - 10:00am

Session Developer/Chair: **Jonathan Parker**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Developer: **Elizabeth Benton**,
EPRI, Charlotte, NC, USA
Session Co-Chair: **Young Kwon**,
Naval Postgraduate School, Monterey, CA, USA
Panelists: **H. Riedel**,
Fraunhofer Institute for Mechanics of Materials IWM, Freiburg, Deutschland
D. Hayhurst,
The University of Manchester, Manchester, UK

Session 4.1Q (XPR-1-1)
1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats and Mitigation Strategies
Lower Lobby, Congress Hall III 8:15am - 10:00am

Session Developer: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Chair: **Oreste Salvatore Bursi**,
University of Trento, Trento, Italy
Session Co-Chair: **Antonio Caputo**,
Roma Tre University Department of Engineering, Rome, Italy

8:15am
Key Issues in Resilience Calculation of Critical Infrastructures
Keynote Presentation: PVP2018-85166

Gian Paolo Cimellaro, *Polytechnic of Turin, Turin, Italy*

Block 4.2 Thursday, July 19 10:15AM - 12:00PM

Session 4.2A (MF-18-3)
Creep & Fatigue Damage Analyses
Mezzanine, Karlin I 10:15am - 12:00pm

Session Developer/Chair: **Catrin Mair Davies**,
Imperial College London, London, UK
Session Co-Chair: **Rita Kirchhofer,**
Exponent, Menlo Park, CA, USA

10:15am
Uniaxial Fatigue, Creep and Ratcheting Response Simulations of Alloy 617 Using Damage Coupled Viscoplastic Model
Technical Paper Publication: PVP2018-84756

Nazrul Islam, *North Carolina State University, Raleigh, NC, USA*
Tasnim Hassan, *NC State University, Raleigh, NC, USA*

10:36am
Creep and Creep-Fatigue Deformation and Life Assessment of Ni-based Alloy 740H and Alloy 617
Technical Paper Publication: PVP2018-85079

Shengde Zhang, Yukio Takahashi,*Central Research Institute of Electric Power Industry, Yokosuka, Japan*

10:57am
Effect of Simulated Heat Affected Zone Thermal Cycle on the Creep Deformation and Damage Response of Grade 91 Steel Considering Heat-to-Heat Variation
Technical Paper Publication: PVP2018-85102

Yukio Takahashi, *Central Res Inst Elec Pwr Ind, Yokosuka, 240-0196, Japan*
Haruhisa Shigeyama, *Central Research Institute of Electric Power Industry, Yokosuka, Japan*
John Siefert, *Jonathan Parker, Electric Power Research Institute, Charlotte, NC, USA*

11:18am
Study on the Creep Property by Small Beam Specimen with Fixed Constraints
Technical Paper Publication: PVP2018-84959

Guoyan Zhou, Hongyu Qin, Junqi Wang, Shantung Tu, Jian-Guo Gong, *East China University of Science and Technology, Shanghai, Shanghai, China*,

11:39am
Effect of Hydrogen on Creep Behavior of a Vanadium-Modified CRMO Steel and its Continuum Damage Analysis
Technical Paper Publication: PVP2018-84291

Yu Zhou, Xuedong Chen, Zhichao Fan, Peng Xu, Xiaoliang Liu, *Hefei General Machinery Research Institute, Hefei, China*

Session 4.2B (MF-12-1)
Small-Scale Testing and Statistical Analysis of Mechanical Properties - I
Mezzanine, Karlin II 10:15am - 12:00pm

Session Developer/Chair: **Masato Yamamoto**, *CRIEPI, Yokosuka, Japan*
Session Developer/Co-Chair: **Ludek Stratil**, *Institute of Physics of Materials, Academy of Sciences of the Czech Republic, v. v. i., Brno, Czech Republic*

10:15am
Creep Properties Assessment of Materials by a Small Cantilever Beam Specimen
Technical Paper Publication: PVP2018-84135

Fakun Zhuang, Guoshan Xie, Shanshan Shao, Luowei Cao, *China Special Equipment Inspection & Research Institute, Beijing, China*
Shantung Tu, *East China University of Science & Technology, Shangai, China*

10:41am
Assessment of Heat-to-Heat Variation of Gr.91 Boiler Pipings by Small Punch Creep Test
Technical Paper Publication: PVP2018-84153

Shin-ichi Komazaki, Keisuke Obata, *Kagoshima University, Kagoshima, Japan*
Masato Tomobe, Masatsugu Yaguchi, *Central Research Institute of Electric Power Industry, Yokosuka, Kanagawa, Japan*
Akihiro Kumada, *Kobe Material Testing Laboratory Co., Ltd., Harima-cho, Kako-gun, Hyogo, Japan*

11:07am
Effective Portion of Sample Taken From USC Boiler Pipes to Consider Heat-to-Heat Variation of Creep
Technical Paper Publication: PVP2018-84173

Masatsugu Yaguchi, Masato Tomobe, *Central Research Institute of Electric Power Industry, Yokosuka, Kanagawa, Japan*
Shin-ichi Komazaki, *Kagoshima University, Kagoshima, Japan*
Akihiro Kumada, *Kobe Material Testing Laboratory Co., Ltd., Harima-cho, Kako-gun, Hyogo, Japan*

11:33am
Combined Statistical-Mechanical Characterization of a Next Generation Textured PTFE for Extreme Environments
Technical Paper Publication: PVP2018-84039

Sannmit Shinde, *Ali Gordon, University of Central Florida, Orlando, FL, USA*
Zachary Poust, James Drago, Steve Pitolaj, Paul Nichols, *Garlock Sealing Technologies, Palmyra, NY, USA*

Session 4.2C (MF-2-4)
Hydrogen-Assisted Fatigue and Fracture of Ferritic Steels
Mezzanine, Karlin III 10:15am - 12:00pm

Session Developer: **Chris San Marchi**, *Sandia National Laboratories, Livermore, CA, USA*
Session Chair: **Paolo Bortot**, *TenarisDalmine, Dalmine (BG)Italy, Italy*
Session Co-Chair: **Wada Yoru**, *The Japan Steel Works,Ltd, Hokkaido, Japan*

10:15am
Oxygen Impurity Effects on Hydrogen Assisted Fatigue and Fracture of X100 Pipeline Steel
Technical Paper Publication: PVP2018-84163

Joseph Ronevich, Chris San Marchi, Robert Kolasinski, Konrad Thurmer, Norm Bartelt, Farid El Gabaly, *Sandia National Laboratories, Livermore, CA, USA*
Brian Somerday, *Southwest Research Institute, San Antonio, TX, USA*

10:36am
Influence of Hydrogen and Oxygen Impurity Content in a Natural Gas / Hydrogen Blend on the Toughness of an API X70 Steel
Technical Paper Publication: PVP2018-84658

Laurent Briottet, Hamza Ez-Zaki, *French Alternative Energies and Atomic Energy Commission (CEA), Grenoble, France*

10:57am
Orientation Dependence of Hydrogen Accelerated Fatigue Crack Growth Rates in Pipeline Steels
Technical Paper Publication: PVP2018-84835

Eun-Ju Song, Joseph Ronevich, *Sandia National Laboratories, Livermore, CA, USA*

11:18am
Hydrogen-Assisted Fatigue Crack Propagation in a Pure BCC Iron
Technical Paper Publication: PVP2018-84783

Domas Birenis, Øystein Prytz, *University of Oslo, Oslo, Norway*,
Yuhei Ogawa, Hisao Matsunaga, Osamu Takakuwa, Junichiro Yamabe, *Kyushu University, Fukuoka, Japan*,
Annett Thøgersen, *Sintef, Oslo, Norway*

11:39am
Study on Hydrogen Compatibility of S31603 Weld Joints in 98MPa Gaseous Hydrogen
Technical Paper Publication: PVP2018-84453

Qi He, Zhengli Hua, Jinyang Zheng, *Zhejiang University, Hangzhou, Zhejiang, China*

Session 4.2D (CS-7-2)
Recent Developments in ASME Codes and Standards - II
Mezzanine, Palmovka 10:15am - 12:00pm

Session Developer/Chair: **T.-L. (Sam) Sham**, *Argonne National Laboratory, Lemont, IL, USA*
Session Co-Chair: **Mark Messner,** *Argonne National Laboratory, Lemont, IL, USA*

10:15am
Establishing Temperature Upper Limits for the ASME Section III, Division 5 Design by Elastic Analysis Methods
Technical Paper Publication: PVP2018-84105

Mark Messner, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*
Bob Jetter, *R.I. Jetter Consulting, Pebble Beach, CA, USA*

10:41am
Pressure Temperature Ratings of Aluminum Alloy Flanges
Technical Paper Publication: PVP2018-84076

Kang Xu, *Praxair, Tonawanda, NY, USA*
Mahendra Rana, *Consultant, Niantic, CT, USA*

11:07am
N-Bar Problems as Approximations to the Bree Problem
Technical Paper Publication: PVP2018-84106

Mark Messner, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*
Yanli Wang, *Oak Ridge National Laboratory, Oak Ridge, TN, USA*

11:33am
Anisotropic Materials Use in the ASME Boiler and Pressure Vessel Code
Technical Paper Publication: PVP2018-84823

Jay Cameron, *The Hartford Steam Boiler Inspection and Insurance Co., Agawam, MA, USA*

Session 4.2E (CS-12-2)
Recent Developments in European Codes and Standards - II
Mezzanine, Rokoska 10:15am - 12:00pm

Session Developer/Chair: **John Sharples**, *AMEC Foster Wheeler, Warrington, Cheshire, UK*
Session Developer/Co-Chair: **Jinhua Shi**, *AMEC Foster Wheeler, Gloucester, UK*

10:15am
Thermal Fatigue Evaluation Based on the Methods for Structural Stress Determination According to EN 13445-3 Annex NA Comparison with Other Codes for Unfired Pressure Vessels
Technical Paper Publication: PVP2018-84904

Ralf Trieglaff, Martin Beckert, *TÜV NORD EnSys GmbH & Co. KG, Hamburg, Germany*
Juergen Rudolph, *Framatome GMBH, Erlangen, Bavaria, Germany*
Daniel Friers, *Krones AG, Neutraubling, Germany*

10:41am
UK Programme on Codes, Standards and Procedures Needs for SMR and GEN IV Reactors
Technical Paper Publication: PVP2018-85075

Peter James, *Wood, Warrington, Cheshire, UK*
John Sharples, *AMEC Foster Wheeler, Warrington, Cheshire, UK*
Nicholas Underwood, *National Nuclear Laboratory, Warrington, UK*

11:07am
Normative Technical Documentation of Association of Mechanical Engineers, Czech Code of Equipment and Piping of Nuclear Power Plants of WWER Type
Technical Paper Publication: PVP2018-85155

Lubomir Junek, *Institute of Applied Mechanics Brno, Brno, Czech Republic*

11:33am
Recent Studies Towards Updating the BS7910 Flaw Interaction Rule
Technical Paper Publication: PVP2018-84119

Bostjan Bezensek, *Shell Global Solutions Ltd, Laurencekirk, UK*
Harry Coules, *University of Bristol, Bristol, UK*

Session 4.2F (SE-8-2)
Seismic Evaluation of Systems, Structures and Components - II
Mezzanine, Hercovka 10:15am - 12:00pm

Session Developer/Chair: **Akemi Nishida**, *Japan Atomic Energy Agency, Chiba, Japan*
Session Developer/Co-Chair: **Akihito Otani**, *IHI Corporation, Yokahoma, Japan*

10:15am
Development of Seismic Design Approach Using Inelastic Dynamic Analysis for Equipment and Piping Systems
Technical Paper Publication: PVP2018-84126

Ichiro Tamura, Atsushi Okubo, *The Chugoku Electric Power Company, Hiroshima, Japan*,
Tadashi Iijima, Yusuke Minakawa, *Hitachi-GE Nuclear Energy, Ltd., Hitachi-shi, Japan*,
Nobuyoshi Goshima, *MHI, Kobe, Japan*,
Masanori Amino, *Mitsubishi Heavy Industries, Ltd., Kobe, Japan*,
Yukihiko Okuda, Shunji Okuma, *Toshiba Corp, Yokohama, Japan*

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10:50am
Development of Seismic Countermeasures against Cliff Edges for Enhancement of Comprehensive Safety of NPP - Cliff Edges Relevant to NPP Building System
Technical Paper Publication: PVP2018-85066

Akemi Nishida, Byunghyun Choi, *Japan Atomic Energy Agency, Chiba, Japan*,
Hidemasa Yamano, *Japan Atomic Energy Agency, Ibaraki, Japan*,
Tsuyoshi Takada, *The University of Tokyo, Tokyo, Japan*

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11:25am
Seismic Responses from Linear and Nonlinear Dynamic Analyses of RC Shear Walls
Technical Paper Publication: PVP2018-84851

Do Yeon Kim, *KEPCO E&C, Gimcheon-Si, Korea (Republic)*

Session 4.2G (DA-10-3)
Robert Noble Memorial Session on Bolted Joint Assembly
Mezzanine, Tyrolka 10:15am - 12:00pm

Session Developer/Chair: **Gysbert Van Zyl**, *Sabic, Jubail, Saudi Arabia*
Session Developer/Co-Chair: **Warren Brown**, *Integrity Engineering Solutions, Dunsborough, WA, Australia*

10:15am
Comparison of Torque Application Tool Performance
Technical Paper Publication: PVP2018-84813

Scott Hamilton, *Hex Technology, Austin, TX, USA*
Dan Mahoney, *HollyFrontier, Dallas, TX, USA*
Jason Wright, *CHS Refining, McPherson, KS, USA*

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10:41am
Assessment of Technical Knowledge: Assembly of Bolted Flange Joints
Technical Paper Publication: PVP2018-85085

Scott Hamilton, *Hex Technology, Austin, TX, USA*
Brett Thibodeaux, *Sasol, Westlake, LA, USA*

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11:07am
PCC-1 Appendix A Training Methodology
Technical Presentation: PVP2018-84825

Scott Hamilton, *Hex Technology, Austin, TX, USA*

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11:33am
ASME PCC-1-2013 Appendix A Qualifying Organization Update
Technical Presentation: PVP2018-84881

Jason Barnard, *Hydratight, Darlaston, UK*

Session 4.2H (CS-14-2)
Repair, Replacement and Mitigation Activities
Lobby, Amsterdam 10:15am - 12:00pm

Session Developer/Chair: **Jonathan Tatman**, *EPRI, Charlotte, NC, USA*
Session Co-Chair: **Koji Dozaki**, *The Japan Atomic Power Co, Tokyo, Japan*

10:15am
Crack Remaining Repair Techniques in Japan
Technical Paper Publication: PVP2018-84472

Hiroya Ichikawa, *Toshiba Energy Systems and Solutions Corporation, Yokohama, Kanagawa, Japan*
Yoshiyuki Miyoshi, *Mitsubishi Heavy Industries, Ltd., Kobe, Hyogo, Japan*
Ryuji Kimura, *Hitachi-Ge Nuclear Energy, Ltd, Hitachi, Ibaraki, Japan*
Takayuki Kaminaga, *Tokyo Electric Power Company Holdings, Inc., Chiyoda-ku, Tokyo, Tokyo, Japan*

11:07am
Guideline on Application Process of Techniques Developed for Repair, Replacement and Mitigation Activities
Technical Paper Publication: PVP2018-84480

Koji Koyama, *Mitsubishi Heavy Industries, Ltd, Kobe, Japan*
Hiroyuki Kobayashi, *The Japan Atomic Company, Tokyo 101-0053, Japan*
Kiminobu Hojo, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*

Session 4.2I (MF-24-1)
Asian Programs in Structural Integrity - I
Lobby, Athens 10:15am - 12:00pm

Session Developer: **Yuh J. Chao**, *Univ Of South Carolina, Columbia, SC, USA*
Session Co-Developers: **Zhenfeng Tong**, *China Institute of Atomic Energy, Beijing, China,* **Hsoung-Wei Chou**, *Institute of Nuclear Energy Research, Taoyuan City, Taiwan*
Session Chair: **Guian Qian**, *Paul Scherrer Institute, Villigen-Psi, Switzerland*
Session Co-Chair: **Lele Gui**, *CSEI, Beijing, China*

10:15am
The Fracture Toughness Properties of China Manufactured Reactor Pressure Vessel Steels in Transition Temperature Range
Technical Paper Publication: PVP2018-84110

Kai Sun, Xiaoyong Wu, Guoyun Li, Bang Wen, *Nuclear Power Institute of China, Chengdu, China*

10:41am
Comparison of Pressure-Temperature Limits for a Pressurized Water Reactor Pressure Vessel Considering Beltline and Extended Beltline Regions
Technical Paper Publication: PVP2018-84145

Hsoung-Wei Chou, Yu-Yu Shen, Chin-Cheng Huang, *Institue of Nuclear Energy Research, Taoyuan, Taiwan*

11:07am
Toughness Requirement of Chinese Pressure Vessel Steel 07MnNiMoDR Based on Fracture Mechanics Assessment Method
Technical Paper Publication: PVP2018-84228

Lele Gui, Tong Xu, Yonghui Sun, Xuexin Shang, *CSEI, Beijing, China*

11:33am
A Study on the Fracture Toughness at Different Locations of SMAW Welded Joint of Primary Coolant Piping
Technical Paper Publication: PVP2018-84422

Weiwei Yu, Minyu Fan, Fei Xue, Mingya Chen, *Suzhou Nuclear Power Research Institute, Suzhou, Jiangsu Province, P.R. China*
Jinhua Shi, *Amec Foster Wheeler, Gloucester, UK*
Chen Xu, **Tianjin University, Tianjin, Tianjin, China**

Session 4.2J (MF-23-1)
Emerging Manufacturing and Mitigation Process Simulation
Lobby, Barcelona 10:15am - 12:00pm

Session Developer/Chair: **Vincent Robin**, *EDF, Chatou Cedex, France*
Session Developer/Co-Chair: **Cory Hamelin**, *EDF Energy, Maidenhead, Berkshire, UK*
Session Co-Developer: **Andrew Duncan**, *Savannah River National Laboratory, Aiken, SC, USA*

10:15am
Modelling of Dilution Effects on Microstructure and Residual Stress in a Multi-Pass Weldment
Technical Paper Publication: PVP2018-85110

Yongle Sun, Mike Smith, Anastasia Vasileiou, Thomas Flint, John Francis, *The University of Manchester, Manchester, UK*
Cory Hamelin, *EDF Energy, Maidenhead, Berkshire, UK*

10:36am
Hybrid Welding - Investigation of the Induced Residual Stresses
Technical Paper Publication: PVP2018-84996

Sebastien Gallee, Remi Lacroix, *Esi-France, Lyon Cedex 06, France*,
Vincent Robin, *EDF, Chatou Cedex, France*,
Florence Gommez, Erwan Jourden, *AREVA Np, Lyon, France*

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10:57am
Surrogate Modelling for Welding Simulation: Improve FE Modelling Robustness
Technical Presentation: PVP2018-85052

Vincent Robin, Sofiane Hendili, Loic Le-Gratiet, *EDF, Chatou Cedex, France*,
Florence Gommez, Erwan Jourden, *AREVA NP, Lyon, France*,
Remi Lacroix, Sebastien Gallee, *Esi-France, Lyon Cedex 06, France*

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11:18am
Prediction of Local Microstructure for Wire-Arc Additive Manufacturing of Aluminum Alloys
Technical Presentation: PVP2018-85114

Anna d'Entremont, Andrew Duncan, *Savannah River National Laboratory, Aiken, SC, USA*,
Poh-Sang Lam, Paul Korinko, *Savannah River National Lab, Aiken, SC, USA*,

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11:39am
Use of Modelling to Characterize the Risk of Hot Cracking in Austenitic Stainless Steels During Welding
Technical Presentation: PVP2018-85057

Vincent Robin, *EDF, Chatou Cedex, France*,
Denis Carron, Philippe Le-Masson, *Universite Bretagne Sud, Lorient, France*,
Julien Stodolna, *EDF, Ecuelles, France*,
Antoine Andrieu, *EDF, Moret Sur Loing, France*,
Josselin Delmas, Giai Tran Van, *EDF, Chatou, France*

Session 4.2K (OAC-8-2)
Aging and Life Management and Extension - II
Lobby, Berlin 10:15am - 12:00pm

Session Developer: **Garry Young**,
Entergy Services Inc, Russellville, AR, USA
Session Co-Developer/Chair: **Georges Bezdikian**,
Georges Bezdikian Consulting, Le Vesinet, France
Session Co-Chair: **Paolo Bragatto**,
INAIL, Monteporzio Catone, RM, Italy

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10:15am
Managing Pressure Equipment Aging in Plants with Major Accident Hazard: A Methodology Satisfying the Requirements of the European Directive 2012/18/Ue Seveso III
Technical Paper Publication: PVP2018-84687

Paolo Bragatto, *INAIL, Monteporzio Catone, RM, Italy*,
Corrado Delle Site, Annalisa Pirone, INAIL, Rome, Italy,
Maria Francesca Milazzo, *Università di Messina Dipartimento di Ingegneria, Messina, ME, Italy*,
Maria Rosaria Vallerotonda, *INAIL DIT, Roma, RM, Italy*

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10:50am
Methodology for Identifying Blunt Flaws Using Ultrasonic In-Service Inspection Data
Technical Paper Publication: PVP2018-85138

Mikko Jyrkama, Mahesh Pandey, *University of Waterloo, Waterloo, ON, Canada*
Ming Li, *Ontario Power Generation, Pickering, ON, Canada*

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11:25am
Pneumatic Test of Pressurised Equipment: Its Hazards and Alternatives
Technical Paper Publication: PVP2018-84025

Kaveh Ebrahimi, Saeid Rahimi Mofrad, *Fluor Ltd, Farnborough, UK*

Session 4.2L (HPT-3-1)
Darren Stang Memorial Session on Design, Analysis and Life Prediction of High-Pressure Vessels and Equipment
Lobby, Brussels 10:15am - 12:00pm

Session Developer/Chair: **Rolf Wink**, *Uhde High Pressure Tech Gmbh, Hagen, Germany*
Session Co-Developer: **Karl Simpson**, *Exxon Mobil Chemical, Scotlandville, LA, USA*
Session Developer/Co-Chair: **Kumarswamy Karpanan**, *TechnipFMC, Houston, TX, USA*

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10:15am
Modification to ASME VIII-3 Fatigue Analysis Mean Stress Correction
Technical Presentation: PVP2018-84124

Kumarswamy Karpanan, William Thomas, *TechnipFMC, Houston, TX, USA*

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10:41am
Structural Capacities of Flanged Joints
Technical Paper Publication: PVP2018-85088

Finn Kirkemo, *Statoil, Tranby, Norway*

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11:07am
Comparison Between the ASME BPVC Section VIII Division 3 and the Chinese Regulation TSG 21-2016 with Regard to the Design of High Pressure Vessels
Technical Paper Publication: PVP2018-84300

David Fuenmayor, Rolf Wink, Matthias Bortz, *Uhde High Pressure Technologies Gmbh, Hagen, Germany*

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11:33am
A Kinematic Hardening Material Model Describing Yield Surface Evolution and Elastic Stiffness Reduction Of Pressure Vessel Steel
Technical Presentation: PVP2018-85047

Christopher Aiello, *Benet Laboratories, Delmar, NY, USA*

Session 4.2M (MF-11-2)
Pipeline Integrity - II
Lobby, Sofia 10:15am - 12:00pm

Session Developer/Chair: **Dong-Yeob Park**, *Canmetmaterials, Natural Resources Canada, Calgary, AB, Canada*
Session Co-Chair: **Xiankui Zhu**, *EWI - Structural Integrity, Columbus, OH, USA*

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10:15am
Development of a Closed-Form Expression for the Assessment of the Integrity of Internally Corroded Pipelines
Technical Paper Publication: PVP2018-84020

Melad Fahed, *The Petroleum Institute, Abu Dhabi, UAE*
Imad Barsoum, *PI Abu Dhabi, Abu Dhabi, UAE*

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10:35am
Assessment Methods and Challenges of Remaining Strength for Corrosion Defects in Pipelines
Technical Paper Publication: PVP2018-84976

Xiankui Zhu, *EWI - Structural Integrity, Columbus, OH, USA*

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10:55am
Interaction Of Longitudinal Corrosion Defects On A Pipeline
Technical Paper Publication: PVP2018-84773

Jason C. Land, Thomas Yahner, William V. Harper, Michiel Brongers, *DNV GL USA, Inc., Dublin, OH, USA*
Jeffrey Kobs, *Rose Rock Midstream, Tulsa, OK, USA*

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11:15am
Microstructure and Tensile Properties of a 1.25Cr-0.5Mo Main Steam Pipe After Long-Term Service
Technical Paper Publication: PVP2018-84185

Bin Yang, *China University of Petroleum (East China), Qingdao, China*,
Wenchun Jiang, *College of Chemical Engineering, China University of Petroleum(East China), Qingdao, China*,
Wen-Qi Sun, Yan-Ling Zhao, Weiya Zhang, *China University of Petroleum (East China), Qingdao, China*

11:35am
Experimental Analysis of Corrosion Perfortion in a Crude Oil Gathering Pipeline
Technical Paper Publication: PVP2018-84515

Ke Tong, Hua Zhang, Lixia Zhu, Changyi Qin, Xiaodong He,*CNPC Tubular Goods Research Institute, Xi'an, Shaanxi Province, China*,

Session 4.2N (DA-7-2)
Thermal Stresses and Elevated Temperature Design - II
Lower Lobby, Madrid 10:15am - 12:00pm

Session Developer: **Albert Segall**,
Penn State University, University Park, PA, USA
Session Co-Developer: **San Iyer**,
Indian Institute of Technology, Delhi, India
Session Co-Developer/Chair: **Tasnim Hassan**,
NC State University, Raleigh, NC, USA
Session Co-Chair: **Junya Miura**,
Toyo University, Saitama, Japan

10:15am
Evolution of Temperature, Microstructure and Inter-Granular Stresses during Directionally Solidification Process Of A Ni-Based Superalloy
Technical Paper Publication: PVP2018-85046

Maryam Torfeh, Jamshid Aghazadeh, *Amirkabir University, Tehran, Tehran, Iran*
Soheil Nakhodchi, *K.N.Toosi University, Tehran, Iran*

10:50am
Thermal and Structural Analysis of Reactor Vessel Lower Head Considering Core Meltdown Accident
Technical Paper Publication: PVP2018-85101

Juan Luo, Jiacheng Luo, Lei Sun, Peng Tang, *Nuclear Power Institute of China, Chengdu, China*

11:25am
Finite Element Analysis of Printed Circuit Heat Exchanger Core for High Temperature Creep and Burst Responses
Technical Paper Publication: PVP2018-84748

Heramb Mahajan, Urmi Devi, Tasnim Hassan, *North Carolina State University, Raleigh, NC, USA*

Session 4.2O (EPRI-1-2)
EPRI Workshop on Continuum Damage Modeling
Session 2 - Properties and Models for Low Alloy Steels
Lower Lobby, Congress Hall I 10:15am - 12:00pm

Session Developer: **Jonathan Parker**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Developer: **Elizabeth Benton**,
EPRI, Charlotte, NC, USA
Session Chair: **Robert A. Ainsworth**,
University of Manchester, Manchester, UK
Session Co-Chair: **Ralf Mohrmann**,
RWE Power AG, Essen, Germany
Panelists: **P. Flewitt**,
University of Bristol, Bristol, UK
O. N'mec,
CEZ, Czech Republic
B. Cane,
Consultant, Thailand
H. Oesterlin,
Fraunhofer Institute for Mechanics of Materials IWM, Freiburg, Deutschland

Session 4.2Q (XPR-1-2)
1st International Workshop on Risk and Resilience of Industrial Installations against Natural Threats and Mitigation Strategies
Lower Lobby, Congress Hall III 10:15am - 12:00pm

Session Developer/Co-Chair: **Oreste Salvatore Bursi**,
University of Trento, Trento, Italy
Session Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy

10:15am
Problems and Perspectives in Seismic Risk and Resilience of Chemical Process Plants for Decision Making
Keynote Presentation: PVP2018-85167

Antonio Caputo, *Roma Tre University, Department of Engineering, Rome, Italy*

Block 4.3 Thursday, July 19 2:15AM - 4:00PM

Session 4.3A (MF-18-4)
Creep Modelling and Assessment Methodologies
Mezzanine, Karlin I 2:15pm - 4:00pm

Session Developer: **Catrin Mair Davies**, *Imperial College London, London, UK*
Session Co-Developer/Chair: **Frederick (Bud) Brust**, *Engineering Mechanics Corp of Columbus, Upper Arlington, OH, USA*
Session Co-Chair: **Catrin Mair Davies**, *Imperial College London, London, UK*

2:15pm
A Quantitative Assessment of Microstructural Evolution for Grade 91
Technical Paper Publication: PVP2018-84273

Chang Che, Gong Qian, Xisheng Yang, *China Special Equipment Inspection and Research Institute, Beijing, China*

2:36pm
Fundamental Modelling of Mechanisms Contributing to Tertiary Creep in Copper at 215 and 250°C
Technical Paper Publication: PVP2018-84288

Fangfei Sui, *KTH Royal Institute of Technology, Stockholm, Stockholm, Sweden*
Rolf Sandström, *KTH-Royal Institute of Technology, Stockholm, Sweden*

2:57pm
Comparison between Strain-based and Energy-based Creep Failure Simulation
Technical Paper Publication: PVP2018-84569

Seung Jae Kim, Young Ryun Oh, *Korea University, Seoul, Korea (Republic)*
Yun-Jae Kim, *Korea Univ, Seoul 136-701, Korea (Republic)*

3:18pm
Application of Impression Creep Tests to Grade Creep Deformation Properties across an Austenitic Stainless Steel Weldment
Technical Paper Publication: PVP2018-84618

S. Dey, D. Knowles, C.E. Truman, *University of Bristol, Bristol, UK*

3:39pm
Creep Modeling of 9-12%Cr Ferritic Steels Accounting for Subgrain Size Evolution
Technical Paper Publication: PVP2018-84671

Luca Esposito, *University of Naples, Naples, Naples, Italy*
Gabriel Testa, *University of Cassino and Southern Lazio, Cassino, Italy*
Alcide Bertocco, *University of Napoli "Federico II", Napoli, Italy*
Nicola Bonora, *Universita Di Cassino, Cassino, Italia*

Session 4.3B (MF-12-2)
Small-Scale Testing and Statistical Analysis of Mechanical Properties - II
Mezzanine, Karlin II 2:15pm - 4:00pm

Session Developer/Chair: **William L. Server**, *ATI-Consulting, Black Mountain, NC, USA*
Session Developer/Co-Chair: **Masatsugu Yaguchi**, *CRIEPI, Yokosuka-Shi, Japan*
Session Co-Developer: **Masato Yamamoto**, *CRIEPI, Yokosuka, Japan*

2:15pm
Reconstituted Mini Tensile Specimens
Technical Paper Publication: PVP2018-84760

Attila Kovacs, Akos Horvath, Marta Horvath, Ildiko Szenthe, Ferenc Gillemot, *Hungarian Academy of Sciences Centre for Energy Research, Budapest, Hungary*

2:41pm
The Size Effect on J-R Curve for Construction Steels and its Prediction by Simplified Mechanical Model
Technical Paper Publication: PVP2018-84866

Ludek Stratil, Filip Siska, Hynek Hadraba, Ivo Dlouhy, *Institute of Physics of Materials, Academy of Sciences of the Czech Republic, v.v.i., Brno, Czech Republic*

3:07pm
Analysis of Three-Dimensional Clamped Single Edge Notched Tension(SENT) Specimens
Technical Paper Publication: PVP2018-84868

Zheng Liu, Chen Xu, *Tianjin University, Tianjin, Tianjin, China*
Xin Wang, *Carleton University/Tianjin University, Ottawa, ON, Canada*

3:33pm
On the Development of CT-Type Specimen from VVER-1000 Surveillance Specimen Materials Reconstruction Procedure
Technical Presentation: PVP2018-85087

Denis Zhurko, *NRC «Kurchatov Institute», Moscow, Russia*

Session 4.3C (CS-8-1)
Compatibility and Suitability of Materials for Hydrogen Service
Mezzanine, Karlin III 2:15pm - 4:00pm

Session Developer/Chair: **Chris San Marchi**, *Sandia National Laboratories, Livermore, CA, USA*
Session Developer/Co-Chair: **Steven Xu**, *Kinectrics, Toronto, ON, Canada*
Session Co-Developer: **Michael Martin**, *Rolls-Royce, Derbyshire, UK*

2:15pm
Introduction of Technical Document in Japan for Safe Use of Ground Storage Vessels Made of Low Alloy Steels for Hydrogen Refueling Stations
Technical Paper Publication: PVP2018-84099

Hajime Fukumoto, *JPEC, Minato-Ku, Japan*
Wada Yoru, *The Japan Steel Works,Ltd, Hokkaido, Japan*
Hisao Matsunaga, *Kyushu University, Fukuoka, Japan*
Takeru Sano, *The High Pressure Gas Safety Institute of Japan, Machida-shi, Tokyo, Japan*
Hiroshi Kobayashi, *Japan Petroleum Energy Center, Tokyo, Japan*

2:41pm
Improving the Hydrogen Embrittlement Database of a CrMo Steel Under Hydrogen Pressure
Technical Presentation: PVP2018-84158

Laurent Briottet, *French Alternative Energies and Atomic Energy Commission (CEA), Grenoble, France*
Paolo Bortot, *TenarisDalmine, Dalmine (BG)Italy, Italy*
Jader Furtado, *Air Liquide R&D, Jouy-en-Josas, France*
Béatrice Fuster, Olivier Bardoux, *Air Liquide, Jouy en Josas, France*

3:07pm
Hydrogen Compatibility and Suitability of (Ni)-Cr-Mo High-Strength Low-Alloy Seamless Line Pipe Steels for Pressure Vessels for Hydrogen Storage
Technical Paper Publication: PVP2018-84726

Akihide Nagao, Nobuyuki Ishikawa, *JFE Steel Corporation, Kawasaki, Kanagawa, Japan*,
Toshio Takano, *JFE Container Corporation, Chiyoda-ku, Tokyo, Japan*

3:33pm
Effect of Hydrogen on Fracture Toughness Behavior of 2.25Cr1Mo0.25V Steel
Technical Paper Publication: PVP2018-84486

Mengyu Chai, **Yan Song**, **Zaoxiao Zhang**, **Quan Duan**, **Guangxu Cheng**, Xi'an Jiaotong University, *Xi'an, China*

Session 4.3D (CS-7-3)
Recent Developments in ASME Codes and Standards - III
Mezzanine, Palmovka 2:15pm - 4:00pm

Session Developer/Chair: **T.-L. (Sam) Sham**, *Argonne National Laboratory, Lemont, IL, USA*
Session Co-Chair: **Mark Messner**, *Argonne National Laboratory, Lemont, IL, USA*

2:15pm
Assessment of Passively Actuated In-Situ Cyclic Surveillance Test Specimens for Advanced Non-Light Water Reactors
Technical Paper Publication: PVP2018-84793

T.-L. (Sam) Sham, Mark Messner, V. Tung Phan, *Argonne National Laboratory, Lemont, IL, USA*
Bob Jetter, *R.I. Jetter Consulting, Pebble Beach, CA, USA*

2:41pm
Detection of Ratcheting in Finite Element Calculations
Technical Paper Publication: PVP2018-84102

Mark Messner, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*

3:07pm
Technical Basis for Proposed Fifth Revision to ASME Code Case N-513
Technical Paper Publication: PVP2018-84092

Robert McGill, *Structural Integrity Associates, San Jose, CA, USA*
Eric Houston, *Structural Integrity Associates, Inc., Centennial, CO, USA*
Russell Cipolla, *Intertek AIM, Santa Clara, CA, USA*
Dylan Cimock, *EPRI, Charlotte, NC, USA*

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3:33pm
The Mechanical Interaction of Clad and Base Metal for Molten Salt Reactor Structural Components
Technical Paper Publication: PVP2018-84101

Mark Messner, V. Tung Phan, T.-L. (Sam) Sham, *Argonne National Laboratory, Lemont, IL, USA*,
Bob Jetter, *R.I. Jetter Consulting, Pebble Beach, CA, USA*,

Session 4.3E (CS-25-1)
Integrity of Reactor Pressure Vessels and Internals for Codes
Mezzanine, Rokoska 2:15pm - 4:00pm

Session Developer/Chair: **Kiminobu Hojo**, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*
Session Developer/Co-Chair: **Russell Cipolla**, *Intertek AIM, Santa Clara, CA, USA*

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2:15pm
Evaluation of Reactor Internals Integrity and Lifetime According to the NTD ASI
Technical Paper Publication: PVP2018-84140

Milan Brumovsky, *UJV Rez, Rez, Czech Republic*

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2:41pm
Fracture Analysis of Ductile-Brittle Transition Temperature Region Considering with Specimens with Different Constraints
Technical Paper Publication: PVP2018-84385

Kiminobu Hojo, Yasuto Nagoshi, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*
Takatoshi Hirota, Naoki Ogawa, Kentaro Yoshimoto, *Mitsubishi Heavy Industries, LTD., Takasago, Japan*
Shinichi Kawabata, *Ryoyu System Gijutu, Kobe, Japan*

3:07pm
Analysis of a Weld Overlay to Address Fatigue Cracking in a Stainless Steel Nozzle
Technical Paper Publication: PVP2018-84722

Stephen Marlette, Anees Udyawar, *Westinghouse Electric Company, Cranberry Township, PA, USA*
John Broussard, *Dominion Engineering, Inc., Reston, VA, USA*

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3:33pm
Reactor Vessel Nozzle Inner Radius Fracture Analyses Using Elastic-Plastic Fracture Mechanics
Technical Paper Publication: PVP2018-85130

Stephen Marlette, *Westinghouse Electric Company, Cranberry Township, PA, USA*

Session 4.3F (SE-6-1)
Seismic Analysis and Design of Piping Systems
Mezzanine, Hercovka 2:15pm - 4:00pm

Session Developer/Chair: **Gerry Slagis**, *G C Slagis Associates, Roseville, CA, USA*
Session Developer/Co-Chair: **Izumi Nakamura**, *National Research Institute of Earth Sciences/Disaster Prevention, Miki-shi, Hyogo 673-0515, Japan*

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2:15pm
Effect of Static Load Components in Dynamic Loading on Gross Plastic Deformation of Structure
Technical Paper Publication: PVP2018-84415

Satoru Kai, Akihito Otani, *IHI Corporation, Yokohama, Japan*

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2:41pm
On Categorization of Seismic Load as Primary or Secondary for Piping Systems with Hardening Capacity
Technical Paper Publication: PVP2018-84608

Pierre B. Labbe, *Ecole Spéciale des Travaux Publics, Paris, France*

3:07pm
Ultimate Limit States of Piping Supports with Outer Diagonal Brace under High Acceleration Sinusoidal Shaking Condition
Technical Paper Publication: PVP2018-84937

Ryuya Shimazu, *CRIEPI, Abiko-Shi, Chiba-ken, Japan*
Michiya Sakai, *CRIEPI, Abiko, Chiba, Japan*

3:33pm
The OECD-NEA Programme on Metallic Component Margins under High Seismic Loads (MECOS): Towards New Criteria
Technical Presentation: PVP2018-84684

Pierre Sollogoub, *PS Consult, Clamart, France*

3:07pm
J-R Curve Prediction of Pre-strained Stainless Steel 316 Material Using FE Damage Analysis Method
Technical Paper Publication: PVP2018-84627

Jun-Min Seo, Ji-Soo Kim, Yun-Jae Kim, *Korea University, Seoul, Korea (Republic)*,

3:33pm
Comparison of Two Ductile Crack Propagation Models of CZM and GTN for Pipe Steel Fracture
Technical Paper Publication: PVP2018-84689

Wang Junqiang, Haitao Wang, Nan Lin, Jinlong Wang, Honglian Ma, *China Special Equipment Inspection and Research Center, Beijing, China*,

Session 4.3G (MF-31-1)
3D Crack Growth Simulation Using FEA
Mezzanine, Tyrolka 2:15pm - 4:00pm

Session Developer/Chair: **Do-Jun Shim**,
Structural Integrity Associates, Inc., San Jose, CA, USA
Session Developer/Co-Chair: **Yinsheng Li**,
Japan Atomic Energy Agency, Ibaraki-Ken, Japan

2:15pm
SCC Crack Growth Analysis for a Dissimilar Metal Weld Using Advanced FEA
Technical Paper Publication: PVP2018-84513

Takuya Ogawa, Masao Itatani, Takahiro Hayashi, Toshiyuki Saito, *Toshiba Energy Systems & Solutions Corporation, Yokohama, Japan*

2:41pm
Ductile Tearing Simulation of Circumferential Cracked Pipe Under Cyclic Loading Using Damage Criteria Determined by Monotonic Pipe Test Data
Technical Paper Publication: PVP2018-84588

Jin-ha Hwang, Gyo-Geun Youn, Yun-Jae Kim, *Korea University, Seoul, Korea (Republic)*
Naoki Miura, *Central Research Institute of Electric Power Indus, Yokosuka, Japan*

Session 4.3H (OAC-6-1)
Reliability and Optimization
Lobby, Amsterdam 2:15pm - 4:00pm

Session Developer/Chair: **Ayman Cheta**,
Qatar Shell GTL, Doha, Qatar
Session Developer/Co-Chair: **Yasumasa Shoji**,
YS Corporation LLC, Tokyo, Japan

2:15pm
Supercritical CO2 Heat Exchanger Fouling and its Impact on RCBC Efficiency
Technical Paper Publication: PVP2018-84091

Darryn Fleming, Salvador Rodriguez, Kirsten Norman, James Pasch, Gary Rochau, Matt Carlson, *Sandia National Labs, Albuquerque, NM, USA*

2:41pm
Experimental Research on the Effect of Heating Temperature, Demulsifier Dose and Water Cut on the Oil-Water Separation in Three-Phase Separator
Technical Paper Publication: PVP2018-84285

Ang Li, Yun Shen, Hang Jin, Wei Wang, Jing Gong, Yaorong Feng, *China University of Petroleum-Beijing, Beijing, China*
Jianfeng Bai, *Xi'an Changqing Technology & Engineering Co.,Ltd., Xi'an, China*,

3:07pm
Optimization of Reactor's Start-Up and Shutdown Procedures by Transient Thermo-Mechanical Finite Element Analysis
Technical Paper Publication: PVP2018-84123

Ohgeon Kwon, Vitor Lopes Garcia, *Quest Integrity, Wellington, New Zealand*
Sang-Mo Lee, *SK Energy, Ulsan, Korea (Republic)*

3:33pm
Modeling and Mitigation of Acoustic Induced Vibration (AIV) in Piping Systems
Technical Paper Publication: PVP2018-84107

Brandon Ridens, Sarah Simons, Timothy Allison, Klaus Brun, *Southwest Research Institute, San Antonio, TX, USA*

Session 4.3I (MF-24-2)
Asian Programs in Structural Integrity - II
Lobby, Athens 2:15pm - 4:00pm

Session Developer: **Guian Qian**, *Paul Scherrer Institute, Villigen-Psi, Switzerland*
Session Co-Developers: **Yuh J. Chao**, *University Of South Carolina, Columbia, SC, USA*, **Poh-Sang Lam**, *Savannah River National Lab, Aiken, SC, USA*
Session Chair: **Hsoung-Wei Chou**, *Institute of Nuclear Energy Research, Taoyuan City, Taiwan*
Session Co-Developer: **Yupeng Cao**, *Shanghai Nuclear Engineering Research and Design Institute, Shanghai, China*
Session Co-Chair: **Yinghua Liu**, *Tsinghua University, Beijing, Beijing, China*

2:15pm
Constraint Assessment for Cruciform Specimens with a Semi-Elliptical Crack
Technical Paper Publication: PVP2018-84427

Yupeng Cao, Yinbiao He, *Shanghai Nuclear Engineering Research and Design Institute, Shanghai, China*
Guian Qian, *Paul Scherrer Institute, Villigen-Psi, Switzerlan*
Yuh J. Chao, *University of South Carolina, Columbia, SC, USA*

2:36pm
Application of Flaw Updating Process on Probabilistic Structural Evaluation for A Reactor Pressure Vessel Under Pressurized Thermal Shocks
Technical Paper Publication: PVP2018-84477

Pin-Chiun Huang, Yuh-Ming Ferng, *National Tsing Hua University, Hsinchu, Taiwan*
Hsoung-Wei Chou, *Institute of Nuclear Energy Research, Taoyuan City, Taiwan*

2:57pm
Material Constraint Effect for the Mode II Crack in Power-Law Creeping Solids
Technical Paper Publication: PVP2018-84623

Yanwei Dai, Yinghua Liu, *Tsinghua University, Beijing, Beijing, China*,
Yuh J. Chao, *University of South Carolina, Columbia, SC, USA*

3:18pm
Analysis of Fluid Structure Interaction Behavior Of Straight Pipe With Non-Penetrating Circumferential Crack
Technical Paper Publication: PVP2018-85109

Cao Yinhang, Zong Yucheng, *Harbin Engineering University, Heilongjiang, China*,
Liu Gongmin, *Harbin Engineering University, Harbin, Heilongjiang, China*,

3:39pm
Probabilistic Leak-Before-Break Analysis of a Nuclear Piping Considering Intergranular Stress Corrosion Cracking
Technical Presentation: PVP2018-85025

Guian Qian, Markus Niffenegger, *Paul Scherrer Institute, Villigen-Psi, Switzerland*

Session 4.3J (MF-9-1)
Mechanistic Modelling of Deformation and Fracture - I
Lobby, Barcelona 2:15pm - 4:00pm

Session Developer: **Anthony Horn**, *Wood, Warrington, UK*
Session Chair: **Peter James**, *Wood, Warrington, Cheshire, UK*
Session Co-Chair: **Sergio Cicero**, *University of Cantabria, Santander, Spain*

2:15pm
Using Virtual Testing to Study the Influence of Constraint of Fracture Properties
Technical Paper Publication: PVP2018-84603

Christopher Seal, Robert A. Ainsworth, *The University of Manchester, Manchester, UK*

2:41pm
Predicting the Effect of Low Constraint on the Onset of Upper Shelf Temperature
Technical Paper Publication: PVP2018-84606

Christopher Seal, Andrew Sherry, *The University of Manchester, Manchester, UK*

3:07pm
Limits of Applicability of the Notch Failure Assessment Diagram
Technical Paper Publication: PVP2018-85062

Anthony Horn, *Wood, Warrington, UK*
Chris Aird, *EDF Energy, Gloucester, UK*

3:33pm
A Local Approach to Assess Effects of Specimen Geometry on Cleavage Fracture Toughness in Reactor Pressure Vessel Steels
Technical Paper Publication: PVP2018-85063

Diego F. B. Sarzosa, Rafael G. Savioli, Claudio Ruggieri, *University of Sao Paulo USP, Sao Paulo, Brazil*
Jack Beswick, Andrey P. Jivkov, *School of Mechanical, Aerospace and Civil Engineering, Manchester, UK*

Session 4.3K (DA-16-1)
Vessel Design Philosophy - I : The Owner / Purchaser Perspective
Lobby, Berlin 2:15pm - 4:00pm

Session Co-Developer/ Co-Chair: **Leslie Antalffy**, *Fluor, Sugar Land, TX, USA*
Session Chair: **Jaan Taagepera**, *Chevron ETC, Richmond, CA, USA*

Session 4.3L (HPT-3-2)
Design and Evaluation of LDPE Equipment
Lobby, Brussels 2:15pm - 4:00pm

Session Developer/Chair: **Hermann Maderbacher**, *BHDT Gmbh, Kapfenberg, Austria*
Session Developer/Co-Chair: **Karl Simpson**, *Exxon Mobil Chemical, Scotlandville, LA, USA*

2:15pm
Approach for the Dimensioning of Bolted Joint Connections with Threaded Flanges for High Pressure Applications
Technical Paper Publication: PVP2018-84613

Matthias Bortz, *Uhde High Pressure Technologies Gmbh, Hagen, Germany*
David Fuenmayor, *Uhde High Pressure Technologies, Hagen, Germany*
Rolf Wink, *Uhde High Pressure Tech Gmbh, Hagen, Germany*

2:41pm
From Piping Deformation to Pressure Pulsation Measurements to Solve LDPE Plants Vibration Issues
Technical Paper Publication: PVP2018-84666

Cosimo Carcasci, Marco Sacco, *CST, Firenze, Italy*
Marco Landucci, Marco Fiaschi, *Sint Technology, Calenzano, Firenze, Italy*

3:07pm
Market Opportunities and Outlook For LDPE/EVA Resins
Technical Presentation: PVP2018-84980

Dieter Littmann, *LyondellBasell, Frankfurt, Germany*

3:33pm
The Influence of Bauschinger Effect on the Stability of Residual Stresses in Autofrettaged High Pressure Tubes
Technical Paper Publication: PVP2018-85123

Hermann Maderbacher, *BHDT Gmbh, Kapfenberg, Austria*
Manfred Poelzl, *BHDT, Kapfenberg, Austria*

Session 4.3N (DA-4-1)
Inelastic, Nonlinear and Limit Load Analysis - I
Lower Lobby, Madrid 2:15pm - 4:00pm

Session Developer: **Dan Vlaicu**,
Ontario Power Generation, Pickering, ON, Canada
Session Chair: **Hany Abdalla**,
Nile University, Cairo, Egypt
Session Co-Chair: **Jan Blachut**,
University ofLiverpool, Liverpool L693GH, UK

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2:15pm
Shakedown-Ratcheting Analysis of a Spherical Pressure Vessel by Anisotropic Continuum Damage Mechanics
Technical Paper Publication: PVP2018-84065

Ali Nayebi, Azam Surmiri, *Shiraz University, Shiraz, Iran*
Hojjatollah Rokhgireh, *University of Larestan, Lar, Fars, Iran*

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2:41pm
Simplified Analysis of Strains Accumulated in the State of Elastic Shakedown Considering Multi-Parameter Loadings
Technical Paper Publication: PVP2018-84070

Hartwig Hübel, Bastian Vollrath, *Brandenburg University of Technology, Cottbus, Germany*

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3:07pm
Buckling of Corroded Torispherical Shells under External Pressure
Technical Paper Publication: PVP2018-84309

Jan Blachut, *University Of Liverpool, Liverpool L693GH, UK*

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3:33pm
Local Mesh Refinement for Correlation of FEA Estimated Plastic Strain to Tests in Areas of High Plastic Strain
Technical Paper Publication: PVP2018-84630

Katharine Liu, *Emerson, Wuqing, Tianjin, China*,
Gregory Westwater, *Emerson, Marshalltown, IA, USA*,
Christopher Johnson, *Emerson, Ankeny, IA, USA*,
Emma Xiao, *Emerson, Wuqing, Tianjin, China*,
J. Adin Mann III, *Emerson Process Management, Fisher Valve Division, Marshalltown, IA, USA*

Session 4.3O (EPRI-1-3)
EPRI Workshop on Continuum Damage Modeling
Session 3 - Properties and Models for Martensitic Steels
Lower Lobby, Congress Hall I 2:15pm - 4:00pm

Session Developer: **Jonathan Parker**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Developer: **Elizabeth Benton**,
EPRI, Charlotte, NC, USA
Session Chair: **John Siefert**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Chair: **Mirko Bader**,
Uniper Kraftwerke GmbH, Gelsenkirchen, Germany
Panelists: **J. Parker**,
EPRI, Charlette, NC, USA
P. Mayr,
Technische Universität Chemnitz, Chemnitz, Germany
M. Bader,
Uniper, Germany
Y. Takahashi,
Central Research Institute of Electric Power Industry (CRIEPI), Japan

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Session 4.3Q (XPR-1-3)
1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats and Mitigation Strategies
Lower Lobby, Congress Hall III 2:15pm - 4:00pm

Session Developer/Co-Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Chair: **Antonio Caputo**,
Roma Tre University Department of Engineering, Rome, Italy

2:15pm
A Probabilistic Methodology for the Risk Assessment of Process Plants Including Domino Effects
Keynote Presentation: PVP2018-85168

Fabrizio Paolacci, *University Roma Tre, Rome, Italy*

Block 4.4 Thursday, July 19 4:15PM - 6:00PM

Session 4.4A (MF-18-5)
Creep Life Prediction and Microstructural Analyses
Mezzanine, Karlin I 4:15pm - 6:00pm

Session Developer: **Catrin Mair Davies**,
Imperial College London, London, UK
Session Co-Developer/Chair: **Yun-Jae Kim**,
Korea Univ, Seoul 136-701, Korea (Republic)
Session Co-Chair: **Luca Esposito**,
University of Naples, Naples, Naples, Italy

4:15pm
The Influence of Creep Strain Rate on Creep Damage Formation in Austenitic Stainless Steel
Technical Paper Publication: PVP2018-84635

Edward Hares, Christopher E. Truman, Mahmoud Mostafavi, Rick. A. W. Bradford, *University of Bristol, Bristol, UK*

4:36pm
Microstructure Evolution During Hot Deformation of AD730TM Ni-Based Superalloy: Influence of Strain Rate And Temperature
Technical Paper Publication: PVP2018-85140

Nathan Harris, Mathias Lieutaud, Mohammad Jahazi, *Ecole de Technologie Supérieure, Montreal, QC, Canada*
Alexandre Devaux, *Aubert et Duval, Les Ancizes, France*
Jonathan Cormier, *CNRS, Chasseneuil, France*

4:57pm
Effect of Carburization on Creep Performance of Cr35Ni45Nb Heat Resistant Alloy
Technical Paper Publication: PVP2018-84226

Luowei Cao, Guoshan Xie, Zhiyuan Han, Fakun Zhuang, *China Special Equipment Inspection & Research Institute, Beijing, China*

5:18pm
Research on Creep Analysis of Alloy 617 in AUSC Turbine Components
Technical Paper Publication: PVP2018-84227

Yifeng Hu, Lingen Sun, *Shanghai Electric Power Generation Equipment Co., Ltd. Shanghai Turbine Plant, Shanghai, China*
Gang Chen, *Shanghai Electric Power Generation Equipment Co., Ltd., Shanghai, China*

5:39pm
Influence of W in Solid Solution on the Creep Rate of Nickel
Technical Paper Publication: PVP2018-84286

Jing Zhang, Rolf Sandström, *KTH-Royal institute of Technology, Stockholm, Sweden*

Session 4.4C (CS-8-2)
Hydrogen from Non-Gaseous Environments
Mezzanine, Karlin III 4:15pm - 6:00pm

Session Developer/Chair: **Steven Xu**,
Kinectrics, Toronto, ON, Canada
Session Co-Developer: **Chris San Marchi**,
Sandia National Laboratories, Livermore, CA, USA
David Cho,
Bruce Power, Toronto, ON, Canada
Session Co-Chair: **Andrew Duncan**,
Savannah River National Laboratory, Aiken, SC, USA

4:15pm
Cycle-Wise Process-Zone Model for Prediction of Delayed Hydride Cracking Initiation under Flaw-Tip Hydride Ratcheting Conditions
Technical Paper Publication: PVP2018-85116

Steven Xu, Jun Cui, Douglas Scarth, *Kinectrics, Toronto, ON, Canada*
David Cho, *Bruce Power, Toronto, ON, Canada*

4:41pm
Effect of Pre-Heat Treatment on Hydrogen Concentration Behavior of y-Grooved Weld Joint Based on a Coupled Analysis of Heat Transfer-Thermal Stress-Hydrogen Diffusion
Technical Paper Publication: PVP2018-84178

Go Ozeki, A. Toshimitsu Yokobori, Jr., *Teikyo University, Tokyo, Japan*
Toshihito Ohmi, *Shonan Institute of Technology, Kanagawa, Japan*
Tadashi Kasuya, Manabu Enoki,*The University of Tokyo, Tokyo, Japan*
Nobuyuki Ishikawa, *JFE Steel Corporation, Kawasaki, Kanagawa, Japan*
Satoshi Minamoto, *National Institute for Materials Science (NIMS), Ibaraki, Japan*

5:07pm
Hydrogen Diffusion Concentration Behaviors for Square Groove Weld Joint
Technical Paper Publication: PVP2018-84192

Toshihito Ohmi, *Shonan Institute of Technology, Kanagawa, Japan*
A. Toshimitsu Yokobori, Jr., Go Ozeki, *Teikyo University, Tokyo, Japan*
Tadashi Kasuya, Manabu Enoki, The University of Tokyo, Tokyo, Japan
Nobuyuki Ishikawa, JFE Steel Corporation, Kawasaki, Kanagawa, Japan
Satoshi Minamoto, National Institute for Materials Science (NIMS), Ibaraki, Japan

5:33pm
A Compendium of Mechanical Testing of Austenitic Stainless Steels on Hydrogen
Technical Paper Publication: PVP2018-84723

Poh-Sang Lam, Andrew Duncan, Michael Morgan, Robert Sindelar, Thad Adams, *Savannah River National Laboratory, Aiken, SC, USA*

Session 4.4D (CS-10-1)
Structural Integrity Assessment of Pressure Boundary Components
Mezzanine, Palmovka 4:15pm - 6:00pm

Session Developer/Chair: **Naoki Miura**, *Central Research Institute of Electric Power Indus, Yokosuka, Japan*
Session Developer/Co-Chair: **Yinsheng Li**, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*
Session Co-Developers: **Seiji Asada**, *Mitsubishi Heavy Industries, Ltd, Kobe 652-8585, Japan*
Kai Lu, *Japan Atomic Energy Agency, Naka-Gun, Japan*

4:15pm
Effect of Chronological Order of Cyclic Loads with Different Amplitudes on Fatigue Crack Growth
Technical Paper Publication: PVP2018-84956

Naoki Miura, Masaki Nagai, *Central Research Institute of Electric Power Indus, Yokosuka, Japan*

4:41pm
Development of Crack Evaluation Models for Probabilistic Fracture Mechanics Analyses of Japanese Reactor Pressure Vessels
Technical Paper Publication: PVP2018-84965

Kai Lu, *Japan Atomic Energy Agency, Naka-Gun, Japan*
Masaki Koichi, Jinya Katsuyama, Yinsheng Li, *Japan Atomic Energy Agency, Ibaraki, Japan*

5:07pm
Sensitivity Study on the Effects of Nondestructive Examinations on Failure Probabilities of Reactor Pressure Vessels
Technical Paper Publication: PVP2018-84989

Kensaku Arai, Jinya Katsuyama, Yinsheng Li, *Japan Atomic Energy Agency, Ibaraki, Japan*

5:33pm
Proposal of Flaw Evaluation Method for Securing Reliability of Circumferential Flawed Pipes
Technical Paper Publication: PVP2018-84995

Hideo Machida, *Tepco Systems Corporation, Tokyo, Japan*

Session 4.4E (CS-24-1)
International Session for Fast Reactor Design and Construction
Mezzanine, Rokoska 4:15pm - 6:00pm

Session Developer/Chair: **Cécile Petesch**, *CEA Saclay, Gif-sur-Yvette, France*
Session Co-Chair: **Jorge-Enrique Munoz-Garcia**, *French Alternative Energies and Atomic Energy Commission (CEA), Gif-sur-Yvette, France*

4:15pm
Efficiency Diagram Alternative Rule for Ratchetting: Historical Background, Overview, On-Going Developments
Technical Paper Publication: PVP2018-84161

Thierry Lebarbe, Jorge-Enrique Munoz-Garcia, Giacomo Aiello, *CEA, Gif-sur-Yvette, France*
Cécile Petesch, *CEA Saclay, Gif-sur-Yvette, France*
Yves Lejeail, Pierre Lamagnère, *CEA Cadarache, Saint Paul-Lez-Durance, France*
Antoine Martin, *AREVA NP SAS, Lyon, France*

4:41pm
Development of a Program for High-Temperature Design Analysis and Defect Assessment According to RCC-MRX
Technical Paper Publication: PVP2018-84242

Hyeong-Yeon Lee, Woo Gon Kim, *Korea Atomic Energy Research Institute, Daejeon, Korea (Republic)*
Mingu Won, *Sungkyunkwan University, Suwon, Korea (Republic)*
Nam-Su Huh, *Seoul National University of Science and Technology, Seoul, Korea (Republic)*

5:07pm
2018 RCC-MRX Code Edition: Context, Overview, On-Going Developments
Technical Paper Publication: PVP2018-84706

Cécile Petesch, *CEA Saclay, Gif-sur-Yvette, France*
Thierry Lebarbe, *CEA, Gif Sur Yvette, France*,
Odile Gelineau, *AREVA NP, Lyon, France*
Martine Blat-Yrieix, *EDF, Moret sur Loing, France*
Damien Vallot, *TechnicAtome, Saint Paul Lez Durance, France*

5:33pm
Feedback based on Application of Code Rules to Design and Construction of Prototype Fast Breeder Reactor
Technical Paper Publication: PVP2018-84880

Sriramachandra Aithal, Amzad Pasha, S. Athmalingam, K. Krishna Prasad, R. Vijayashree , S. C. Ravichandar, S. Raghupathy, P. Puthiyavinayagam, Indira Gandhi Centre for Atomic Research, Kalpakkam, Tamil Nadu, India
V. Balasubramaniyan, Safety Research Institute, AERB Kalpakkam, Tamil Nadu, India

Session 4.4F (SE-13-1)
Ratcheting Deformation of Materials and Piping
Mezzanine, Hercovka 4:15pm - 6:00pm

Session Developer: **Chen Xu**, *Tianjin University, Tianjin, Tianjin, China*
Session Co-Chair: **Radim Halama**, *VSB-Technical University of Ostrava, Ostrava, Czech Republic*
Session Co-Developer/Chair: **Tasnim Hassan**, *NC State University, Raleigh, NC, USA*

4:15pm
Pipe Ovalization Prediction for the Pipe-Laying Ocean System
Technical Paper Publication: PVP2018-84785

Radim Halama, *VSB-Technical University of Ostrava, Ostrava, Czech Republic*
Matej Bartecky, *Continental Automotive Czech Republic, Frenstat pod Radhostem, Czech Republic*

4:40pm
Model Improvement for Simulation of Low Cycle Fatigue and Ratcheting Responses of SS304 Elbows
Technical Presentation: PVP2018-84744

Nazrul Islam, Tasnim Hassan, *North Carolina State University, Raleigh, NC, USA*

5:05pm
Multiaxial Ratcheting with Incorporation of Anisotropic Damage Model
Technical Paper Publication: PVP2018-84305

Hojjatollah Rokhgireh, *University of Larestan, Lar, Fars, Iran*
Ali Nayebi, *Shiraz University, Shiraz, Iran*

5:30pm
Ratcheting Behavior of Pressurized Elbow Pipe After Thermal Aging
Technical Paper Publication: PVP2018-84108

Caiming Liu, Dunji Yu, Chen Xu, *Tianjin University, Tianjin, Tianjin, China*

5:55pm
Simulation of Ratcheting by a Directional Distortional Hardening Plasticity Constitutive Model
Technical Presentation: PVP2018-84709

Rene Marek, *Institute of Thermomechanics of the CAS, v.v.i., Prague, Czech Republic*
Yannis F. Dafalias, *University of California at Davis, Dept. of Civil and Environmental Engineering Davis, CA, USA*
Heidi P. Feigenbaum, *Northern Arizona University, Dept. of Mechanical Engineering, Flagstaff, AZ, USA*
Slavomir Parma, Jiri Plesek, *Institute of Thermomechanics of the CAS, v.v.i., Prague, Czech Republic*

Session 4.4G (CS-21-1)
Fatigue Monitoring and Related Assessment Methods
Mezzanine, Tyrolka 4:15pm - 6:00pm

Session Developer/Chair: **Juergen Rudolph**, *Framatome GmbH, Erlangen, Bavaria, Germany*
Session Developer/Co-Chair: **Gaston Bourguigne**, *Nucleoelectrica Argentina S.A., Ciudad Autonoma De, Buenos Aires, Argentina*

4:15pm
Fatigue Monitoring: Case Studies in Nuclear Power Plant
Technical Paper Publication: PVP2018-84007

Gaston Bourguigne, *Nucleoelectrica Argentina S.A., Ciudad Autonoma De, Buenos Aires, Argentina*
Fernando Schroeter, *Nucleoeléctrica Argentina S.A., Cap Federal Bs Ar 1429, Argentina*

4:41pm
Fatigue Monitoring of a Dented Piping Specimen Using Infrared Thermography
Technical Paper Publication: PVP2018-84597

Jose Freire, *PUC-Rio, Rio De Janeiro, Brazil*
Vitor Paiva, Giancarlo Gonzáles, Ronaldo Vieira, Jose Eduardo Maneschy, Renato Vieira, *Pontifical Catholic University, Rio De Janeiro, Brazil*

5:07pm
Issues with Multiaxial Fatigue Assessment in the ASME Boiler and Pressure Vessel Code
Technical Paper Publication: PVP2018-84979

Marco Antonio Meggiolaro, Jaime T.P. Castro, *PUC-Rio, Rio de Janeiro, RJ, Brazil*
Hao Wu, *Tongji University, Shanghai, China*

5:33pm
Operational Strategies, Maintenance and Life Assessment for Future Power Plants
Technical Presentation: PVP2018-85128

Andreas Klenk, *MPA Stuttgart, Stuttgart, Germany*
Xaver Schuler, *Materials Testing Institute (MPA) University of Stuttgart, Stuttgart, Baden-Württemberg, Germany*
Klaus Metzger, *GKM Grosskraftwerk Mannheim Aktiengesellschaft, Mannheim, Germany*
Steffen Bergholz, *AREVA GmbH, Erlangen, Bavaria, Germany*
Juergen Rudolph, *Framatome GMBH, Erlangen, Bavaria, Germany*

Session 4.4H (OAC-6-2)
Fitness for Service and Continued Safe Operation
Lobby, Amsterdam 4:15pm - 6:00pm

Session Developer/Chair: **Yasumasa Shoji**, *YS Corporation LLC, Tokyo, Japan*
Session Developer/Co-Chair: **Ayman Cheta**, *Qatar Shell GTL, Doha, Qatar*

4:15pm
Fitness-For-Service Assessment Of An Injection Point In A Boiler Feed-Water Line Subjected To Corrosion
Technical Paper Publication: PVP2018-85038

Takuyo Kaida, Masahiro Sasaki, Luis Alejandro Baldomir Gutierrez, *Rabigh Refining and Petrochemical Co., Rabigh, Saudi Arabia*

4:41pm
Effects of Nut Thinning Due to Corrosion on the Sealing Performance in Bolted Flange Joints under Internal Pressure
Technical Paper Publication: PVP2018-85064

Tsutomu Kikuchi, *IDEMITSU Kosan Co.,Ltd, Chiba, Japan*
Hirokazu Tsuji, Daichi Tsurumi, *Tokyo Denki University, Tokyo, Japan*

5:07pm
Repair and FFS of Vacuum Column for Corrosion Under Insulation
Technical Paper Publication: PVP2018-84545

Yeswanth Kumar Adusumilli, *Shell Eastern Petroleum (Pte) Ltd, Singapore, Singapore*
Siva Kumar Chiluvuri, *Shell India Markets Private Ltd, Bangalore, India*
Ayman Cheta, *Qatar Shell GTL, Doha, Qatar*

5:33pm
API RP 582 - Welding Guidelines for the Chemical, Oil, and Gas Industries
Technical Presentation: PVP2018-84891

Jorge Penso, *Shell Oil, Cypress, TX, USA*

Sessions 4.4I (CS-15-1)
Probabilistic and Risk-informed Methods for Structural Integrity Assessment
Lobby, Athens 4:15pm - 6:00pm

Session Developer: **Steven Xu**, *Kinectrics, Toronto, ON, Canada*
Session Co-Developer: **David Rudland**, *US NRC, Frederick, MD, USA*
Session Co-Developer/Chair: **Yinsheng Li**, *Japan Atomic Energy Agency, Ibaraki-Ken, Japan*
Session Co-Chair: **Leonid Gutkin**, *Kinectrics Inc., Toronto, ON, Canada*

4:15pm
Management of Complex Loading Histories For Use In Probabilistic Creep-Fatigue Damage Assessments
Technical Paper Publication: PVP2018-84400

Nader Zentuti, Julian D. Booker, *R. A. W. Bradford, C.E. Truman, University of Bristol, Bristol, UK*

4:41pm
Effects of Non-Normal Input Distributions and Sampling Region on Monte Carlo Results
Technical Paper Publication: PVP2018-84767

Konstantinos Tsembelis, Seyun Eom, John Jin, Christopher Cole, *CNSC, Ottawa, ON, Canada*

5:07pm
Development of Probabilistic Fracture Mechanics Analysis Code PASCAL Version 4 for Reactor Pressure Vessels
Technical Paper Publication: PVP2018-84964

Kai Lu, *Japan Atomic Energy Agency, Naka-Gun, Japan*, **Masaki Koichi, Jinya Katsuyama, Yinsheng Li**, *Japan Atomic Energy Agency (JAEA), Ibaraki, Japan*, **Shumpei Uno**, *Mizuho Information & Research Institute, Inc., Tokyo, Japan*

5:33pm
Acceptance Criteria for Probabilistic Fracture Protection Evaluations of CANDU Zr-Nb Pressure Tubes
Technical Paper Publication: PVP2018-85086

Douglas Scarth, Leonid Gutkin, *Kinectrics Inc., Toronto, ON, Canada*

Session 4.4J (MF-9-2)
Mechanistic Modelling of Deformation and Fracture - II
Lobby, Barcelona 4:15pm - 6:00pm

Session Developer: **Anthony Horn**, *Wood, Warrington, UK*
Session Chair: **Anthony Horn**, *Wood, Warrington, UK*
Session Co-Chair: **Sergio Cicero**, *University of Cantabria, Santander, Spain*

4:15pm
Advanced Assessment of Ductile Fracture Behaviour in Dissimilar Metal Welds Using X-Ray Tomography
Technical Paper Publication: PVP2018-84014

William Brayshaw, Adam Cooper, Andrew Sherry, *University of Manchester, Manchester, UK*
Peter James, *Wood, Warrington, Cheshire, UK*

4:41pm
Challenges Associated with the Quantitative Analysis of Ductile Damage Using X-Ray Computed Tomography
Technical Paper Publication: PVP2018-84023

Adam Cooper, Timothy Burnett, *University of Manchester, Manchester, UK*,
Andrew H. Sherry, Olivia Tuck, *National Nuclear Laboratory, Warrington, UK*,

5:07pm
Mode I Ductile Crack Growth of 1TCT Specimen Under Large Cyclic Loading (Part II)
Technical Paper Publication: PVP2018-84383

Kiminobu Hojo, *Mitsubishi Heavy Industries Ltd, Kobe, Hyogo, Japan*
Shinichi Kawabata, *Ryoyu System Gijutu, Kobe, Japan*
Naoki Ogawa, *Mitsubishi Heavy Industries Ltd, Takasago, Japan*

5:33pm
Evolution of the Hysteresis Loop Under Cyclic Plasticity and its Influence on Creep Deformation in 316H Stainless Steel Polycrystals
Technical Presentation: PVP2018-84724

Tomiwa Erinosho, Kiranmayi Abburi Venkata, Mahmoud Mostafavi, D. Knowles, C.E. Truman, *University of Bristol, Bristol, UK*

Session 4.4K (DA-16-2)
Vessel Design Philosophy - II: The Fabricators' Perspective
Lobby, Berlin 4:15pm - 6:00pm

Session Developer/Chair: **Jaan Taagepera**, *Chevron ETC, Richmond, CA, USA*
Session Co-Developer: **Nathan Barkley**, *Contract Fabricators, Inc., Holly Springs, MS, USA*
Session Developer/Co-Chair: **Leslie Antalffy**, *Fluor, Sugar Land, TX, USA*

Session 4.4N (DA-4-2)
Inelastic, Nonlinear and Limit Load Analysis -II
Lower Lobby, Madrid 4:15pm - 6:00pm

Session Developer: **Dan Vlaicu**, *Ontario Power Generation, Pickering, ON, Canada*
Session Chair: **Ifeanyi Emmanuel Kalu**, *University of Pretoria, Pretoria, Guateng, South Africa*
Session Co-Chair: **Hany Abdalla**, *Nile University, Cairo, Egypt*

4:15pm
An Iterative Method for Solving Piping Static Analysis Including Friction Between Support and Pipes
Technical Paper Publication: PVP2018-84645

Martin Anderegg, *DST Computer Services SA, Geneva, Geneve, Switzerland*

4:41pm
Effect of Defect Geometry of Localized External Erosion on Failure of Boiler Tubes
Technical Paper Publication: PVP2018-84787

Ifeanyi Emmanuel Kalu, Helen Mary Inglis, Schalk Kok, *University of Pretoria, Pretoria, Guateng, South Africa*

5:07pm
Trial for United Representation of Monotonic Stress-Strain Relations of Various Alloys
Technical Paper Publication: PVP2018-85041

Yukio Takahashi, *Central Res Inst Elec Pwr Ind, Yokosuka, 240-0196, Japan*

5:33pm
Load Carrying Capacities of Pressurized 90 Degree Miter and Smooth Bends Subjected to Monotonic In-Plane Bending Moments
Technical Paper Publication: PVP2018-85071

Hany Abdalla, *Nile University, Cairo, Egypt*
Mohamed Roshdy, *Nile University, Sheikh Zayed City, Giza, Egypt*

Session 4.4O (EPRI-1-4)
EPRI Workshop on Continuum Damage Modeling
Session 4 - Properties and Models for Stainless Steels
Lower Lobby, Congress Hall I 4:15pm - 6:00pm

Session Developer: **Jonathan Parker**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Developer: **Elizabeth Benton**,
EPRI, Charlotte, NC, USA
Session Chair: **Brian Cane**,
Dr Brian Cane Ceng, FIMMM, Prachuap Khiri Khan, Thailand
Session Co-Chair: **Yun-Jae Kim**,
Korea Univ, Seoul 136-701, Korea (Republic)
Panelists: **F. Masuyama**,
Kyushu Institute of Technology, Japan
D. Dean,
EDF Energy, Gloucester, UK
R. Ainsworth,
The University of Manchester, Manchester, UK

Session 4.4Q (XPR-1-4)
1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats and Mitigation Strategies
Lower Lobby, Congress Hall III 4:15pm - 6:00pm

Session Developer: **Oreste Salvatore Bursi**,
University of Trento, Trento, Italy
Session Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Co-Chair: **Antonio Caputo**,
Roma Tre University Department of Engineering, Rome, Italy

4:15pm
Metamaterial-based Shield for Resilience Enhancement of Petrochemical Plant
Keynote Presentation: PVP2018-85169

Oreste Salvatore Bursi, *University of Trento, Trento, Italy*

Block 5.1 Friday, July 20 8:15AM - 10:00AM

Session 5.1O (EPRI-1-5)
EPRI Workshop on Continuum Damage Modeling
Session 5: Fundamental Approaches for Modelling - Considering BOTH Damage
Tolerant and Damage Susceptible Steels
Mezzanine Level, Tyrolka 8:15am - 10:00am

Session Developer: **Jonathan Parker**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Developer: **Elizabeth Benton**,
EPRI, Charlotte, NC, USA
Session Chair: **David Hayhurst**,
The University of Manchester, Manchester, UK
Session Co-Chair: **D. Knowles**,
University of Bristol, Bristol, Select State/Province, UK
Panelists: **A. Cocks**,
University of Oxford, Oxford, UK
I. Perrin,
Structural Integrity Associates, Inc, Huntersville, NC, USA
A. Klenk,
Materials Testing Institute, University of Stuttgart, Stuttgart, Germany

---

Session 5.1Q (XPR-1-5)
1st International Workshop on Risk and Resilience of Industrial Installations
Against Natural Threats And Mitigation Strategies
Mezzanine Level, Palmovka & Rokoska 8:15am - 10:00am

Session Developer/Co-Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Co-Developer/Chair: **Oreste Salvatore Bursi**,
University of Trento, Trento, Italy

8:15am
Coastal Resilience of Chemical and Petrochemical Storage Tanks
Keynote Presentation: PVP2018-85170

Jamie Padgett, *Rice University, Houston, TX, USA*

Block 5.2 Friday, July 20 10:15AM - 12:00PM

Session 5.2O (EPRI-1-6)
EPRI Workshop on Continuum Damage Modeling

Session 6: Design and Component Assessment Applications
Mezzanine Level, Tyrolka 10:15am - 12:00pm

Session Developer: **Jonathan Parker**,
Electric Power Research Institute, Charlotte, NC, USA
Session Co-Developer: **Elizabeth Benton**,
EPRI, Charlotte, NC, USA
Session Chair: **Ian Perrin**,
Structural Integrity Associates, Huntersville, NC, USA
Session Co-Chair: **Ond'ej N'mec**,
CEZ, Bílina, Czech Republic
Panelists: **N. Komaii**,
Mitsubishi Heavy Industries, Ltd., Nagasaki, Japan
D. Anderson,
Doosan, West Sussex, UK
J. Siefert,
EPRI, Charlette, NC, USA
R. Blum,
Consultant, Denmark

Session 5.2Q (XPR-1-6)
1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats and Mitigation Strategies
Mezzanine Level, Palmovka & Rokoska
10:15am - 12:00pm

Session Developer: **Oreste Salvatore Bursi**,
University of Trento, Trento, Italy
Session Co-Developer/Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Co-Chair: **Matteo Pozzi**,
Carnegie Mellon University, Pittsburgh, PA, USA

10:15am
Decision Making, Maintenance, Operation and Resilience
Keynote Presentation. PVP2018-85171

Matteo Pozzi, *Carnegie Mellon University, Pittsburgh, PA, USA*

Block 5.3 Friday, July 20 2:15PM - 4:00PM

Session 5.3Q (XPR-1-7)
1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats And Mitigation Strategies
Mezzanine Level, Palmovka & Rokoska 2:15pm - 4:00pm

Session Developer: **Antonio Caputo**,
Roma Tre University Department of Engineering, Rome, Italy
Session Co-Developer/Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Co-Chair: **Stefano Marelli**,
ETH Zurig, Zurig, Switzerland

2:15pm
Efficient Simulation Techniques For Reliability And Resilient Analysis Of Complex Systems
Keynote Presentation: PVP2018-85172

Edoardo Patelli, *University of Liverpool, Liverpool, UK*

Block 5.4 Friday, July 20 4:15PM - 6:00PM

Session 5.4Q (XPR-1-8)
1st International Workshop on Risk and Resilience of Industrial Installations Against Natural Threats and Mitigation Strategies
Mezzanine Level, Palmovka & Rokoska 4:15pm - 6:00pm

Session Developer: **Oreste Salvatore Bursi**,
University of Trento, Trento, Italy
Session Co-Developer/Chair: **Fabrizio Paolacci**,
University Roma Tre, Rome, Italy
Session Co-Chair: **Edoardo Patelli**,
University of Liverpool, Liverpool, UK

4:15pm
Metamodels For Uncertainty Quantification And Structural Reliability Analysis
Keynote Presentation: PVP2018-85173

Stefano Marelli, *ETH Zurig, Zurig, Switzerland*

Acknowledgments

Committees

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Vivek Agarwal
Idaho National Laboratory

Sandra Dugan
Swiss Federal Nuclear Safety Inspectorate ENSI

Rudy Scavuzzo Student Paper Symposium and 26th Annual Student Paper Competition
Daniel T. Peters
Structural Integrity Associates, Inc.

Douglas A. Scarth
Kinectrics, Inc.

Electric Power Research Institute (EPRI) Expert Workshop on Creep Continuum Damage Models for Structural Mechanics
Jonathan Parker
Electric Power Research Institute

Elizabeth Benton
Electric Power Research Institute

Tutorials and Workshops
Maher Y.A. Younan
The American University in Cairo

Technical Program Representatives 1st International Workshop on Risk & Resilience of Industrial Installations Against Natural Threats & Mitigation Strategies
Fabrizio Paolacci
University Roma Tre

Oreste Salvatore Bursi
University of Trento

Session Chairs/Co-Chairs, Developers, Plenary & Tutorial Speakers

Name	Title/Role	Session Number	Session Index
Abdalla, Hany	Session Chair	DA-4-1	4.3N
Abdalla, Hany	Session Co-Chair	DA-4-2	4.4N
Adibi-Asl, Reza	Session Developer	CT-14-1	3.3J
Adibi-Asl, Reza	Session Developer/Session Chair	CT-12-1	4.1J
Agarwal, Vivek	Session Developer/Session Chair	NDPD-2-1	2.3J
Agarwal, Vivek	Session Developer/Session Chair	NDPD-2-2	2.4J
Aida, Kiyoshi	Session Co-Developer/Session Chair	SE-4-1	3.1F
Aida, Kiyoshi	Session Co-Developer/Session Chair	SE-4-2	3.2F
Ainsworth, R A.	Session Chair	EPRI-1-2	4.2O
Antalffy, Leslie	Session Co-Developer/Session Co-Chair	DA-16-1	4.3K
Antalffy, Leslie	Session Developer/Session Co-Chair	DA-16-2	4.4K
Artini, Gianluca	Session Co-Chair	FSI-2-3	3.1E
Asada, Seiji	Session Developer/Session Chair	CS-3-1	1.3A
Asada, Seiji	Session Developer	CS-3-2	1.4A
Asada, Seiji	Session Developer/Session Co-Chair	CS-3-3	2.1A
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Asada, Seiji	Session Developer/Session Chair	CS-3-5	2.3A
Asada, Seiji	Session Developer/Session Chair	DA-3-2	3.1A
Asada, Seiji	Session Co-Developer	CS-10-1	4.4D
Bader, Mirko	Session Co-Chair	EPRI-1-3	4.3O
Baramili, André	Session Chair	FSI-2-5	3.3E
Barkley, Nathan	Session Developer/Session Co-Chair	DA-1-1	1.1N
Barkley, Nathan	Session Developer/Session Chair	DA-1-2	1.3N
Barkley, Nathan	Session Developer/Session Co-Chair	DA-1-3	1.4N
Barkley, Nathan	Session Co-Developer	DA-16-2	4.4K
Barnes, Richard	Session Developer/Session Co-Chair	CS-38-1	3.3H
Barsoum, Imad	Session Co-Chair	MF-1-3	1.4B
Basavaraju, C.	Session Developer/Session Chair	DA-2-1	2.1N
Basavaraju, C	Session Developer/Session Chair	DA-2-4	2.4N
Bedoya, Julian	Session Chair	DA-15-2	2.2O
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Belingardi, G.	Session Co-Chair	CT-8-1	2.3G
Belingardi, G.	Session Developer/Session Chair	CT-8-3	3.2O
Benaouicha, M.	Session Co-Chair	FSI-2-2	2.4E
Benson, Michael	Session Developer/Session Chair	CS-1-1	1.3I
Benson, Michael	Session Developer/Session Co-Chair	CS-1-2	1.4I
Benton, Elizabeth	Session Co-Developer	EPRI-1-1	4.1O
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Benton, Elizabeth	Session Co-Developer	EPRI-1-6	5.2O
Bezdikian, Georges	Session Developer	OAC-8-1	4.1K
Bezdikian, Georges	Session Chair	OAC-8-1	4.1K
Bezdikian, Georges	Session Co-Developer	OAC-8-2	4.2K
Bezdikian, Georges	Session Chair	OAC-8-2	4.2K
Blachut, Jan	Session Co-Chair	DA-4-1	4.3N
Bortot, Paolo	Session Chair	MF-2-4	4.2C
Bosch, Alexander	Session Co-Chair	DA-3-1	2.4A
Bourguigne, Gaston	Session Developer/Session Co-Chair	CS-21-1	4.4G
Bragatto, Paolo	Session Co-Chair	OAC-8-2	4.2K
Briottet, Laurent	Session Co-Chair	MF-2-1	3.2C

Name	Title/Role	Session Number	Session Index
Broc, Daniel	Session Chair	FSI-2-3	3.1E
Brongers, Michiel	Session Co-Chair	MF-5-1	2.4H
Brongers, Michiel	Session Co-Chair	MF-5-2	3.1H
Brown, Warren	Session Developer/Session Chair	DA-10-4	3.1G
Brown, Warren	Session Developer/Session Chair	DA-10-5	3.2G
Brown, Warren	Session Co-Developer/Session Co-Chair	DA-10-1	3.3G
Brown, Warren	Session Developer/Session Chair	DA-10-2	4.1G
Brown, Warren	Session Developer/Session Co-Chair	DA-10-3	4.2G
Brumovsky, Milan	Session Developer	OAC-3-1	2.1K
Brumovsky, Milan	Session Developer	OAC-3-2	2.2K
Brumovsky, Milan	Session Co-Developer/Session Co-Chair	OAC-5-1	2.3K
Brumovsky, Milan	Session Co-Developer/Session Chair	OAC-5-2	2.4K
Brunella, Valentina	Session Co-Chair	CT-8-3	3.2O
Brust, F. (Bud)	Session Developer/Session Chair	MF-3-1	1.1C
Brust, F. (Bud)	Session Developer/Session Co-Chair	MF-3-2	1.3C
Brust, F. (Bud)	Tutorial Speakers	TW-2-3	2.1Q
Brust, F. (Bud)	Tutorial Speakers	TW-2-4	2.2Q
Brust, F. (Bud)	Session Co-Developer/Session Chair	MF-18-4	4.3A
Bursi, O. S.	Session Developer/Session Co-Chair	SE-9-1	2.1F
Bursi, O. S.	Session Chair	XPR-1-1	4.1Q
Bursi, O. S.	Session Developer/Session Co-Chair	XPR-1-2	4.2Q
Bursi, O. S.	Session Developer	XPR-1-4	4.4Q
Bursi, O. S.	Session Co-Developer/Session Chair	XPR-1-5	5.1Q
Bursi, O. S.	Session Developer	XPR-1-6	5.2Q
Bursi, O. S.	Session Developer	XPR-1-8	5.4Q
Cane, Brian	Session Chair	EPRI-1-4	4.4O
Cao, Yupeng	Session Co-Developer	MF-24-2	4.3I
Caputo, Antonio	Session Co-Developer	SE-9-1	2.1F
Caputo, Antonio	Session Co-Chair	XPR-1-1	4.1Q
Caputo, Antonio	Session Chair	XPR-1-3	4.3Q
Caputo, Antonio	Session Co-Chair	XPR-1-4	4.4Q
Caputo, Antonio	Session Developer	XPR-1-7	5.3Q
Carroll, Blair	Session Chair	MF-1-2	1.3B
Carroll, Blair	Session Chair	CS-1-2	1.4I
Carroll, Blair	Session Chair	MF-16-1	2.2I
Carter, Robert G.	Session Developer/Session Chair	CS-22-3	3.3B
Chadda, Tej	Session Co-Chair	DA-15-2	2.2O
Chao, Yuh J.	Session Developer	MF-24-1	4.2I
Chao, Yuh J.	Session Co-Developer	MF-24-2	4.3I
Chaouadi, Rachid	Session Chair	CS-22-2	3.2B
Chen, Xiang	Session Co-Chair	CS-22-3	3.3B
Chen, Xuedong	Session Developer/Session Chair	CS-11-3	1.4D
Chen, Xuedong	Session Developer/Session Chair	CS-11-7	2.4D
Cheta, Ayman	Session Developer/Session Chair	OAC-6-1	4.3H
Cheta, Ayman	Session Developer/Session Co-Chair	OAC-6-2	4.4H
Cho, David	Session Co-Developer	CS-8-2	4.4C
Chou, Hsoung-Wei	Session Co-Developer	MF-24-1	4.2I
Chou, Hsoung-Wei	Session Chair	MF-24-2	4.3I
Cicero, Sergio	Session Co-Chair	MF-9-1	4.3J
Cicero, Sergio	Session Co-Chair	MF-9-2	4.4J
Cipolla, Russell	Session Chair	SPC-2-1	2.2L
Cipolla, Russell	Session Developer/Session Chair	CS-9-1	3.2D
Cipolla, Russell	Session Developer/Session Chair	CS-9-2	3.3D
Cipolla, Russell	Session Developer/Session Co-Chair	CS-25-1	4.3E
Cluever, Joseph	Session Developer/Session Co-Chair	OAC-1-1	1.3K

Name	Title/Role	Session Number	Session Index
Cluever, Joseph	Session Developer/Session Chair	OAC-1-2	1.4K
Cluever, Joseph	Session Co-Chair	OAC-8-1	4.1K
Cohn, Marvin	Session Developer	MF-5-1	2.4H
Cohn, Marvin	Session Developer	MF-5-2	3.1H
Coules, Harry	Session Co-Chair	MF-1-1	1.1B
Crane, Ryan	Session Chair	CS-28-1	2.3I
Crane, Ryan	Session Co-Chair	CS-9-1	3.2D
Crane, Ryan	Session Co-Chair	CS-9-2	3.3D
Davies, Catrin	Session Co-Chair	MF-18-1	4.1A
Davies, Catrin	Session Co-Chair	MF-18-4	4.3A
Davies, Catrin Mair	Session Co-Chair	MF-27-2	1.4J
Davies, Catrin Mair	Session Developer	MF-18-1	4.1A
Davies, Catrin Mair	Session Developer/Session Chair	MF-18-3	4.2A
Davies, Catrin Mair	Session Developer	MF-18-4	4.3A
Davies, Catrin Mair	Session Developer	MF-18-5	4.4A
De Baglion, Laurent	Session Developer/Session Chair	DA-3-1	2.4A
Dempster, William	Session Co-Chair	DA-11-1	2.1I
Deng, Guide	Session Developer/Session Co-Chair	CS-11-2	1.3D
Deng, Guide	Session Developer/Session Co-Chair	CS-11-6	2.3D
Doddihal, Preeti	Session Developer	MF-1-2	1.3B
Donato, Gustavo	Session Developer	MF-1-1	1.1B
Dozaki, Koji	Session Co-Chair	CS-14-2	4.2H
Dugan, Sandra	Session Developer/Session Chair	NDPD-1-1	2.1J
Dugan, Sandra	Session Co-Chair	NDPD-1-2	2.2J
Dugan, Sandra	Session Co-Chair	NDPD-2-2	2.4J
Dulieu, Pierre	Session Developer/Session Co-Chair	CS-23-1	3.1J
Duncan, Andrew	Session Co-Developer	MF-19-1	1.3M
Duncan, Andrew	Session Developer/Session Co-Chair	MF-20-1	2.2M
Duncan, Andrew	Session Co-Developer	MF-32-1	4.1I
Duncan, Andrew	Session Co-Developer	MF-23-1	4.2J
Duncan, Andrew	Session Co-Chair	CS-8-2	4.4C
Edel, Matthew	Session Developer/Session Co-Chair	HPT-2-1	2.1E
Edel, Matthew	Session Developer/Session Co-Chair	FSI-6-1	2.2E
Esposito, Luca	Session Co-Chair	MF-18-5	4.4A
Ezekoye, L. Ike	Tutorial Speakers	TW-1-1	0.3O
Ezekoye, L. Ike	Session Developer/Session Chair	OAC-5-1	2.3K
Ezekoye, L. Ike	Session Developer/Session Co-Chair	OAC-5-2	2.4K
Faidy, Claude	Session Co-Chair	CS-3-1	1.3A
Faidy, Claude	Session Chair	CS-3-2	1.4A
Faidy, Claude	Session Developer/Session Chair	CS-3-4	2.2A
Faidy, Claude	Session Co-Developer	CS-12-1	4.1E
Fan, Zhichao	Session Developer/Session Co-Chair	CS-11-3	1.4D
Fan, Zhichao	Session Developer/Session Co-Chair	CS-11-7	2.4D
Finneran, Shane	Session Developer/Session Co-Chair	DA-12-2	2.3B
Finneran, Shane	Session Developer/Session Chair	DA-12-3	2.4B
Fong, Jeffrey	Session Developer/Session Chair	MF-19-1	1.3M
Fong, Jeffrey	Session Developer/Session Chair	MF-19-2	1.4M
Fujita, Katsuhisa	Session Developer	SE-4-1	3.1F
Fujita, Katsuhisa	Session Developer	SE-4-2	3.2F
Fujita, Satoshi	Session Developer/Session Co-Chair	SE-2-1	1.1F
Furuya, Osamu	Session Developer/Session Chair	SE-2-1	1.1F
Gawande, Kshitij	Session Developer/Session Co-Chair	DA-19-1	1.1M
Giannopapa, Christina	Session Co-Developer	FSI-5-1	2.4L
Gill, Peter J.	Session Developer/Session Co-Chair	MF-13-1	2.1M
Gilles, Philippe	Session Chair	DA-12-2	2.3B

Name	Title/Role	Session Number	Session Index
Gilles,Philippe	Session Co-Chair	DA-12-3	2.4B
Girão, Carlos D.	Session Co-Chair	CT-2-1	2.1G
Goglio, Luca	Session Co-Chair	CT-8-2	2.4G
Gross, David	Session Developer/Session Chair	HPT-2-1	2.1E
Gross, David	Session Developer/Session Chair	FSI-6-1	2.2E
Gui, Lele	Session Co-Chair	MF-24-1	4.2I
Gutkin, Leonid	Session Developer	CS-28-1	2.3I
Gutkin, Leonid	Session Co-Chair	CS-15-1	4.4I
Ha, Yoosung	Session Co-Chair	CS-22-4	4.1B
Hadj-Nacer, Mustafa	Session Co-Chair	OAC-4-2	3.2K
Halama, Radim	Session Co-Chair	SE-13-1	4.4F
Hamelin, Cory	Session Developer/Session Co-Chair	MF-23-1	4.2J
Han, Young-Hoon	Session Developer/Session Chair	HPT-6-1	3.1L
Han, Zenghu	Tutorial Speakers	TW-2-7	1.3Q
Han, Zenghu	Tutorial Speakers	TW-2-8	1.4Q
Han, Zenghu	Session Co-Chair	OAC-4-1	3.1K
Han, Zenghu	Session Developer/Session Chair	OAC-4-3	3.3K
Hara, Kensuke	Session Chair	FSI-2-2	2.4E
Hasegawa, Kunio	Session Developer/Session Co-Chair	CS-37-1	2.2H
Hasegawa, Kunio	Session Developer/Session Co-Chair	CS-37-2	2.3H
Hassan, Tasnim	Session Co-Developer/Session Chair	DA-7-1	4.1N
Hassan, Tasnim	Session Co-Developer/Session Chair	DA-7-2	4.2N
Hassan, Tasnim	Session Co-Developer/Session Chair	SE-13-1	4.4F
Hayhurst, David	Session Chair	EPRI-1-5	5.1O
He, Yanzhen	Session Co-Developer	DA-11-1	2.1I
Hojo, Kiminobu	Session Developer/Session Co-Chair	CS-19-1	1.1J
Hojo, Kiminobu	Session Developer/Session Chair	CS-25-1	4.3E
Horn, Anthony	Session Developer/Session Chair	MF-20-1	2.2M
Horn, Anthony	Session Developer	MF-9-1	4.3J
Horn, Anthony	Session Developer	MF-9-2	4.4J
Horn, Anthony	Session Chair	MF-9-2	4.4J
Iijima, Takashi	Session Co-Chair	MF-2-2	3.3C
Inaba, Kazuaki	Session Developer/Session Chair	FSI-5-1	2.4L
Ismail Mourad, A-H	Session Developer/Session Chair	MF-1-3	1.4B
Iyama, Hirofumi	Session Developer/Session Co-Chair	FSI-5-1	2.4L
Iyer, San	Session Co-Developer	DA-7-1	4.1N
Iyer, San	Session Co-Developer	DA-7-2	4.2N
James, Peter	Session Co-Chair	SPC-1-1	1.1L
James, Peter	Session Co-Chair	SPC-1-2	1.3L
James, Peter	Session Developer	SPC-1-4	2.1L
James, Peter	Session Co-Developer/Session Co-Chair	MF-4-1	2.4I
James, Peter	Session Co-Developer	MF-4-2	3.1I
James, Peter	Session Co-Developer/Session Chair	MF-4-3	3.2I
James, Peter	Session Co-Developer	MF-4-4	3.3I
James, Peter	Session Chair	MF-9-1	4.3J
Janzen, Victor P.	Session Co-Developer	SPC-1-1	1.1L
Janzen, Victor P.	Session Co-Developer	HPT-2-1	2.1E
Jaske, Carl	Session Co-Developer	MF-5-1	2.4H
Jaske, Carl	Session Co-Developer	MF-5-2	3.1H
Jaunich, Matthias	Session Chair	OAC-4-1	3.1K
Jesus, Abilio	Session Developer/Session Chair	MF-1-4	2.1B
Jia, Guodong	Session Developer/Session Chair	CS-11-2	1.3D
Jia, Guodong	Session Developer/Session Chair	CS-11-6	2.3D
Jo, Jong Chull	Session Developer/Session Co-Chair	FSI-1-1	1.1E
Jo, Jong Chull	Session Developer/Session Chair	FSI-1-2	1.3E

Name	Title/Role	Session Number	Session Index
Jo, Jong Chull	Session Developer/Session Co-Chair	FSI-1-3	1.4E
Jüngert, Anne	Session Co-Chair	NDPD-1-1	2.1J
Jüngert, Anne	Session Developer/Session Chair	NDPD-1-2	2.2J
Jüngert, Anne	Session Co-Chair	NDPD-2-1	2.3J
Kaculi, Jim	Session Developer/Session Chair	HPT-6-6	3.3L
Kaiktsis, Lambros	Session Co-Developer	FSI-5-1	2.4L
Kalu, Ifeanyi E.	Session Chair	DA-4-2	4.4N
Karpanan, Kumar	Tutorial Speakers	TW-2-5	2.3Q
Karpanan, Kumar	Tutorial Speakers	TW-2-6	2.4Q
Karpanan, Kumar	Session Developer/Session Co-Chair	HPT-6-1	3.1L
Karpanan, Kumar	Session Developer/Session Chair	HPT-6-2	3.2L
Karpanan, Kumar	Session Developer/Session Chair	HPT-1-1	4.1L
Karpanan, Kumar	Session Developer/Session Co-Chair	HPT-3-1	4.2L
Kasahara, Naoto	Session Developer	DA-14-1	3.1N
Kasahara, Naoto	Session Co-Developer/Session Chair	DA-14-2	3.2N
Kataoka, Shunji	Session Developer/Session Chair	DA-12-1	2.2B
Keim, Elisabeth	Session Developer/Session Chair	MF-3-2	1.3C
Keim, Elisabeth	Session Co-Developer	MF-4-1	2.4I
Keim, Elisabeth	Session Co-Developer	MF-4-2	3.1I
Keim, Elisabeth	Session Co-Developer	MF-4-3	3.2I
Keim, Elisabeth	Session Developer/Session Co-Chair	MF-4-4	3.3I
Keltjens, Jan	Session Developer/Session Chair	DA-8-2	1.3H
Kerr, Matthew	Session Co-Developer	MF-17-1	3.2A
Kerr, Matthew	Session Co-Developer	MF-17-2	3.3A
Kim, Yun-Jae	Session Co-Chair	MF-1-4	2.1B
Kim, Yun-Jae	Session Co-Chair	DA-14-2	3.2N
Kim, Yun-Jae	Session Developer/Session Chair	MF-32-1	4.1I
Kim, Yun-Jae	Session Co-Developer/Session Chair	MF-18-5	4.4A
Kim, Yun-Jae	Session Co-Chair	EPRI-1-4	4.4O
King, Christine	Plenary Speaker		1.2P
Kirchhofer, Rita	Session Co-Developer/Session Chair	MF-18-1	4.1A
Kirchhofer, Rita	Session Co-Chair	MF-18-3	4.2A
Kisisel, Ismail	Session Co-Developer	SE-9-1	2.1F
Knowles, D.	Session Co-Chair	EPRI-1-5	5.1O
Kobayashi, Hiroyuki	Session Co-Chair	CS-14-1	4.1H
Kobayashi, Takashi	Session Developer/Session Chair	CT-3-1	1.4G
Kobayashi, Tomohiro	Session Co-Chair	CS-22-1	3.1B
Kojima, Nobuo	Session Co-Chair	SE-12-3	2.4F
Kopriva, Radim	Session Co-Chair	OAC-3-1	2.1K
Kopriva, Radim	Session Chair	OAC-3-2	2.2K
Korinko, Paul	Session Developer/Session Co-Chair	MF-27-1	1.3J
Korinko, Paul	Session Co-Developer/Session Chair	MF-27-2	1.4J
Ku, Francis	Session Chair	MF-5-1	2.4H
Kummari, S. R.	Session Co-Chair	CS-6-1	3.2H
Kwon, Young	Session Co-Chair	EPRI-1-1	4.1O
Kytka, Milos	Session Chair	OAC-3-1	2.1K
Kytka, Milos	Session Co-Chair	OAC-3-2	2.2K
Lacroix, Valery	Session Developer/Session Chair	CS-37-1	2.2H
Lacroix, Valery	Session Developer/Session Chair	CS-37-2	2.3H
Lacroix, Valery	Session Developer/Session Chair	CS-23-1	3.1J
Lam, Jessica	Session Co-Developer	MF-1-2	1.3B
Lam, Poh-Sang	Session Co-Developer/Session Chair	MF-1-1	1.1B
Lam, Poh-Sang	Session Co-Developer	MF-1-3	1.4B
Lam, Poh-Sang	Session Developer/Session Co-Chair	MF-32-1	4.1I
Lam, Poh-Sang	Session Co-Developer	MF-24-2	4.3I

Name	Title/Role	Session Number	Session Index
Li, Bing	Session Chair	SPC-1-1	1.1L
Li, Bing	Session Developer	SPC-1-2	1.3L
Li, Bing	Session Co-Chair	SPC-1-3	1.4L
Li, Bing	Session Co-Chair	DA-2-2	2.2N
Li, Bing	Session Chair	DA-2-3	2.3N
Li, Bing	Session Co-Developer/Session Chair	DA-14-1	3.1N
Li, Bing	Session Developer	DA-14-2	3.2N
Li, Yinsheng	Session Co-Developer	SE-12-1	2.2F
Li, Yinsheng	Session Co-Developer	SE-12-2	2.3F
Li, Yinsheng	Session Co-Developer	SE-12-3	2.4F
Li, Yinsheng	Session Co-Chair	MF-17-1	3.2A
Li, Yinsheng	Session Developer/Session Co-Chair	MF-31-1	4.3G
Li, Yinsheng	Session Developer/Session Co-Chair	CS-10-1	4.4D
Li, Yinsheng	Session Co-Developer/Session Chair	CS-15-1	4.4I
Liu, Liyan	Session Co-Chair	FSI-2-5	3.3E
Liu, Yinghua	Session Developer/Session Chair	CS-11-4	2.1D
Liu, Yinghua	Session Developer/Session Chair	CS-11-8	3.1D
Liu, Yinghua	Session Co-Chair	MF-24-2	4.3I
Liu, Yung	Tutorial Speakers	TW-2-7	1.3Q
Liu, Yung	Tutorial Speakers	TW-2-8	1.4Q
Lu, Kai	Session Co-Developer	CS-10-1	4.4D
Ma, Li	Session Co-Chair	MF-19-1	1.3M
Mam, Qin	Session Co-Chair	CS-20-1	1.1K
Maderbacher, H.	Session Developer/Session Chair	HPT-3-2	4.3L
Maekawa, Akira	Session Developer	SE-12-1	2.2F
Maekawa, Akira	Session Developer	SE-12-2	2.3F
Maekawa, Akira	Session Developer	SE-12-3	2.4F
Maekawa, Akira	Session Developer/Session Co-Chair	SE-1-1	3.3F
Malavasi, Stefano	Session Co-Developer	FSI-5-1	2.4L
Manu, Christopher	Session Co-Chair	MF-1-2	1.3B
Marelli, Stefano	Session Co-Chair	XPR-1-7	5.3Q
Marie, Stephane	Session Co-Developer/Session Chair	MF-4-1	2.4I
Marie, Stephane	Session Developer/Session Co-Chair	MF-4-2	3.1I
Marie, Stephane	Session Co-Developer	MF-4-3	3.2I
Marie, Stephane	Session Co-Developer	MF-4-4	3.3I
Martin, May	Session Co-Developer	MF-2-2	3.3C
Martin, Michael	Session Developer/Session ChairCS-20-1		1.1K
Martin, Michael	Session Co-Developer	CS-8-1	4.3C
Matsunaga, Hisao	Session Chair	MF-2-3	4.1C
Matsuoka, Taichi	Session Developer/Session Chair	SE-2-2	1.3F
Matsuoka, Taichi	Session Co-Chair	SE-2-3	1.4F
McCracken, Steven	Session Developer/Session Chair	CS-14-1	4.1H
McGuffie, Sean	Session Developer/Session Chair	DA-11-1	2.1I
Mertiny, Pierre	Session Developer/Session Chair	DA-17-1	2.3M
Mertiny, Pierre	Session Developer/Session Chair	DA-17-2	2.4M
Mertiny, Pierre	Session Developer/Session Co-Chair	MF-14-1	3.1M
Mertiny, Pierre	Session Developer/Session Co-Chair	MF-14-2	3.2M
Messner, Mark	Session Co-Chair	CS-7-1	4.1D
Messner, Mark	Session Co-Chair	CS-7-2	4.2D
Messner, Mark	Session Co-Chair	CS-7-3	4.3D
Metais, Thomas	Session Co-Chair	CS-3-2	1.4A
Metais, Thomas	Session Developer/Session Chair	CS-3-3	2.1A
Metais, Thomas	Session Co-Chair	CS-3-5	2.3A
Metzger, Don	Session Chair	CT-14-1	3.3J
Minagawa, Keisuke	Session Co-Developer/Session Chair	SE-2-3	1.4F

Name	Title/Role	Session Number	Session Index
Minagawa, Keisuke	Session Co-Chair	SE-4-1	3.1F
Minagawa, Keisuke	Session Co-Chair	SE-4-2	3.2F
Miura, Junya	Session Co-Chair	DA-7-2	4.2N
Miura, Naoki	Session Developer/Session Chair	CS-10-1	4.4D
Mohrmann, Ralf	Session Co-Chair	EPRI-1-2	4.2O
Moinereau, Dominique	Session Co-Developer	MF-4-1	2.4I
Moinereau, Dominique	Session Developer/Session Chair	MF-4-2	3.1I
Moinereau, Dominique	Session Developer	MF-4-3	3.2I
Moinereau, Dominique	Session Developer	MF-4-4	3.3I
Munoz-Garcia, J-E	Session Developer/Session Co-Chair	CS-5-1	1.1I
Munoz-Garcia, J-E	Session Co-Chair	CS-24-1	4.4E
Mureithi, Njuki	Session Developer/Session Chair	FSI-2-1	2.3E
Mureithi, Njuki	Session Developer	FSI-2-2	2.4E
Mureithi, Njuki	Session Developer	FSI-2-3	3.1E
Mureithi, Njuki	Session Developer	FSI-2-4	3.2E
Mureithi, Njuki	Session Developer	FSI-2-5	3.3E
Nagata, Satoshi	Session Co-Developer/Session Chair	CT-3-1	1.4G
Nakamura, Izumi	Session Co-Developer	SE-12-1	2.2F
Nakamura, Izumi	Session Co-Developer/Session Chair	SE-12-2	2.3F
Nakamura, Izumi	Session Developer/Session Co-Chair	SE-12-3	2.4F
Nakamura, Izumi	Session Developer/Session Co-Chair	SE-1-1	3.3F
Nakamura, Izumi	Session Developer/Session Co-Chair	SE-6-1	4.3F
Nanstad, Randy K.	Session Co-Chair	MF-6-1	2.1C
Nanstad, Randy K.	Session Co-Chair	MF-6-2	2.2C
Nanstad, Randy K.	Session Co-Chair	MF-6-3	2.3C
Nanstad, Randy K.	Session Co-Chair	MF-6-4	2.4C
Nanstad, Randy K.	Session Co-Chair	MF-6-5	3.1C
Nassar, Sayed	Session Developer	CT-8-1	2.3G
Nassar, Sayed	Session Developer/Session Chair	CT-8-2	2.4G
Nemec, Ondrej	Session Co-Chair	EPRI-1-6	5.2O
Nicak, Tomas	Session Co-Developer	MF-4-1	2.4I
Nicak, Tomas	Session Co-Developer	MF-4-2	3.1I
Nicak, Tomas	Session Developer/Session Co-Chair	MF-4-3	3.2I
Nicak, Tomas	Session Co-Developer/Session Chair	MF-4-4	3.3I
Nishida, Akemi	Session Co-Chair	SE-12-1	2.2F
Nishida, Akemi	Session Developer/Session Co-Chair	SE-8-1	4.1F
Nishida, Akemi	Session Developer/Session Chair	SE-8-2	4.2F
Nishiguchi, Masato	Session Co-Chair	FSI-2-1	2.3E
O`Dowd, Noel P.	Session Developer	SPC-1-1	1.1L
O`Dowd, Noel P.	Session Co-Chair	SPC-1-4	2.1L
O`Dowd, Noel P.	Session Co-Chair	SPC-2-2	2.3L
Otani, Akihito	Session Developer/Session Chair	SE-8-1	4.1F
Otani, Akihito	Session Developer/Session Co-Chair	SE-8-2	4.2F
Paolacci, Fabrizio	Session Developer	SE-2-3	1.4F
Paolacci, Fabrizio	Session Developer	SPC-1-3	1.4L
Paolacci, Fabrizio	Session Chair	SPC-1-4	2.1L
Paolaccim Fabrizio	Session Co-Chair	SPC-2-1	2.2L
Paolacci, Fabrizio	Session Chair	SE-12-3	2.4F
Paolacci, Fabrizio	Session Developer	XPR-1-1	4.1Q
Paolacci, Fabrizio	Session Chair	XPR-1-2	4.2Q
Paolacci, Fabrizio	Session Developer/Session Co-Chair	XPR-1-3	4.3Q
Paolacci, Fabrizio	Session Chair	XPR-1-4	4.4Q
Paolacci, Fabrizio	Session Developer/Session Co-Chair	XPR-1-5	5.1Q
Paolacci, Fabrizio	Session Co-Developer/Session Chair	XPR-1-6	5.2Q
Paolacci, Fabrizio	Session Co-Developer/Session Chair	XPR-1-7	5.3Q

Name	Title/Role	Session Number	Session Index
Paolacci, Fabrizio	Session Co-Developer/Session Chair	XPR-1-8	5.4Q
Papadakis, George	Session Co-Developer	FSI-5-1	2.4L
Park, Dong-Yeob	Session Co-Chair	MF-11-1	4.1M
Park, Dong-Yeob	Session Developer/Session Chair	MF-11-2	4.2M
Park, Young Ho	Session Developer/Session Chair	CT-9-1	3.2J
Parker, Jonathan	Session Developer/Session Chair	EPRI-1-1	4.1O
Parker, Jonathan	Session Developer	EPRI-1-2	4.2O
Parker, Jonathan	Session Developer	EPRI-1-3	4.3O
Parker, Jonathan	Session Developer	EPRI-1-4	4.4O
Parker, Jonathan	Session Developer	EPRI-1-5	5.1O
Parker, Jonathan	Session Developer	EPRI-1-6	5.2O
Patelli, Edoardo	Session Co-Chair	XPR-1-8	5.4Q
Penso, Jorge	Session Chair	DA-15-3	2.3O
Perrin, Ian	Session Chair	EPRI-1-6	5.2O
Peters, Daniel	Tutorial Speakers	TW-1-2	0.3Q
Peters, Daniel	Session Chair	SPC-2-2	2.3L
Peters, Daniel	Session Co-Chair	HPT-6-6	3.3L
Petesch, Cécile	Session Developer/Session Chair	CS-5-1	1.1I
Petesch, Cécile	Session Developer/Session Chair	CS-24-1	4.4E
Petropoulos, C.	Session Developer/Session Chair	SE-9-1	2.1F
Porter, Michael	Session Developer/Session Co-Chair	DA-9-1	3.3N
Pozzi, Matteo	Session Co-Chair	XPR-1-6	5.2Q
Prchlík, Luboš	Plenary Speaker		1.2P
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Prueter, Phillip E.	Session Co-Developer/Session Chair	CS-6-1	3.2H
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Qian, Guian	Session Developer	MF-24-2	4.3I
Qian, Haiyang	Session Co-Developer	MF-5-1	2.4H
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Rana, Mahendra	Session Co-Chair	DA-8-2	1.3H
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Reich, Alton	Session Developer/Session Co-Chair	OAC-1-2	1.4K
Reinhardt, Wolf	Session Co-Developer/Session Co-Chair	CS-2-1	1.1A
Reinhardt, Wolf	Session Co-Chair	CS-28-1	2.3I
Reinhardt, Wolf	Session Co-Chair	CT-14-1	3.3J
Reinhardt, Wolf	Session Developer/Session Co-Chair	CT-12-1	4.1J
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Ren, Weiju	Session Developer/Session Chair	MF-6-2	2.2C
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Ren, Weiju	Session Developer/Session Chair	MF-6-5	3.1C
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Rodery, Clay	Session Co-Developer	DA-1-3	1.4N
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Rudland, David	Session Co-Developer	MF-17-1	3.2A
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Rudland, David	Session Co-Developer	CS-15-1	4.4I
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Rudolph, Juergen	Session Developer/Session Chair	CS-21-1	4.4G
Rydlewicz, Maciej	Session Chair	FSI-2-4	3.2E
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San Marchi, Chris	Session Developer	MF-2-4	4.2C
San Marchi, Chris	Session Developer/Session Chair	CS-8-1	4.3C
San Marchi, Chris	Session Co-Developer	CS-8-2	4.4C
Sawa, Toshiyuk	Session Developer/Session Chair	CT-1-1	1.3G
Sawa, Toshiyuk	Session Chair	CT-8-1	2.3G
Scarth, Douglas	Session Co-Developer	MF-1-2	1.3B
Scarth, Douglas	Session Chair	SPC-1-2	1.3L
Scarth, Douglas	Session Chair	SPC-1-3	1.4L
Schaaf, Manfred	Session Developer/Session Co-Chair	CT-1-1	1.3G
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Server, William L.	Session Developer	CS-22-1	3.1B
Server, William L.	Session Co-Developer	CS-22-2	3.2B
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Server, William L.	Session Developer/Session Chair	CS-22-4	4.1B
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Sham, T.-L. (Sam)	Session Developer/Session Chair	CS-7-1	4.1D
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Sham, T.-L. (Sam)	Session Developer/Session Chai	rCS-7-3	4.3D
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Sharples, John	Session Co-Developer/Session Co-Chair	CS-12-1	4.1E
Sharples, John	Session Developer/Session Chair	CS-12-2	4.2E
Shen, Jun	Session Developer/Session Co-Chair	CS-11-4	2.1D
Shen, Jun	Session Developer/Session Co-Chair	CS-11-8	3.1D
Shi, Jianfeng	Session Co-Developer/Session Chair	CS-11-1	1.1D
Shi, Jianfeng	Session Developer/Session Co-Chair	CS-11-5	2.2D
Shi, Jinhua	Session Co-Developer/Session Chair	CS-12-1	4.1E
Shi, Jinhua	Session Developer/Session Co-Chair	CS-12-2	4.2E
Shim, Do-Jun	Session Developer/Session Chair	CS-19-1	1.1J
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Siefert, John	Session Chair	EPRI-1-3	4.3O
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Song, Eun-Ju	Session Co-Chair	MF-2-3	4.1C
Stratil, Ludek	Session Developer/Session Co-Chair	MF-12-1	4.2B
Subramanian, Kannan	Session Developer/Session Co-Chair	DA-8-1	1.1H
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Subramanian, Kannan	Session Developer/Session Co-Chair	DA-15-1	2.1O
Subramanian, Kannan	Session Developer/Session Chair	DA-2-2	2.2N
Subramanian, Kannan	Session Co-Developer/Session Co-Chair	DA-2-3	2.3N
Subramanian, Kannan	Session Co-Developer	DA-15-3	2.3O
Subramanian, Kannan	Session Co-Chair	DA-2-4	2.4N
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Weber, Mike	Session Co-Chair	OAC-4-3	3.3K
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Wiersma, Bruce	Session Co-Developer	MF-5-1	2.4H
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Zhu, Xiankui	Session Co-Chair	MF-11-2	4.2M

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Masato Tomobe	MF-12-1	4.2B
Ke Tong	MF-11-2	4.2M
Qiqi Tong	OAC-4-2	3.2K
Maryam Torfeh	DA-7-2	4.2N
Giai Tran Van	MF-23-1	4.2J
Richard Trewin	MF-4-4	3.3I
Manuela Triay	CS-12-1	4.1E
Andrea Tridello	CT-8-3	3.2O
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Christopher E. Truman	MF-18-5	4.4A
Christopher E. Truman	MF-9-2	4.4J
Christopher E. Truman	SPC-1-3	1.4L
Konstantinos Tsembelis	CS-15-1	4.4I
Hirokazu Tsuji	OAC-6-2	4.4H
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Kazuyuki Tsukimori	SE-12-1	2.2F
Daichi Tsurumi	OAC-6-2	4.4H
Kazuya Tsutsumi	CS-22-1	3.1B
Yoshitaka Tsutsumi	SE-12-2	2.3F
Shantung Tu	MF-18-1	4.1A
Shantung Tu	MF-12-1	4.2B
Shantung Tu	MF-18-3	4.2A
Olivia Tuck	MF-9-2	4.4J
Michael Turnbow	CS-38-1	3.3H
Marius Twite	CS-3-2	1.4A
Marius Twite	CS-3-3	2.1A
Marius Twite	CS-3-4	2.2A
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Peng Wang	DA-3-1	2.4A
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附件二 發表論文

Comparison of Pressure-Temperature Limits for a Pressurized Water Reactor Pressure Vessel Considering Beltline and Extended Beltline regions

Proceedings of the ASME 2018 Pressure Vessels & Piping Conference
PVP2018
July 15-20, 2018, Prague, Czech Republic

PVP2018-84145

COMPARISON OF PRESSURE-TEMPERATURE LIMITS FOR A PRESSURIZED WATER REACTOR PRESSURE VESSEL CONSIDERING BELTLINE AND EXTENDED BELTLINE REGIONS

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ABSTRACT

To ensure the structural integrity of the embrittled reactor pressure vessels (RPVs) during startup or shutdown operation, the pressure-temperature (P-T) limits are mainly determined by the fracture toughness of beltline region material with the highest level of neutron embrittlement. However, other vessel parts such as nozzles with structural discontinuities may affect the limits due to the higher stress concentration, even though the neutron embrittlement is insignificant. Therefore, not only beltline material with the highest reference temperature, but also other components with structural discontinuities have to be considered for the development of P-T limits of RPV. In the paper, the pressure-temperature operational limits of a Taiwan domestic pressurized water reactor (PWR) pressure vessel considering beltline and extended beltline regions are established per the procedure of ASME Code Section XI-Appendix G. The three-dimensional finite element models of PWR inlet and outlet nozzles above the beltline region are also built to analyze the pressure and thermal stress distributions for P-T limits calculation. The analysis results indicate that the cool-down P-T limit of the domestic PWR vessel is still dominated by the beltline region, but the heat-up limit is partially controlled by the extended beltline region. On the other hand, the relations of reference temperature between nozzles and beltline region on the P-T limits are also discussed. Present work could be a reference for the regulatory body and is also helpful for safe operation of PWRs in Taiwan.

NOMENCLATURE

a	crack depth of postulated nozzle corner defect (in.)
A_0, A_1, A_2, A_3	coefficients to fit 3rd-order polynomial stress distribution
CR	cool-down rate (°F/hr)
D_i	inner diameters of RPV or pipe (in.)
D_o	outer diameters of RPV or pipe (in.)
HR	heat-up rate (°F/hr)
K_I	applied stress intensity factor (ksi-in.$^{1/2}$)
K_{IC}	required fracture toughness (ksi-in.$^{1/2}$)
K_{Im}	applied stress intensity factor by membrane stress (ksi-in.$^{1/2}$)
K_{Ip}	applied stress intensity factor by nozzle internal pressure (ksi-in.$^{1/2}$)
K_{It}	applied stress intensity factor by thermal stress (ksi-in.$^{1/2}$)
M_m	coefficient for determining K_{Im} from membrane stress (in.$^{1/2}$)
P	permissible pressure (ksi)
$P_{blow\text{-}off}$	blow-off stress (ksi)
R^2	the coefficient of determination for curve fitting
R_i	inner radius of RPV (in.)
RT_{NDT}	reference temperature of nil-ductility transition (°F)
T	crack tip temperature (°F)
T_C	reactor coolant temperature (°F)
t	wall thickness of RPV beltline region (in.)
x	the distance into the cross section of nozzle corner (in.)
σ	stress distribution along the cross section of nozzle corner (ksi)
EFPY	effective full power year
FEA	finite element analysis
FEM	finite element model
PFM	probabilistic fracture mechanics
P-T	pressure-temperature
PWR	pressurized water reactor
RIS	regulatory issue summary
RPV	reactor pressure vessel
U. S. NRC	United States Nuclear Regulatory Commission

INTRODUCTION

After long term operation of nuclear power plant, the operational restrictions of important pressure-retaining components such as reactor pressure vessels (RPVs) have to be determined to prevent unanticipated brittle fracture. 10 CFR 50, Appendix G [1] specifies the requirements and the ASME Code Section XI – Appendix G [2] provides a deterministic fracture methodology for establishing the pressure-temperature operational limits (P-T curves) of RPV. Within the reactor beltline region that directly surrounds the active core of reactor, the shell materials are continuously degraded and become brittle due to the fast neutron irradiation. Therefore, the establishment of P-T curves is usually based on a postulated defect with the worst fracture toughness of beltline region material which

suffers the most radiation embrittlement. However, some vessel parts such as nozzles do not suffer as significant radiation embrittlement as the beltline region but have higher stress concentration due to structural discontinuities that may also restrict the operating limits of RPV. In view of this, the U.S. Nuclear Regulatory Commission (NRC) issued Regulatory Issue Summary (RIS) 2014-11 [3] that requires licensees have to consider not only beltline shell material with the highest reference temperature of nil-ductility transition (RT_{NDT}), but also other vessel components with structural discontinuities when developing the P-T curves.

Before 2010 editions of ASME Code Section XI, the nonmandatory Appendix G provides a convenient method to establish the P-T limits, but is only for the cylindrical RPV beltline region. In order to provide a quantitative evaluation for nozzles, Yin et al. [4] conducted a series of finite element and fracture mechanics analyses to verify the magnification factor method [5, 6] for various nozzles. Subsequently, PVP2011-57015 [7] proposed this method to ASME Code Section XI – Appendix G for nozzles. After 2013 editions of ASME Code Section XI, the magnification factor method has been codified in Appendix G to conservatively estimate the stress intensity factors of nozzle corner defects. In addition, PVP2015-45065 [8] also discussed the relations of RT_{NDT} between beltline region and nozzles that which may dominate the fracture probability of RPV applying the probabilistic fracture mechanics (PFM) methodology. In Taiwan, the regulatory body had ever concerned this issue, but detailed evaluations had never been performed. In this paper, we aim at establishing the P-T limits of a pressurized water reactor (PWR) pressure vessel for beltline and extended beltline regions, respectively, and investigating the RT_{NDT} values of nozzles that may influence the P-T limits of RPV. At first, the P-T curves based on the beltline region considering the material with the highest RT_{NDT} was established per ASME method. Regarding the extended beltline region, the magnification factor method was utilized to determine the stress intensity factors for calculating the P-T limits of nozzles. A series of three-dimensional finite element analyses were conducted to obtain the stress distributions of PWR inlet and outlet nozzles subjected to internal pressure and thermal loading conditions for magnification factor calculation. In addition to the comparison of P-T curves based on the projected embrittlement conditions of the PWR, we also discussed the effects of reference temperature variations of nozzles that the extended beltline region may affect the operational limits of RPV. Present works can be helpful for the regulatory body in Taiwan to review the operational limits of the domestic nuclear power plants.

P-T CURVE FOR BELTLINE REGION

The nonmandatory Appendix G of ASME Code Section XI provides the deterministic fracture methodology for deriving the maximum permissible pressure for reactor normal cool-down (shutdown) and heat-up (startup) of the cylindrical pressure retaining components as following [9-12]:

(1) Assume that a semi-elliptical surface defect with a depth of ¼ -thickness of reactor vessel wall (t/4) and 6:1 aspect ratio exists in the shell to calculate the stress intensity factor (K_I) under the normal cool-down and heat-up transients. The reference flaw is postulated to reside in the region that has the highest value of RT_{NDT}.

(2) The calculated K_I produced by primary membrane stress due to pressure (K_{Im}) and the thermal stress due to thermal gradient through the thickness during startup and shutdown (K_{It}) should be less than the required fracture toughness, giving:

$$2K_{Im} + K_{It} < K_{IC} \quad (1)$$

The temperature-dependent fracture toughness requirement, K_{IC} in the ASME Code follows:

$$K_{IC}(t) = 33.2 + 20.734\exp\left[0.02(T - RT_{NDT})\right] \quad (\text{ksi-in.}^{1/2}) \quad (2)$$

ASME Code Section XI – Appendix G also provides the correlation between the crack tip temperature T and the coolant temperature T_C which depends on the prescribed heat-up and cool-down rate [2]. In eq. (1), $K_{Im} = M_m(PR_i/t)$ where:

P = vessel internal pressure (ksi)
R_i = internal radius of RPV (in.)
t = vessel wall thickness (in.)

And M_m is specified in ASME Code as follows:

$M_m = 0.893\sqrt{t}$ for axially oriented external-surface breaking reference flaw

$M_m = 0.443\sqrt{t}$ for circumferentially oriented external-surface breaking reference flaw

$M_m = 0.926\sqrt{t}$ for axially oriented internal-surface breaking reference flaw

$M_m = 0.443\sqrt{t}$ for circumferentially oriented internal-surface breaking reference flaw

The thermal stress intensity factors K_{It} due to radial thermal gradients from heat-up and cool-down conditions is calculated as follows:

For a postulated axial or circumferential inside surface defect:

$$K_{It} = 0.953 \times 10^{-3} \times \mathrm{CR} \times t^{2.5} \quad (3)$$

For a postulated axial or circumferential outside surface defect:

$$K_{It} = 0.753 \times 10^{-3} \times \mathrm{HR} \times t^{2.5} \quad (4)$$

where CR and HR are the cool-down and heat-up rates (°F/hr), respectively. Therefore, the P-T relation can be described as the following equation:

$$P(T) = (K_{IC}(T) - K_{It})\cdot t/R_i/2M_m \quad (5)$$

It should be noticed that for heat-up transients, the maximum allowable coolant pressure-temperature relationship is the minimum pressure at any coolant temperature determined from [2]:

(1) Application of eq. (5) with K_{It}, M_m, RT_{NDT}, and T evaluated at the deepest point of the external-surface breaking reference flaw.
(2) Application of eq. (5) considering the steady state solution (K_{It}=0) evaluated at the deepest point of both the internal-surface breaking reference flaw and external-surface breaking reference flaw.

P-T CURVE FOR NOZZLE

In general, the linear superposition technique is utilized to calculate the linear elastic stress intensity factor, K_I, for a postulated circular nozzle corner defect. Similar to the RPV beltline region, the development of P-T limits for nozzles is also based on a postulated corner defect that has depth $a = t/4$ but with circular shape (1:1 aspect ratio, see Figs. 1(a) and 1(b)). The calculated K_I due to internal pressure plus external loading (K_{Ip}) and thermal loading (K_{It}) should meet the following equation:

$$2K_{Ip} + K_{It} < K_{IC} \quad (6)$$

In the study, the magnification factor method based on boundary integrity equation and influence function derivation [4] was used to calculate the stress intensity factor for the nozzle corner defect. The magnification factors are constants associated with the constant, linear, quadratic and cubic stress distributions to calculate the stress intensity factor for a given geometry. An arbitrary stress distribution can be fitted to a third-order polynomial as a function of the distance into the cross-section, x, from the nozzle inner corner as follows:

$$\sigma = A_0+A_1x+A_2x^2+A_3x^3 \quad (7)$$

In the magnification factor method, the stress intensity factor for the deepest point of the postulated defect on a nozzle with a rounded inner radius corner (Fig. 1(a)) may be calculated as follows [4,5]:

$$K_I = \sqrt{\pi a}\left[0.706A_0 + 0.537(\frac{2a}{\pi})A_1 + 0.448(\frac{a^2}{2})A_2 + 0.393(\frac{4a^3}{3\pi})A_3\right] \quad (8)$$

where a is the crack depth of the postulated nozzle corner defect. In the above equation, the constants 0.706, 0.537, 0.448 and 0.393 are the magnification factors. For a nozzle with a sharp inner radius corner (Fig. 1(b)), the stress intensity factor of the postulated defect may be calculated by different magnification factors, giving [4, 5]:

$$K_I = \sqrt{\pi a}\left[0.723A_0 + 0.551(\frac{2a}{\pi})A_1 + 0.462(\frac{a^2}{2})A_2 + 0.408(\frac{4a^3}{3\pi})A_3\right] \quad (9)$$

The stress intensity factors resulting from each loading type may be superimposed, including external loading, thermal loading, and internal pressure loading when the stress distribution through the nozzle throat section is available [2]. It should be noted that although eq. (8) is more consistent with most RPV nozzles that have rounded inner radius corner, the 2013 and later editions of ASME Code Section XI – Appendix G still conservatively suggest eq. (9) for calculation of the stress intensity factors. Accordingly, the P-T limits for nozzles under cool-down or heat-up condition can be calculated.

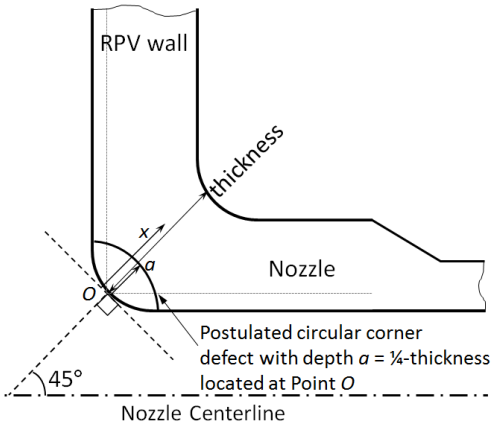


FIG. 1 POSTULATED NOZZLE CORNER DEFECT FOR A NOZZLE WITH (a) A ROUNDED CORNER; (b) A SHARP 90° CORNER

FINITE ELEMENT ANALYSIS OF NOZZLES

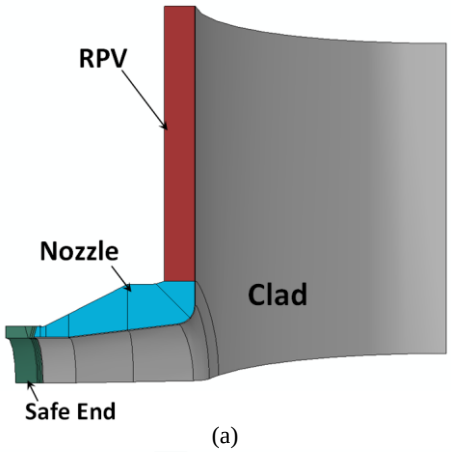
The uncracked 3-D finite element analysis (FEA) was conducted to determine the stress distributions along the 45° path through the nozzle corner under various loading conditions. A finite element package ABAQUS/CAE version 6.14 was employed to perform the analysis. Figs. 2(a) and 2(b) show the geometries of the PWR inlet and out nozzles, respectively according to the drawings referred by reference [4]. One-quarter portion of the nozzles were modeled because of the symmetry. In order to obtain acceptable mesh quality, some appropriate partitions were created on the geometries. The finite element models (FEMs) of the reactor nozzle assembly consist of four portions: (1) a portion of the RPV shell made of SA-533 Gr.B Cl.1 steel; (2) the nozzle forging made of SA-508, Cl.2 steel; (3) weld and safe end made of Alloy 82/182; (4) 316 stainless steel cladding. The temperature dependent thermo-mechanical properties were obtained from the Part D of ASME Code Section II [13] listed in Table 1 and input into the FEMs.

Fig. 3 shows the undeformed FEA mesh and boundary conditions of the inlet nozzle subjected to internal pressure loading condition. All 3-D FEMs were constructed with 20-node brick elements (C3D20). The symmetry boundary conditions were applied on both axial cut planes and the lower circumferential cut plane, and the unit internal pressure (1 ksi) was applied to all of the inner surfaces of the model. The blow-off load which represents the axial stress due to pressure in a closed-end piping system was applied to the end of the pipe and RPV wall, respectively. The blow-off loads were calculated by [4]:

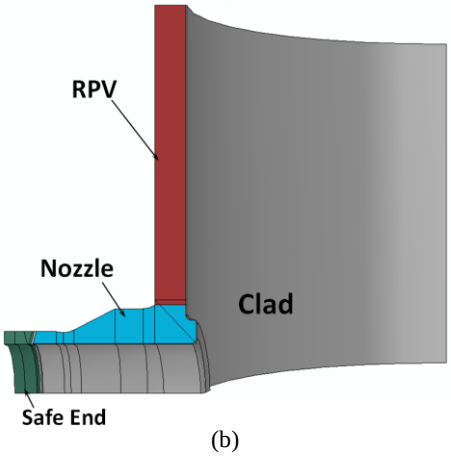
$$P_{blow-off} = \frac{PD_i^2}{D_o^2 - D_i^2} \tag{10}$$

where D_i and D_o are the inner and outer diameters of RPV or pipe when calculate correspondingly, and P denotes the applied pressure. As for the attached piping loads, reference [4] demonstrated that the stress in nozzle corner caused by them is insignificant compared to the stress due to pressure loading. Therefore, nozzle attachment loads were neglected when calculating the P-T limits of RPV.

When performing the thermal analysis under cool-down or heat-up conditions, the 20-node thermally coupled brick element (C3D20T) was used. First, the initial temperature conditions of 550°F and 50°F for cool-down and heat-up thermal stress analyses, respectively were applied on the whole models with the same symmetric constraints. Then, the inner surfaces of nozzle models were subjected to cool-down and heat-up transients at a rate of 100°F/hr, respectively. The thermal stress intensity factors K_{It} were calculated from the thermal stress distribution along the 45° path through the nozzle corner at a transient time when the maximum thermal stress at the one quarter thickness location was determined to occur.



(a)



(b)

FIG. 2 GEOMETRY MODELS OF THE PWR (a) INLET NOZZLE AND (b) OUTLET NOZZLE

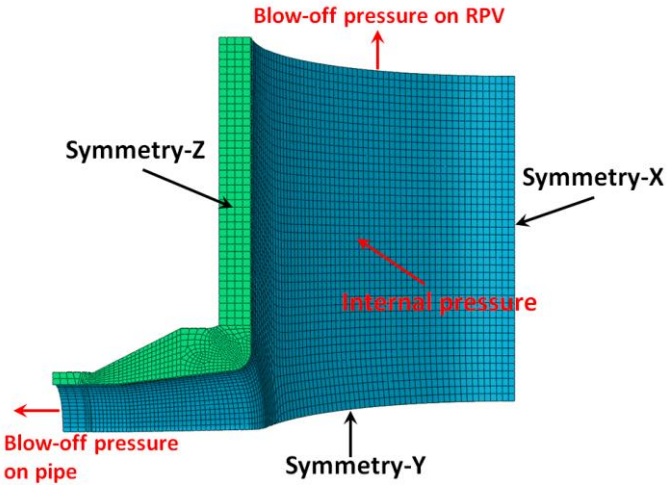


FIG. 3 BOUNDARY CONDITIONS AND LOADS APPLIED TO THE INLET NOZZLE FEM

Fig. 4(a) and Fig. 4(b) show the stress intensity profile for the PWR inlet and outlet nozzle FEMs subjected to 1 ksi internal pressure loading, respectively. It is seen that the maximum stress occurs at the nozzle corner on the axial cut plane, and the

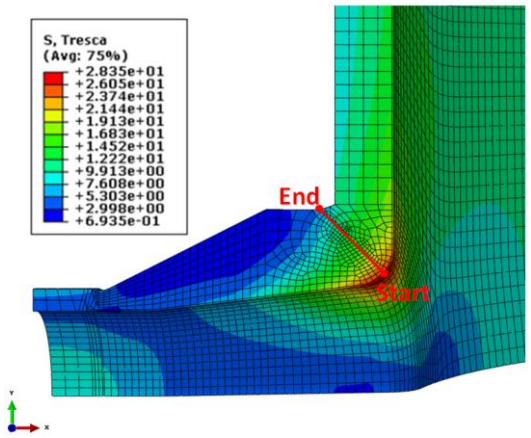
stress varies significantly around the nozzle circumference. The 45° path used to extract the hoop stress from each node is also shown in the figures. Fig. 5(a) and Fig. 5(b) present the hoop stress as a function of distance along the 45° path from the corner of the PWR inlet and outlet nozzles, respectively, as well as the third-order polynomial curve fitting results. On the other hand, the thermal stress analysis result of the PWR inlet nozzle under 100°F/hr cool-down transient is shown in Fig. 6(a) which presents the maximum principal stress profile at 128 minutes while the stress at the one quarter thickness (1/4t) location along a 45° path through the nozzle corner reaches the maximum value (see Fig. 6(b)). Also, it should be noticed that there is a large stress difference between the cladding and nozzle forging caused by the differential thermal expansion of these two materials. As a result, the thermal hoop stress along the entire cross section may not be fit well by a third-order polynomial. Fig. 7 presents the thermal hoop stress distribution along the inlet nozzle thickness under 100°F/hr cool-down transient curve fit in two ways: (1) the polynomial fit for thermal hoop stress across entire path thickness, and (2) the polynomial fit neglecting the stress in the cladding. It is seen that the polynomial fit excluding the cladding stress is much better than considering the entire path (the coefficient of determination R^2 = 0.9998 vs. 0.8159). Therefore, when performing the curve fitting for thermal hoop stress of nozzles, the cladding stress was not used to obtain the third-order polynomial coefficients, which was used to estimate stress intensity factors for the 1/4t circular corner crack using magnification factor method. Finally, all the constants in eq. (7) used to approximate the third-order polynomial stress distribution of nozzles subjected to internal pressure and thermal transients from FEA results are listed in Table 2.

TABLE 1
THERMO-MECHANICAL PROPERTIES OF THE RPV

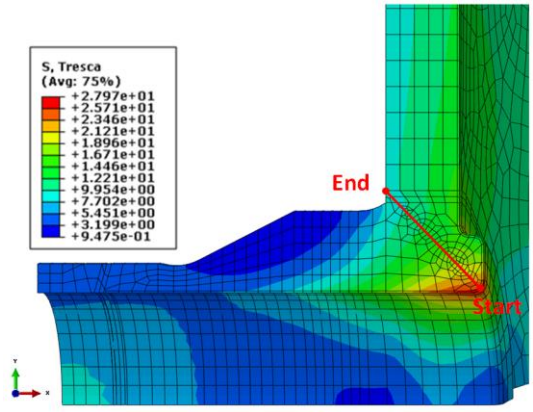
RPV Shell: SA-533 Gr.B Cl.1 steel												
Temperature (°F)	70	100	150	200	250	300	350	400	450	500	550	600
Thermal conductivity (BTU/min-in-°F)	0.0329	0.0328	0.0326	0.0326	0.0325	0.0325	0.0324	0.0321	0.0319	0.0315	0.0313	0.0308
Specific heat (BTU/lbm-°F)	0.107	0.108	0.111	0.115	0.117	0.121	0.123	0.126	0.129	0.131	0.134	0.137
Young's modulus (ksi)	29000			28500		28000		27600		27000		26300
Thermal expansion coefficient (10^{-6}°F^{-1})	7.0	7.1	7.2	7.3	7.3	7.4	7.5	7.6	7.6	7.7	7.8	7.8
Density (lbm/in^3)	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Nozzle Forging: SA-508, Cl.2 steel												
Temperature (°F)	70	100	150	200	250	300	350	400	450	500	550	600
Thermal conductivity (BTU/min-in-°F)	0.0329	0.0328	0.0326	0.0326	0.0325	0.0325	0.0324	0.0321	0.0319	0.0315	0.0313	0.0308
Specific heat (BTU/lbm-°F)	0.107	0.108	0.111	0.115	0.117	0.121	0.123	0.126	0.129	0.131	0.134	0.137
Young's modulus (ksi)	27800			271000		26700		26200		25700		25100
Thermal expansion coefficient (10^{-6}°F^{-1})	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.3	7.4
Density (lbm/in^3)	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
Weld and Safe End: Alloy 82/182												
Temperature (°F)	70	100	150	200	250	300	350	400	450	500	550	600
Thermal conductivity (BTU/min-in-°F)	0.0329	0.0328	0.0326	0.0326	0.0325	0.0325	0.0324	0.0321	0.0319	0.0315	0.0313	0.0308
Specific heat (BTU/lbm-°F)	0.107	0.108	0.111	0.115	0.117	0.121	0.123	0.126	0.129	0.131	0.134	0.137
Young's modulus (ksi)	29600			29000		28500		28000		27400		26900
Thermal expansion coefficient (10^{-6}°F^{-1})	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	7.3	7.3	7.4
Density (lbm/in^3)	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28
316 Stainless Steel Cladding												
Temperature (°F)	70	100	150	200	250	300	350	400	450	500	550	600
Thermal conductivity (BTU/min-in-°F)	0.0114	0.0115	0.0119	0.0122	0.0126	0.0129	0.0132	0.0136	0.0139	0.0142	0.0146	0.0149
Specific heat (BTU/lbm-°F)	0.122	0.123	0.125	0.125	0.128	0.128	0.129	0.131	0.132	0.132	0.134	0.134
Young's modulus (ksi)	28300			27500		27000		26400		25900		25300
Thermal expansion coefficient (10^{-6}°F^{-1})	8.5	8.6	8.8	8.9	9.1	9.2	9.4	9.5	9.6	9.7	9.8	9.9
Density (lbm/in^3)	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28	0.28

TABLE 2
COEFFICIENTS FOR 3RD-ORDER POLYNOMIAL STRESS DISTRIBUTIONS ALONG 45° PATH OF PWR NOZZLES UNDER VARIOUS LOADING CONDITION

$\sigma = A_0+A_1x+A_2x^2+A_3x^3$ (ksi)				
PWR Inlet Nozzle				
Loading Condition	A_0	A_1	A_2	A_3
Internal Pressure	26.8158	-3.1715	0.2502	-0.0113
100°F/hr Cool-down Transient	7.9195	-1.8090	-0.0846	0.0109
100°F/hr Heat-up Transient	-5.3755	1.3897	0.1535	-0.0148
PWR Outlet Nozzle				
Loading Condition	A_0	A_1	A_2	A_3
Internal Pressure	25.3795	-2.8576	0.2189	-0.0068
100°F/hr Cool-down Transient	2.7419	0.2271	-0.1356	0.0041
100°F/hr Heat-up Transient	2.2920	-1.0018	0.1953	-0.0053

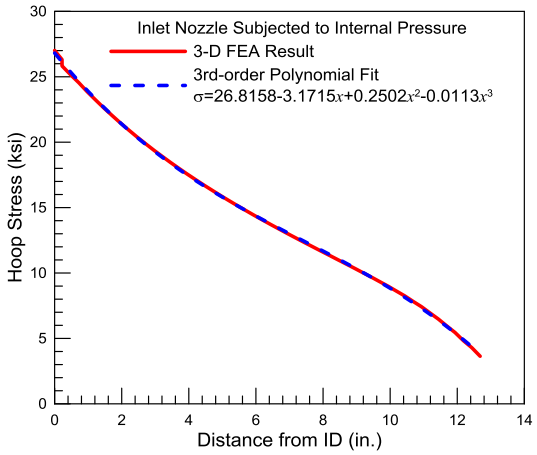


(a)

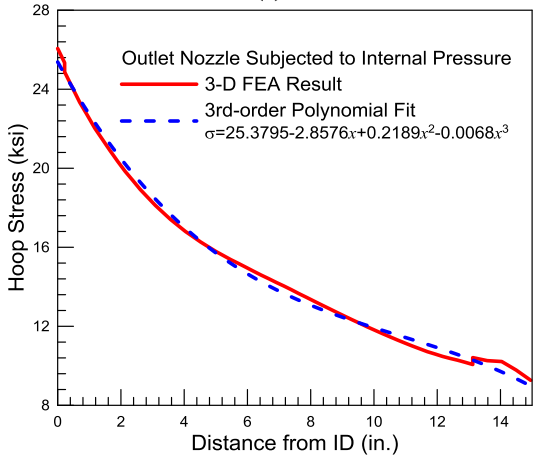


(b)

FIG. 4 STRESS INTENSITY PROFILES OF THE PWR (a) INLET AND (b) OUTLET NOZZLES SUBJECTED TO INTERNAL PRESSURE

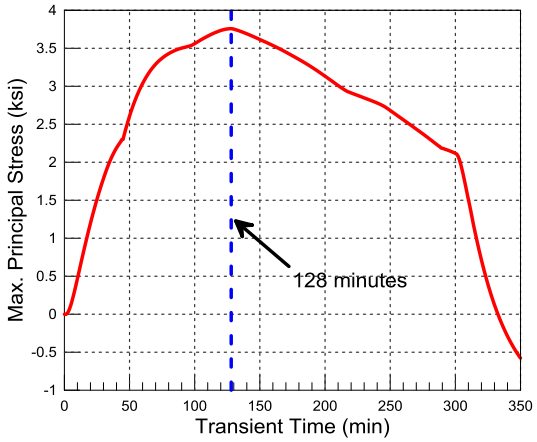


(a)

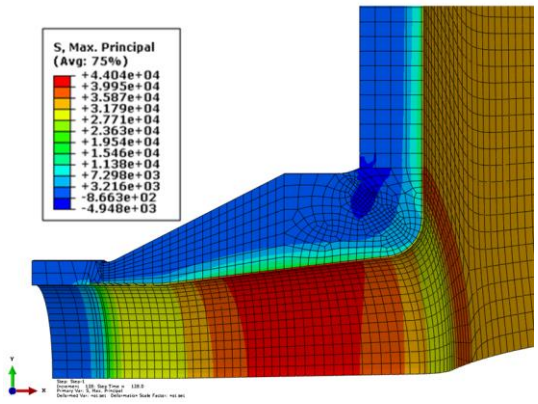


(b)

FIG. 5 HOOP STRESS DISTRIBUTIONS AND CURVING FITTING RESULTS OF THE PWR (a) INLET AND (b) OUTLET NOZZLES SUBJECTED TO INTERNAL PRESSURE



(a)



(b)

FIG. 6 (a) MAXIMUM PRINCIPAL STRESS HISTORY AT QUARTER THICKNESS, AND (b) MAXIMUM PRINCIPAL STRESS PROFILE AT 128 MINITES OF THE PWR INLET NOZZLE UNDER 100°F COOL-DOWN TRANSIENT

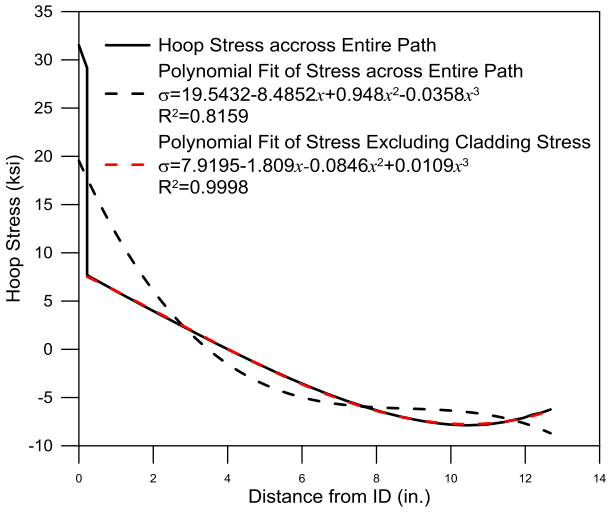


FIG. 7 HOOP STRESS DISTRIBUTION AND POLYNOMIAL FIT RESULTS OF PWR INLET NOZZLE UNDER 100°F/HR COOL-DOWN TRANSIENT

RESULTS AND DISCUSSION

The domestic PWR vessel is a Westinghouse 3 loops reactor. The inner radius and wall thickness of the RPV beltline region are 78.5 inches and 8.04 inches including 0.16 inch stainless-steel cladding, respectively. In this study, the embrittlement condition of the proposed extended operation to 60 years with 90% capacity factor of the PWR plant (54 effective full power years (EFPY)) was considered. According to the relevant reports [14-16], the highest projected RT_{NDT} in the RPV beltline region at 1/4t and 3/4t wall thickness location are 104.9°F and 94.93°F, respectively for 54 EFPY condition. As for the nozzles which locate in the extended beltline region, the 1/4t corner thickness RT_{NDT} are -11°F and 38°F for inlet and outlet nozzles, respectively, which is used to calculate the P-T limits for the extended beltline region [17].

Fig. 8 and Fig. 9 show the cool-down and heat up P-T limits of the PWR RPV, respectively derived from beltline region and extended beltline nozzles based on 54 EFPY embrittlement condition. It is seen that for 100°F/hr cool-down transient, the nozzles present higher permissible pressure than the beltline region, especially the inlet nozzle. Hence, the cool-down limit of the RPV is still controlled by the beltline region. However, for the 100°F/hr heat-up transient, the outlet nozzle influences the P-T limit of the RPV at the lower temperature region, and the limit of inlet nozzle also becomes closer to the beltline region. The reason for that could be preliminarily attributed to the differences of RT_{NDT} values used to calculate P-T limits between the beltline region and nozzles. When calculating the heat-up limits for beltline region, the 3/4t RT_{NDT} of the external surface-breaking reference flaw tip was considered. Therefore, the difference of material toughness between beltline region and nozzles decreases, leading to that the outlet nozzle which has higher stress concentration and RT_{NDT} influences the heat-up limit. Further, Table 3 lists the stress intensity factor components due to internal pressure, cool-down thermal stress and heat-up thermal stress of beltline region, inlet nozzle and outlet nozzle, respectively. The table indicates that the stress intensity factors of the postulated nozzle corner defect produced by primary stress are around doubling of the postulated beltline region defect. Although the stress intensity factor components of nozzles due to thermal stress are lower, the much higher K_{Ip} applied by a factor of 2 dominates the calculation of the P-T limits. Therefore, the outlet nozzle with higher RT_{NDT} produces lower P-T limits than the inlet nozzle, even though the stress concentration in the inlet nozzle under thermal loading is more significant.

TABLE 3
COEFFICIENTS FOR 3RD-ORDER POLYNOMIAL STRESS DISTRIBUTIONS ALONG 45° PATH OF PWR NOZZLES UNDER VARIOUS LOADING CONDITION

Stress Intensity Factor Component (ksi-in.$^{1/2}$)	Beltline Region		Inlet Nozzle	Outlet Nozzle
K_{Im} or K_{Ip} Due to Unit Pressure	Inner flaw	25.9	51.7	52.1
	Outer flaw	25.0		
K_{It} Due to Cool-down	16.6		11.3	6.4
K_{It} Due to Heat-up	13.1		7.5	3.2

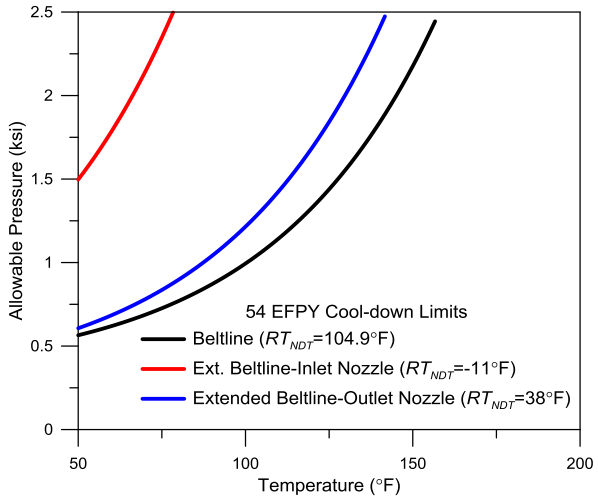


FIG. 8 COOL-DOWN P-T LIMITS AT A RATE OF 100°F/HR

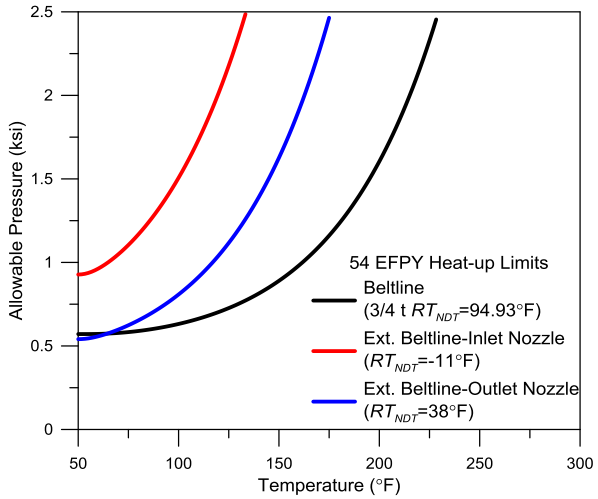


FIG. 9 HEAT-UP P-T LIMITS AT A RATE OF 100°F/HR

On the other hand, in order to investigate the embrittlement conditions of nozzles that they may affect the P-T limits of the RPV, the 54 EFPY P-T limits derived from the beltline region were compared with nozzles calculated by various RT_{NDT}. Fig. 10(a) and Fig. 10(b) show the 100°F/hr cool-down limit of 54 EFPY beltline region compared with inlet nozzle and outlet nozzle with various RT_{NDT}, respectively. Similarly, Fig. 11(a) and Fig. 11(b) display the results of 100°F/hr heat-up limits. Within the operational range of the PWR RPV (50°F to 550°F for temperature and 0 to 2.5 ksi for pressure), the RT_{NDT} values of nozzles that start to influence (i.e. limits of beltline region and nozzles start to intersect each other) or entirely control (i.e. limits of nozzles are entirely below the limit of beltline region) the P-T limit of RPV could be determined. For 100°F/hr cool-down transient, when the RT_{NDT} values of inlet and outlet nozzles rise to 54°F and 45°F, respectively, the permissible pressure will be influenced by the extended beltline region, and then partially control the operational limit. If the RT_{NDT} values reach 68°F and 52°F for inlet and outlet nozzles, respectively, the extended beltline region will dominate the operational limit instead of the beltline region. Also, the RT_{NDT} values that the extended beltline region starts to influence and entirely controls the 100°F/hr heat-up limit are 54°F and 81°F for the inlet nozzle, and 33°F and 89°F for the outlet nozzle, respectively. Consequently, it can be concluded that when the RT_{NDT} values of the inlet and outlet nozzles are higher than 54°F and 45°F respectively for cool-down transient, or 54°F and 33°F respectively for heat-up transient, the extended beltline region would become critical and gradually dominate the operational limit of RPV. In other words, for the domestic PWR at 54 EFPY condition, the beltline region still dominates the cool-down P-T limit with around 7°F margin of RT_{NDT} for the outlet nozzle. However, the RT_{NDT} of the outlet nozzle is around 5°F higher than the critical value of heat-up transients. Therefore, the heat-up P-T limit is partially controlled by the extended beltline region.

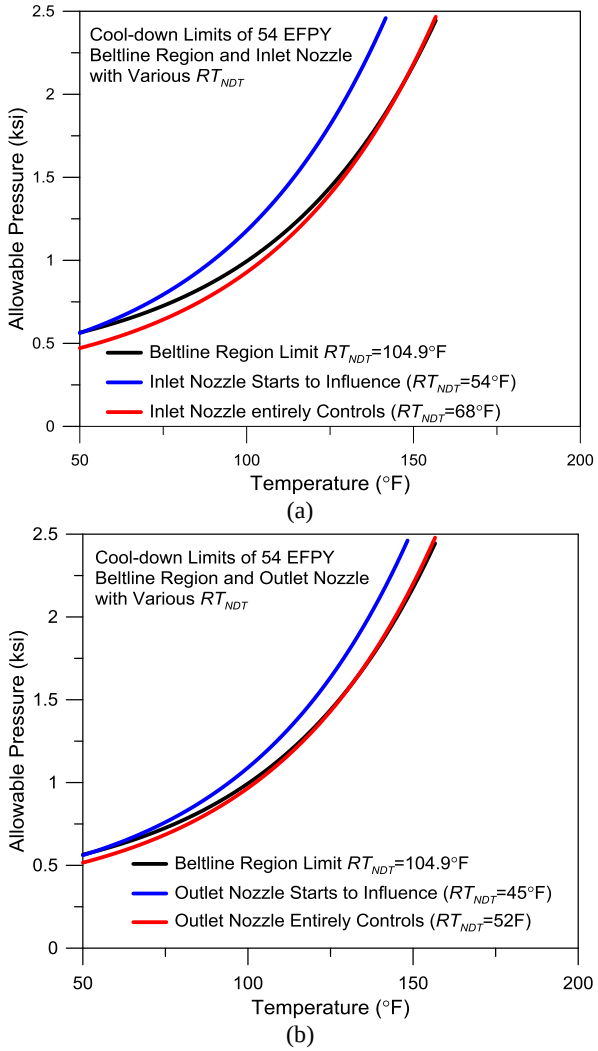


FIG. 10 54 EFPY COOL-DOWN LIMIT OF BELTLINE REGION COMPARED WITH (a) INLET AND (b) OUTLET NOZZLES WITH VARIOUS RT_{NDT}

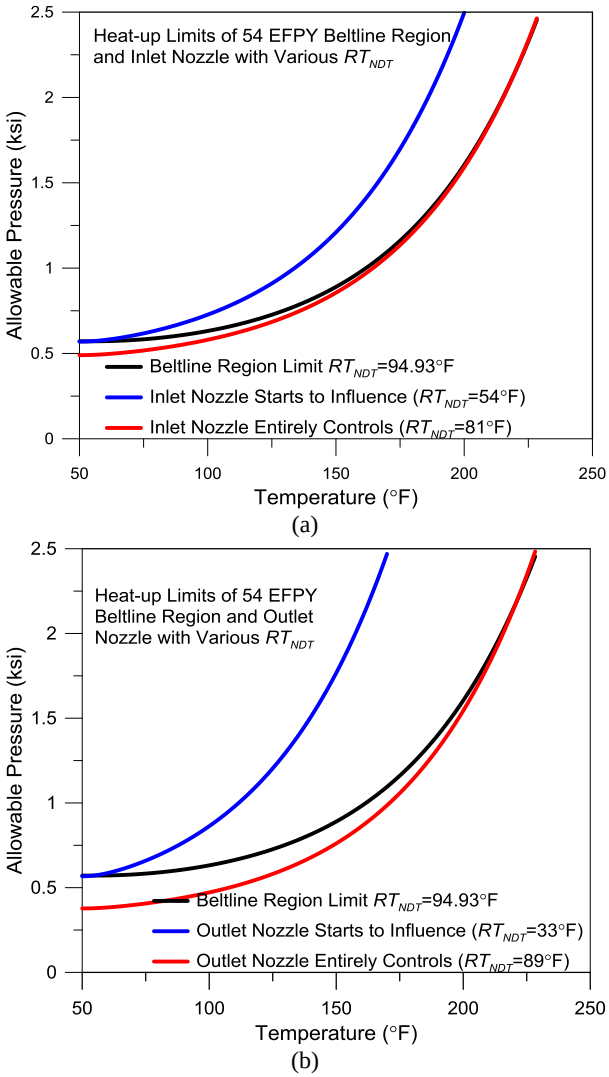


FIG. 11 54 EFPY HEAT-UP LIMIT OF BELTLINE REGION COMPARED WITH (a) INLET AND (b) OUTLET NOZZLES WITH VARIOUS RT_{NDT}

CONCLUSION

This paper presents the P-T curve calculation for a Taiwan domestic PWR RPV considering beltline region and extended beltline region nozzles based on deterministic fracture methodology. A series of finite element analyses for PWR inlet and outlet nozzles were conducted and associated with the magnification factor method to determine the stress intensity factors of the postulated corner defect. It is found that for the 54 EFPY condition of the domestic PWR vessel, the cool-down P-T limit is still dominated by the beltline region that suffers remarkable radiation embrittlement. However, the outlet nozzle that has relatively higher RT_{NDT} than the inlet nozzle would influence the heat-up limit. In addition, the relations of RT_{NDT} values that the extended beltline region starts to influence the P-T limits of the RPV were investigated. The results imply that once the RT_{NDT} values of inlet and outlet nozzles exceed 54°F and 33°F, respectively, the extended beltline region may partially control the P-T limit, until the values reach 68°F and 52°F that the extended beltline region will entirely replace the beltline region to restrict the plant operation. Present study could provide the operation basis and regulation reference for PWR plants in Taiwan.

ACKNOWLEDGMENT

This work was supported by the Atomic Energy Council of Taiwan ROC. The support is greatly acknowledged.

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附件三 發表論文

Application of Flaw Updating Process on Probabilistic Structural Evaluation for a Reactor Pressure Vessel under Pressurized Thermal Shocks

DRAFT
Proceedings of the ASME 2018 Pressure Vessels & Piping Conference
PVP2018
July 15-20, 2018, Prague, Czech Republic

PVP2018-84477

APPLICATION OF FLAW UPDATING PROCESS ON PROBABILISTIC STRUCTURAL EVALUATION FOR A REACTOR PRESSURE VESSEL UNDER PRESSURIZED THERMAL SHOCKS

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ABSTRACT

The structural integrity of a reactor pressure vessel (RPV) is one of the most important issues for the operation of nuclear power plant. Nowadays, the probabilistic fracture mechanics (PFM) technique is widely used in evaluating the structural integrity of RPVs. However, the flaw characteristics used for PFM analysis are mainly derived from the Pressure Vessel Research User Facility (PVRUF) and Shoreham vessel inspection database, which may not be able to truly represent the vessel-specific condition of the analyzed RPV. In this work, the NUREG-2163 procedure which modifies the flaw characteristic parameters is employed. The Bayesian updating process which combines the prior flaw data with non-destructive examination (NDE) results as well as uncertainties is used to develop the posterior vessel-specific flaw distributions. Subsequently, the updated flaw files are used for PFM analysis to investigate the effects of NDE updated flaw characteristics on the fracture probability of RPV subjected to pressurized thermal shocks. Considering the updated flaws based on the NDE data, the analyzed results could be more plant-specific to predict the fracture risks of RPVs during operation.

INTRODUCTION

The reactor pressure vessel (RPV) is the most important component as it is subjected to high pressure, high temperature and serious radiation environment during the normal operation of nuclear power plant. However, some accidental events such as pressurized thermal shocks (PTSs) in the pressurized water reactor (PWR) may occur and impact the structural integrity of the RPV. Therefore, the fracture toughness requirements of vessel material subjected to neutron irradiation should be determined to prevent the brittle fracture under PTSs. In early 2010, the U.S. Nuclear Regulatory Commission (NRC) promulgated the alternate pressurized thermal shock (PTS) Rules, 10 CFR 50.61a[1], which replaces the previous regulations and provides alternate embrittlement requirements for protection against PTS events for PWR RPV. The previous regulations, known as 10 CFR 10.61[2], can be conditionally relieved by applying 10 CFR 10.61a due to some over conservative assumptions. PWR licensees may choose to comply with the alternate PTS rule because of the reduction of regulatory burden while still maintaining sufficient safety. Furthermore, in alternate PTS rule Section d, the plant-specific through wall crack frequency (TWCF) analysis is required. The probabilistic fracture mechanics code, FAVOR [3], which was developed by the Oak Ridge National Laboratory (ORNL) in the United States, was used for TWCF analysis to meet the alternate PTS rule.

For FAVOR analysis, the thermal hydraulic data of transients, beltline region geometry, chemical content of RPV materials, and flaw distributions have to be firstly prepared. In general, flaw distributions for FAVOR analysis were generated by pacific northwest national laboratory (PNNL)'s VFLAW code [4] to characterize the numbers and sizes of flaws in the various regions of the RPV. Instead of using non-destructive examination (NDE) data of each vessel, flaw distributions generated by VFLAW were based on detailed inspection results of pressure vessel research user facility (PVRUF) and Shoreham vessels, and then associated with geometry and material conditions of the analyzed vessel to generate the flaw distributions. For instance, Chou et al. [5] and Chen et al. [6] performed the probabilistic fracture mechanics (PFM) studies for Taiwan domestic light water reactor pressure vessels with flaw distributions without considering the plant-specific NDE data, which may be over conservative to represent the vessel-specific condition of the analyzed RPV. Therefore the flaw distributions considering the plant-specific NDE data would be critical for evaluating TWCF of RPV.

The NUREG-2163[7] report provides guidance which describes the combination between examination data and plant-specific TWCF analysis. The revised flaw distributions parameters of Beaver Valley 2 were calculated by the Bayesian updating method in the report, as listed in Table 1. By re-running the VFLAW code modified by the revised flaw distributions parameters, the plant-specific flaw distribution can be generated

based on the in-service inspection (ISI) data. It should be noted that VFLAW combined all submerged arc welding (SAW) and shielded arc welding (SMAW) flaw data to arrive at the gamma distribution with α_1 = 21.68 and α_2 = 52 from Table 6.6 of NUREG-6817[4]. However, the analysis example in NUREG-2163 only considered PVRUF SAW data for large flaw depths to build the specialized Beaver Valley posterior probability density function (PDF). Therefore, the flaw distributions simulated from SMAW and repair welds remain the same.

In this study, the revised flaw parameters of Beaver Valley 2 from NUREG-2163 in Table 1 are used to modify the VFLAW source code and generate the plant-specific flaw distributions, which are used as FAVOR input files to perform the plant-specific PFM analyses subjected to PTS events. According to NUREG-1874 and NUREG-1806 reports[17,18], there are total 61 PTS transients analyzed from Beaver Valley, 9 for loss-of-coolant accident (LOCA), 28 for stuck-open primary safety relief valves (SO-1), 8 for main steam line break (MSLB), 8 for secondary side stuck-open valves (SO-2), and 8 for others.

Five serious PTS transients of different categories were chosen in the analysis as the loading condition based on the ORNL's former PFM analysis [8]. Table 2 summarizes the transient descriptions of these PTS events [8-10], and the corresponding pressure and temperature histories are shown in Fig. 1. To explain the conclusions of the updating process, some FAVOR deterministic analyses were also performed to discuss the fracture probability mechanism. The present study could usefully be a reference of RPV integrity evaluation that combines the PFM analysis and real ISI data for a specific plant.

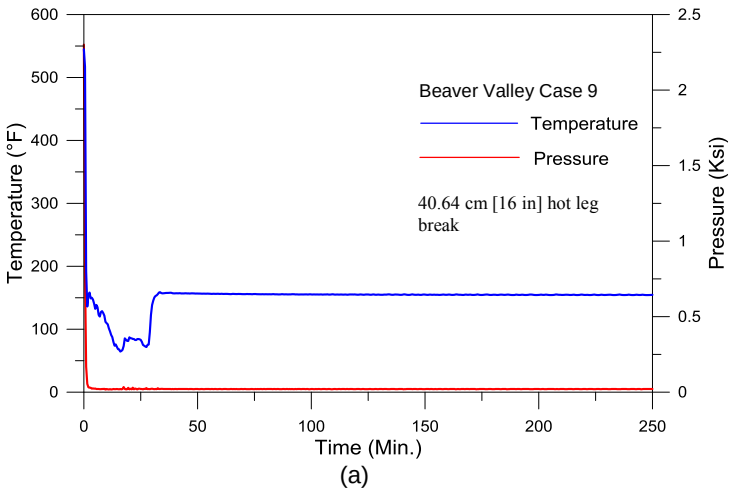
TABLE 1
SUMMARY OF THE POSTERIOR PARAMETER PDFS OF FLAW DEPTH AND FLAW DENSITY TO BE USED IN VFLAW AND FAVOR ANALYSIS FOR BEAVER VALLEY 2 [7]

Flaw Size Category	Welding Process	Distribution Describing Uncertainty of Parameters of PDF	Original VFLAW Parameters of Uncertainty	Revised VFLAW Parameters of Uncertainty
Small Flaw Depth ($a \le \Delta$)	SAW	Dirichlet	U_1 = 34 U_2 = 8 U_3 = 1	U_1' = 513.7 U_2' =17.71 U_3' = 1.54
Large Flaw Depth ($a > \Delta$)	SAW	Gamma	α_1 = 4.615 α_2 = 4	α_1' = 4.563 α_2' = 5
Small Flaw Density ($a \le \Delta$)	SAW	Gamma	α_3 = 0.180 α_4 = 1419	α_3' = 0.230 α_4' = 1909
Large Flaw Density ($a > \Delta$)	SAW	Gamma	α_3= 0.180 α_4 = 4	α_3' = 0.230 α_4' = 5

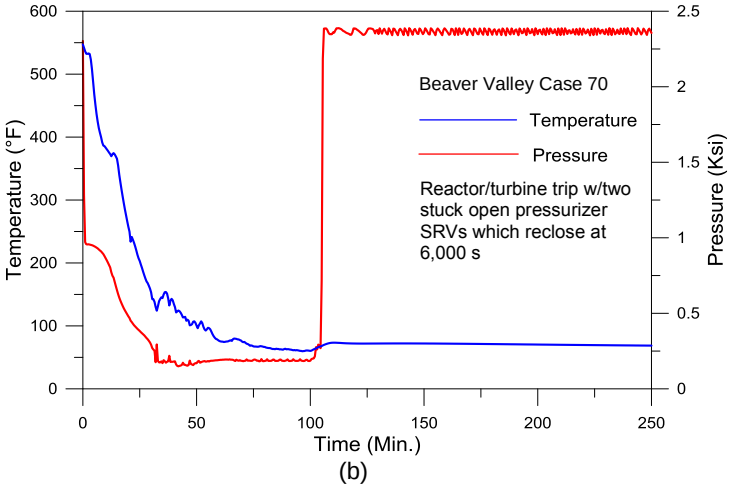
Δ : Weld bead thickness = 6.5mm [4]

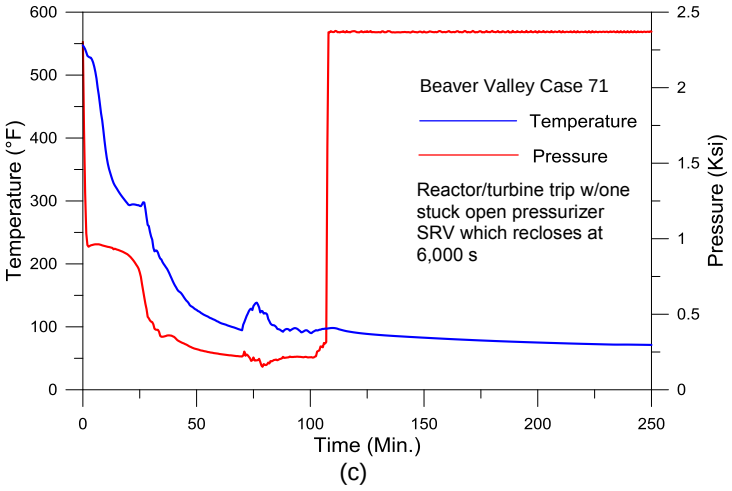
TABLE 2
DESCRIPTION OF PTS TRANSIENTS

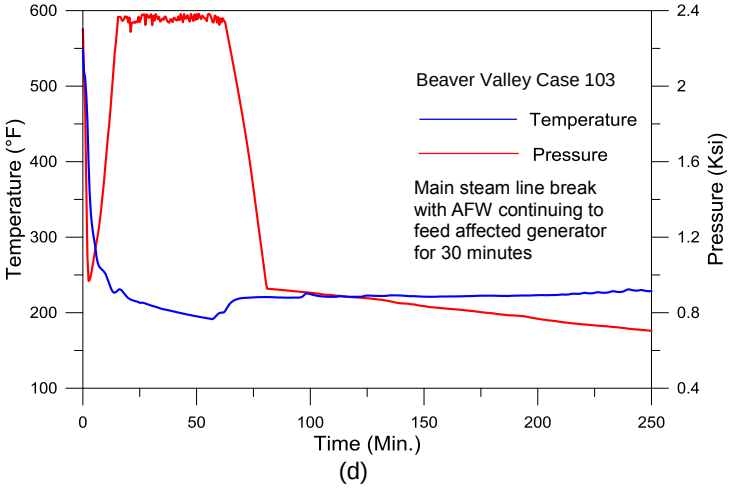
Case No.	Transient Description	Operator Action	Mean Frequency (/yr)	Transient Class
9	40.64 cm [16 in] hot leg break	None.	1.95×10^{-6}	LOCA(medium and large)
70	Reactor/turbine trip w/two stuck open pressurizer SRVs which reclose at 6,000 s.	None.	5.3×10^{-8}	SO-1 with valve later reclosure
71	Reactor/turbine trip w/one stuck open pressurizer SRV which recloses at 6,000 s.	None.	8.15×10^{-6}	SO-1 with valve later reclosure
103	Main steam line break with AFW continuing to feed affected generator for 30 minutes.	Operator controls HHSI 30 minutes after allowed. Break is assumed to occur inside containment so that the operator trips the RCPs due to adverse containment conditions.	1.17×10^{-5}	MSLB
110	Small steam line break (simulated by sticking open all SG-A SRVs) with AFW continuing to feed affected generator for 30 minutes	Operator controls HHSI 60 minutes after allowed.	8.74×10^{-4}	SO-2



(a)







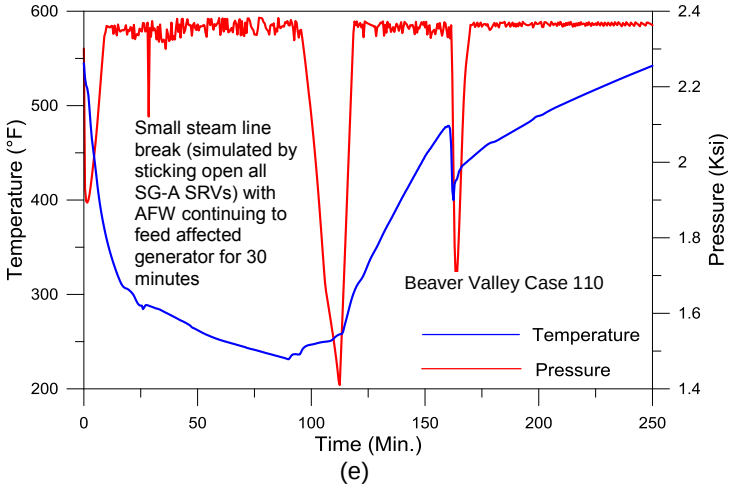


FIG. 1 PRESSURE AND TEMPERATURE HISTORIES OF BEAVER VALLEY PTS TRANSIENTS (a) CASE 9; (b) CASE 70; (c) CASE 71; (d) CASE 103; (e) CASE 110

THE BAYESIAN UPDATING PROCESS

Bayesian inference is a statistical method used to update the probability for hypothesis distributions (e.g., the probability density functions representing flaw depth and flaw density) as new evidence or information becomes available, for example vessel-specific NDE data. It provides a powerful approach to combine observed or measured data with prior hypothesis distributions. The uncertainty of a random variable of unknown value in Bayesian inference can be quantified by assigning a probability density function (PDF) to its possible values. In the Bayesian updating process, for example, the parameters of an exponential distribution representing flaw depth are treated as random variables. Therefore, each parameter can be described as a corresponding PDF. In some cases, for example, prior information about the parameters, such as the intensity parameter (λ) of an exponential distribution representing the various flaw depth, may be known from related observations and data of similar vessels. It is possible to update any prior PDF of the intensity parameter by combining the NDE data with the prior PDF, if new NDE results provide more specific data.

In this study, the Bayesian updating is used to combine the prior information with specific NDE data to build a posterior PDF, which can be more representative of the true intensity parameter. The parameter θ, which is assumed as a continuous random variable, causes the prior and posterior PDFs of θ to be continuous. $L(\text{Data}|\theta)$ shows how likely it is to observe the data according to given values of parameter θ. Then the posterior PDF, $\pi_1(\theta|\text{Data})$, that represents a properly weighted combination of the prior PDF and the likelihood of the parameter θ by Bayesian inference is shown as Eq. 1.

$$\pi_1(\theta|\text{Data}) = \frac{\pi_0(\theta)L(\text{Data}|\theta)}{\int_\theta \pi_0(\theta)L(\text{Data}|\theta)d\theta} \quad (1)$$

In Eq. 1, the denominator is called the marginal density of the data or the normalization constant. The most difficult part of a Bayesian analysis is the computational challenge of determining the normalized constant that often requires multidimensional numerical integration. The conjugate distribution could make posterior PDF calculations simpler because it eliminates the complex, and computationally challenging integrations in Eq. 1. The definition of conjugate is that the functional form of prior distribution is the same as the posterior distribution. Hamada et al. [11] present a comprehensive overview of the mathematical steps for updating the conjugate distributions used in the Bayesian analyses.

The data flow diagram of Bayesian analysis is shown in Fig. 2. These PVRUF flaw data reported in NUREG-6817, which describe the flaw size and density, are used as the prior data in the analysis. The EPRI report by Spanner [12] provides UT-based measured flaw data near the inner surface (around 2.5 inches) of the Beaver Valley 2 RPV, which are mostly in the form of interval-censored data. These plant-specific data are used as reference conditions in the study as summarized [12]:

(1) Nineteen weld flaws were detected by the ultrasonic testing of Beaver Valley 2 in the first inch of RPV. The inspection volume is specified in Supplement 4 to Mandatory Appendix VIII to Section XI of the ASME Code, where having a flaw depth less than 0.125".
(2) The detected weld flaws of Beaver Valley 2 in the first 3/8t (2.953") were reported, all 103 flaws with flaw depths less than 0.125", except for one flaw that measured 0.260".

The NDE data described above provide an incomplete depiction of the true flaws in the Beaver Valley 2 RPV because they contain uncertainties associated with the UT technology used to detect and size flaws. Therefore, the variability in the characteristics of the data, such as size, range, and number of flaws measured, and the UT system performance (probability of detection and measurement/sizing errors) need to be considered. The POD function of UT-detected performance data reported by EPRI [13] was employed to compute the analysis. Currently, EPRI is updating these performance data and will supply more appropriate POD models for future consideration; the POD and flaw-sizing error functions used here are therefore intended only to illustrate this numerical method [7].

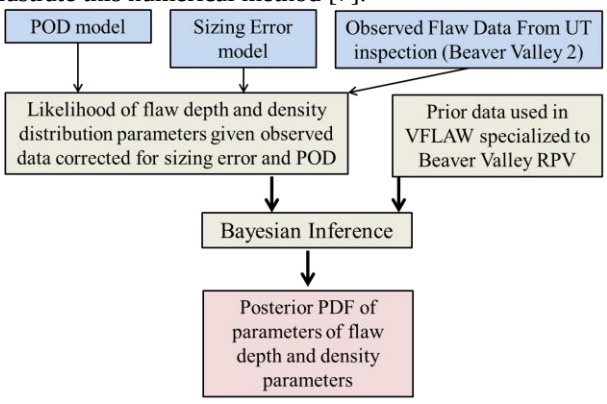


FIG. 2 DATA FLOW DIAGRAM OF BAYESIAN UPDATING PROCESS OF THE BEAVER VALLEY 2 [7]

PFM ANALYSIS METHOD

The data flow diagram of combination between Bayesian analysis result and PFM analysis are shown in Fig. 3. The posterior PDF of parameters of flaw depth and density parameters are used to updating the VFLAW code and simulated the posterior flaw characteristic distribution, which can represent the NDE data. In PFM analysis, two computational modules of the latest version of the probabilistic fracture mechanics code, FAVOR v16.1, were used in the study: (1) the deterministic load generator (FAVLoad), and (2) the Monte Carlo PFM module (FAVPFM). The input file for FAVLoad contains the RPV geometry, material properties and thermal hydraulic conditions of transients. FAVLoad first calculates and then outputs the histories of stress, temperature and stress intensity factor, K_I, with various depth and aspect ratio along the wall thickness of the RPV under each transient. Based on the output of FAVLoad, the instantaneous conditional probability of initiation (cpi) of each simulated flaw tip at each time step, τ, during the transient is calculated according to the Weibull probability function by FAVPFM, given by [14]:

$$cpi(\tau) = \begin{cases} 0 & , \quad K_I(\tau) \le a_{K_{IC}} \\ 1 - exp\left(\frac{-\left(K_I(\tau) - a_{K_{IC}}\right)}{b_{K_{IC}}{}^{c_{K_{IC}}}}\right) & , \quad K_I(\tau) > a_{K_{IC}} \end{cases} \tag{2}$$

where

$a_{K_{IC}}(T - RT_{NDT}) = 19.35 + 8.335exp[0.02254(T - RT_{NDT})]$

$b_{K_{IC}}(T - RT_{NDT}) = 15.61 + 50.132exp[0.008(T - RT_{NDT})]$

$c_{K_{IC}} = 4$

The conditional probability of initiation (CPI) of each simulated flaw during the transient is defined as the maximum value of $cpi(\tau)$. The simulated flaw is defined as the conditional probability of failure (CPF) when the crack depth propagates to 90% of vessel wall thickness. It is a remarkable fact that the warm-prestress (WPS) effect, which is characterized as an apparent increase of fracture toughness of ferritic steels after first being prestressed at an elevated temperature, was also taken into account. This effect may exclude most crack initiation under cool-down type transients. To explain the PFM analysis results updating by Bayesian inference, the baseline WPS model of FAVOR was applied in the study. If a flaw is in a state of WPS, it is not eligible for initiation (or re-initiation if it has arrested) until following conditions are met [14]:

(3) The applied-K_I of the flaw tip is great than $a_{K_{IC}}$ in Eq. (2) for the temperature at the flaw tip (applied-$K_I(\tau) > a_{K_{IC}}$).
(4) A raising applied-K_I field, i.e. the time-rate-of-change of the applied-K_I is positive ($dK_I/d\tau > 0$).
(5) In a rising applied-K_I field, the applied-K_I must exceed the previously-established maximum value experienced by the flaw tip during the transient up to the current point in time under consideration (applied-$K_I(\tau) > K_{I(max)}(\tau)$).

When a crack initiates, it will be assumed to become surface breaking with infinite aspect ratio, and then enter the Initiation-Growth-Arrest (IGA) submodule to evaluate the crack propagation and ductile-tearing behavior. The conditional probability of failure (CPF) of each simulated flaw is defined as the crack propagation up to 90% of vessel wall thickness.

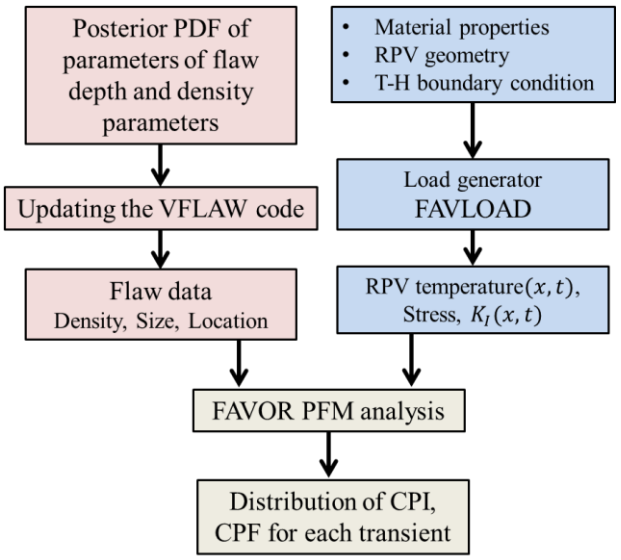


FIG. 3 DATA FLOW DIAGRAM OF BAYESIAN UPDATING PROCESS RESULTS AND PFM ANALYSIS

ANALYSIS MODEL

Analysis of flaws should consider different vessel regions and welding types. Fig. 4 shows the configuration of welds and plates within the RPV beltline region of Beaver Valley 2, including the corresponding sizes. The inner radius and wall thickness of the RPV beltline region are 78.5 inches and 8.04 inches which includes 0.16 inch stainless-steel cladding, respectively. Three flaw files which describe the flaw characteristics of surface breaking flaw, S.dat, embedded weld flaw, W.dat, and embedded plate flaw, P.dat, for FAVOR were generated by PNNL's VFLAW code [15]. FAVOR assumes all pre-existing internal surface breaking flaws are circumferentially oriented. This assumption is basis on the vessel fabrication, which has austenitic stainless-steel cladding applied to the inner surface of the vessel. Embedded weld flaws are oriented axially for axial welds, and oriented circumferentially for circumferentially welds. Welding types include the Submerged Arc Weld (SAW), Shielded Metal Arc Weld (SMAW), and repair weld. It is assumed that all flaws reported are Submerged Arc Welds (SAWs), which form over 90% of welds in the VFLAW data, with the bead thickness of $\Delta = t_{tr} = 0.26"$.

The adjusted RT_{NDT}, which caused by neutron irradiation, was calculated by the Eason's correlation [16] consistent with the U.S. NRC's PTS re-evaluation [17] and MRP-250 report. Compared with the conventional correlation in Regulatory Guide 1.99 Rev.2 [18], the new model not only includes parameters of chemistry, but considers irradiation temperature, neutron flux level, contents of phosphorus and manganese, effective copper parameter etc, which is much complicated but realistic. The neutron fluence (10^{19} n/cm^2, E>1MeV), f, which attenuates along the vessel wall, can be evaluated as below [18] :

$$f=f_{surf}(e^{-0.24x}) \quad (3)$$

where f_{surf} is the neutron fluence at the inner wetted surface and x is the position of the flaw tip (in inches) from the inner surface. Table 3 lists the weight percentage of the decisive chemical contents which include cooper (Cu), nickel (Ni), manganese (Mn) and phosphorous (P), as well as the initial RT_{NDT} of each beltline region material provided by the manufacturer.

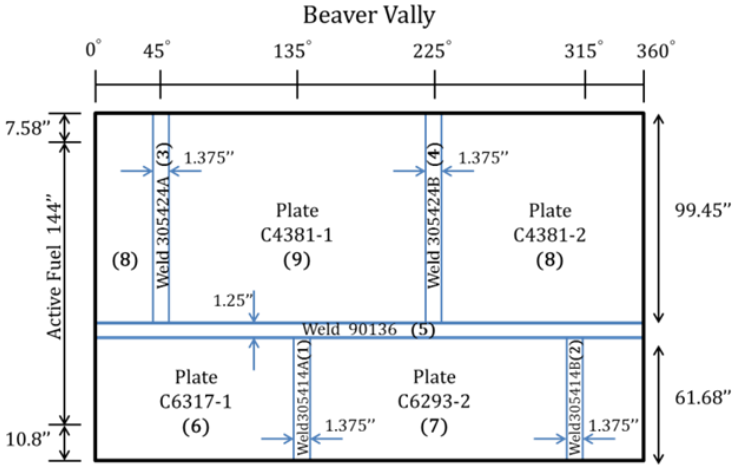


FIG. 4 THE CONFIGURATION OF WELDS AND PLATES IN THE RPV BELTLINE REGION

TABLE 3
EMBRITTLEMENT-RELATED PROPERTIES OF BELTLINE REGION MATERIALS

Material ID		Major Region	Cu (%)	Ni (%)	P (%)	Mn (%)	Initial RT_{NDT} (°F)
Axial welds	305414A	1	0.337	0.609	0.012	1.440	-56.0
	305414B	2	0.337	0.609	0.012	1.440	-56.0
	305424A	3	0.273	0.609	0.013	1.440	-56.0
	305424B	4	0.273	0.609	0.013	1.440	-56.0
Cir. weld	90136	5	0.269	0.070	0.013	0.964	-56.0
Plates	C6317-1	6	0.200	0.540	0.010	1.310	27.0
	C6293-2	7	0.140	0.570	0.015	1.300	20.0
	C4381-2	8	0.140	0.620	0.015	1.400	73.0
	C4381-1	9	0.140	0.620	0.015	1.400	43.0

RESULTS AND DISCUSSION

Because NUREG-2163 only calculated the posterior data of SAW, the flaw distribution components of SMAW and REPAIR are remained the same in this study. However, the welds consist mostly of SAW. Therefore, the flaw characteristics in SAW dominate the flaw distributions. According to the posterior parameters of flaw depth and density distributions provided by Bayesian inferences in NUREG-2163 for Beaver Valley 2 RPV, the posterior SAW weld embedded flaw distribution can be generated by the modified VFLAW, and then combined with the original SMAW and REPAIR weld embedded flaw distributions proportionally to obtain the posterior vessel-specific flaw data (W.dat). Consequently, the fracture probabilities of the RPV considering the prior and posterior flaw distributions can be computed and compared. Table 4 lists the PFM analysis results based on the prior and posterior flaw distributions under various PTS transients and embrittlement conditions. Each case was obtained by carrying out 100,000 Monte Carlo simulations. It is seen that every posterior CPI and CPF are significantly less than prior one, especially for case 70 and case 71 transients. For instance, the CPI calculated from the posterior flaw distribution is around 4 times less than from the prior flaw distribution at 32EFPY subjected to PTS transient of case 9. In case 71, the difference increases to around 50 times.

Fig. 5 shows mean flaw density of the RPV weld embedded flaw against the percentage of the vessel wall thickness based on 1000 Monte Carlo simulations. It can be seen that after performing the updating process, the flaw density of the sizes larger than 2% wall thickness is significantly lower than the prior distribution. By contrast, the total flaw number of prior and posterior distributions are about the same, leading to that the flaw density of the size of 1% wall thickness become higher after the updating process to compensate for the decrease of larger flaws. Consequently, the reason for the significantly lower fracture probability resulted from the posterior weld embedded flaw distribution could be preliminary attributed to the decrease of larger flaws (larger than 2% wall thickness).

On the other hand, a series of FAVOR deterministic analyses were also conducted to explain why the fracture probability is reduced by the updated flaw distribution. The postulated flaw for FAVOR deterministic analysis was considered to be an axial inner Category 2 flaw [14] with the depth of 1% the RPV thickness, which is described as an embedded flaw in the base material between the clad/base interface and the inner 1/8th of the base metal thickness. The amount of flaws with small aspect ratio (1 to 1.25) account for a large proportion of all simulated flaws from the VFLAW output files. Therefore, the postulated flaw with the aspect ratio of 1 was analyzed under different types of PTS transients and the results are shown in Fig 7. As seen from the figures, the relatively higher $a_{K_{IC}}$ is presented when subject to cases 70, 71 and 110 PTS transients (i.e. the applied-K_I and $a_{K_{IC}}$ curves do not intersect each other), even if at severe radiation embrittlement levels. Hence, the increased flaws of 1% wall thickness may cause the negligible fracture probability. On the contrary, for cases 9 and 103 PTS transients, it is seen that when the radiation embrittlement level is larger than 100EFPY, the $a_{K_{IC}}$ will be lower than the applied-K_I with positive slop as well as exceed its previously-established maximum value (applied-$K_I(\tau) > K_{I_{(max)}}(\tau)$). Therefore, these types of flaws leave the WPS and then initiate. As a result, the increased small flaws contribute the fracture probability under the PTSs and thus reduce the differences of PFM analysis results between prior and posterior flaw distributions.

In addition, Fig. 6 shows the FAVOR deterministic analysis results of a similar flaw with the depth of 2% the RPV thickness under case 9 PTS. It can be seen that for the larger flaws, the exceedance of applied-K_I higher than $a_{K_{IC}}$ is more obvious, and the trend of leaving WPS is likelier, leading to a higher fracture probability. Consequently, instead of the increased small flaws, the fracture probability decreases significantly with the decreased larger flaws after performing the updating process.

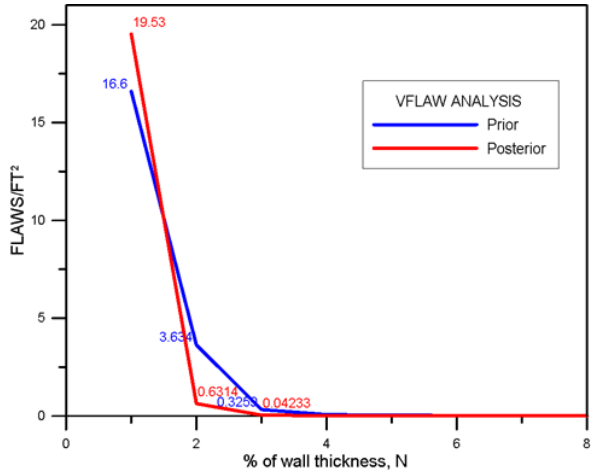


FIG. 5 MEAN FLAW DENSITY DISTRIBUTION OF THE RPV BELTLINE REGION AGAINST THE PERCENTAGE OF THE VESSEL WALL THICKNESS

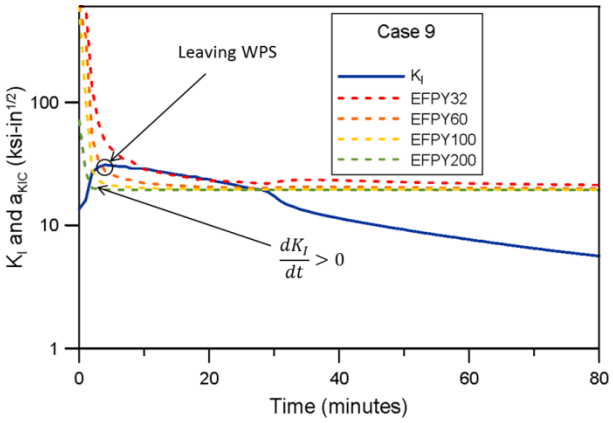


FIG. 6 THE DETERMINISTIC ANALYSIS RESULTS FOR A FLAW OF 2% WALL THICKNESS WITH ASPECT RATIO = 1 IN DIFFERENT EFPY CONDITIONS UNDER BEAVER VALLEY PTS TRANSIENTS CASE 9

TABLE 4
THE PFM ANALYSIS RESULTS OF THE RPV WITH PRIOR AND POSTERIOR DISTRIBUTIONS OF FLAW

		32EFPY		60EFPY		100EFPY		200EFPY	
		Prior	Posterior	Prior	Posterior	Prior	Posterior	Prior	Posterior
Case 9	CPI	8.65E-04	2.26E-04	4.15E-03	1.56E-03	1.67E-02	8.39E-03	1.12E-01	7.70E-02
	CPF	1.18E-05	1.16E-05	1.54E-04	1.52E-04	1.26E-03	1.25E-03	2.04E-02	2.02E-02
Case 70	CPI	1.67E-04	1.94E-05	5.76E-04	7.49E-05	1.72E-03	2.47E-04	8.05E-03	1.43E-03
	CPF	1.86E-05	4.40E-07	3.56E-05	1.62E-06	7.27E-05	9.21E-06	4.62E-04	1.86E-04
Case 71	CPI	5.00E-06	9.35E-08	1.00E-05	2.26E-07	1.86E-05	6.02E-07	8.75E-05	7.12E-06
	CPF	4.99E-06	9.32E-08	9.94E-06	2.16E-07	1.73E-05	4.13E-07	3.97E-05	1.32E-06
Case 103	CPI	1.49E-05	2.37E-06	1.09E-04	2.23E-05	6.52E-04	1.96E-04	8.45E-03	4.28E-03
	CPF	1.21E-06	3.47E-07	1.64E-05	9.53E-06	1.83E-04	1.31E-04	4.68E-03	3.68E-03
Case 110	CPI	5.78E-13	0.00E+00	9.67E-08	1.85E-08	2.36E-06	3.56E-07	9.82E-05	2.18E-05
	CPF	2.28E-16	0.00E+00	6.26E-09	7.16E-10	2.18E-07	3.57E-08	2.49E-05	1.30E-05

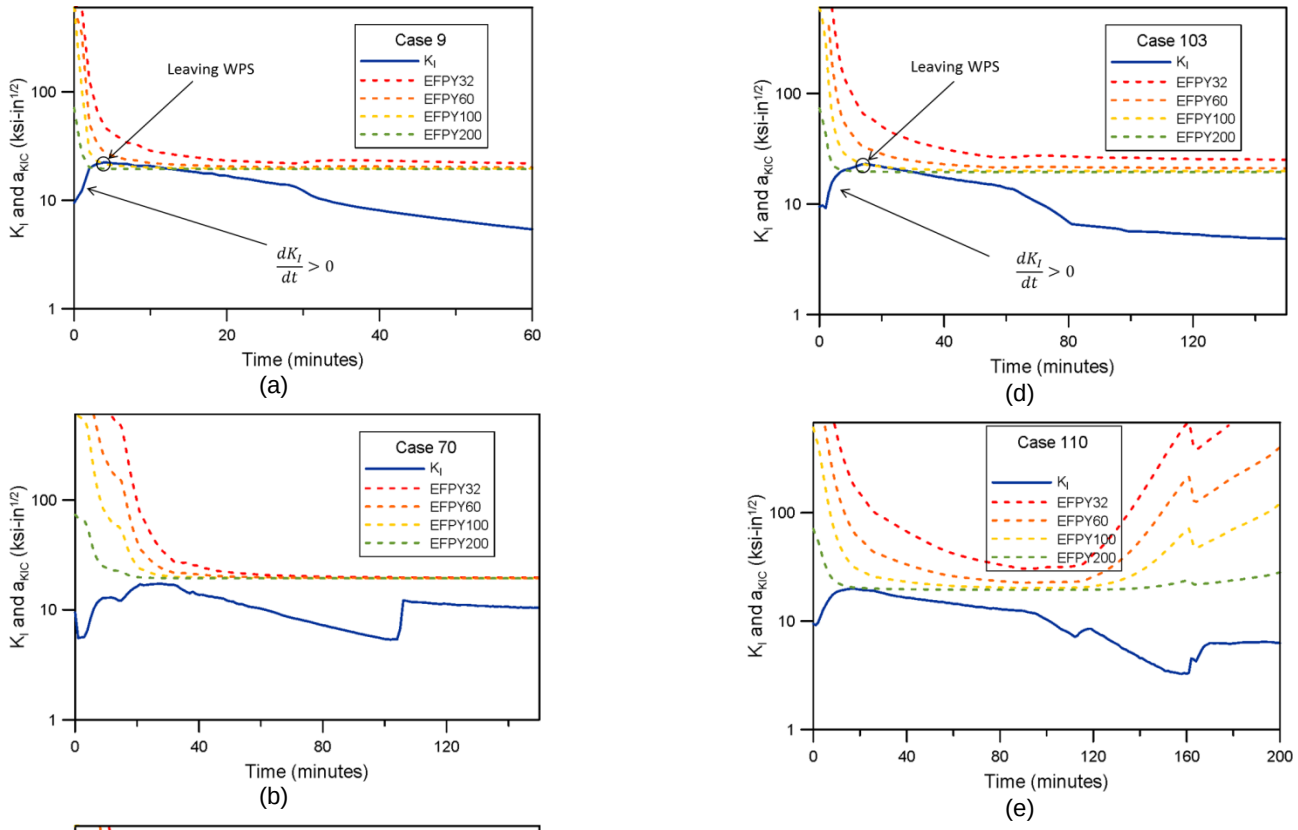


FIG. 7 THE DETERMINISTIC ANALYSIS RESULTS FOR A FLAW OF 1% WALL THICKNESS WITH ASPECT RATIO = 1 IN DIFFERENT EFPY CONDITIONS UNDER BEAVER VALLEY PTS TRANSIENTS (a) CASE 9; (b) CASE 70; (c) CASE 71; (d) CASE 103; (e) CASE 110

CONCLUSION

This paper has presented the application which combines the Bayesian inference and probabilistic structural integrity evaluation for the PWR RPV subjected to various PTS transients. Based on the ISI results of Beaver Valley 2 RPV, it is

demonstrated that the posterior conditional fracture probabilities under PTS transients decrease significantly after the flaw distribution modified by the vessel-specific NDE data, which has most flaw depth less than 0.125".

The deterministic analyses were also taken into account to explain the relationship between the flaw density and vessel-specific PFM analysis results. After performing the updating process, the fracture probability may be slightly increased by the increased flaws of 1% wall thickness, but reduced significantly by the decreased larger flaws.

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附件四 「Aging Management for Spent Fuel Dry Storage and Subsequent Transportation 教育訓練」教材簡報內容

ASME 2018 PRESSURE VESSELS & PIPING CONFERENCE
JULY 15-19, 2018, PRAGUE, CZECH REPUBLIC

Argonne NATIONAL LABORATORY

Tutorial TW-2-7: Aging Management for Spent Fuel Dry Storage and Subsequent Transportation

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Work sponsored by U.S. Department of Energy
Office of Packaging and Transportation

July 16, 2018

U.S. DEPARTMENT OF ENERGY

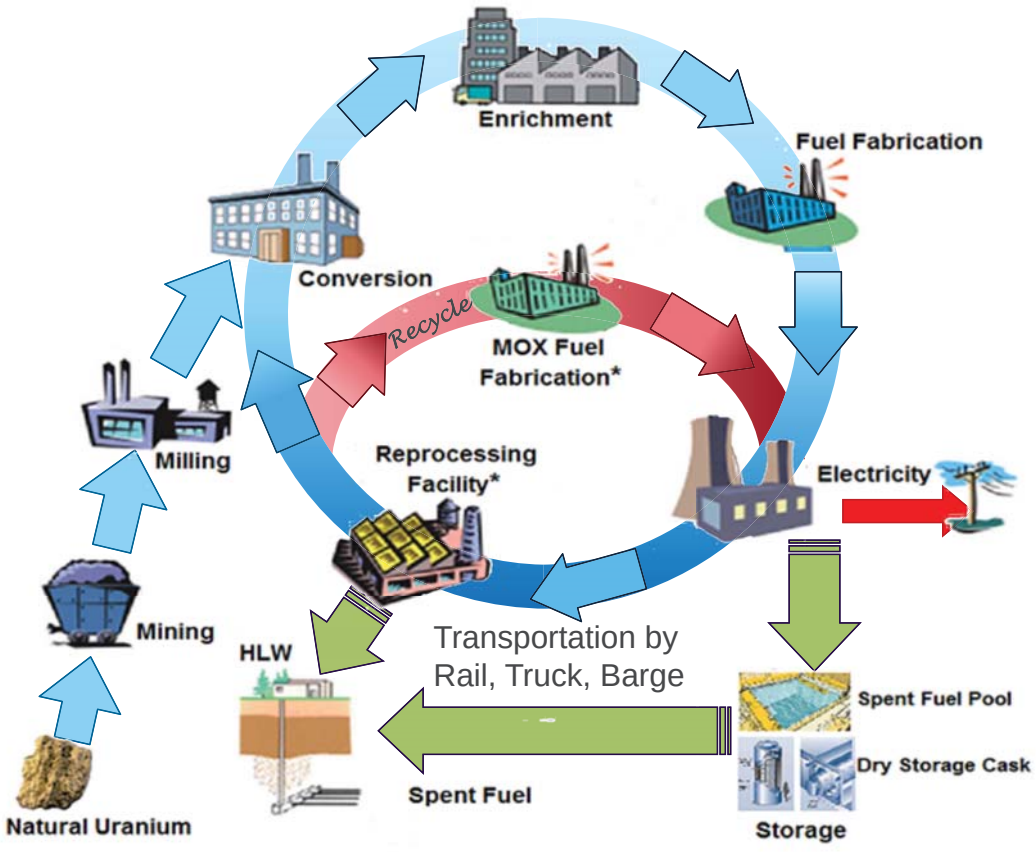
EM Environmental Management
safety · performance · cleanup · closure
DOE PACKAGING CERTIFICATION PROGRAM

Outline

- Nuclear Fuel Cycle and Long-term Storage of Spent Nuclear Fuel
- Title 10 of Code of Federal Regulations Part 72 (10 CFR 72) Licensing Term, License Renewal Requirements and License Renewal Process
- Aging Management Review
  - Time-limited Aging Analyses (TLAAs), and
  - Aging Management Programs (AMPs)

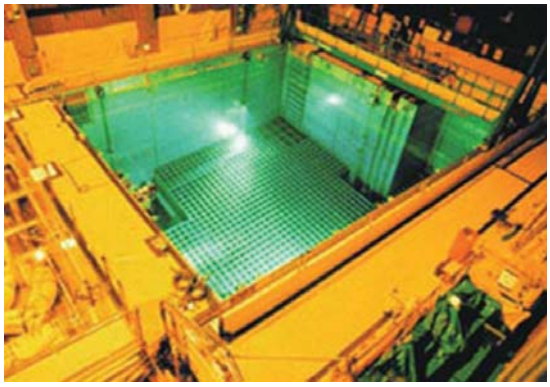
Nuclear Fuel Cycle and Long-term Storage of Spent Nuclear Fuel

Nuclear Fuel Cycle: Transportation, Storage and Disposal – Safe, Secure, Safeguards and Sustainable



Spent Nuclear Fuel Storage (1/3) - Pool

- Nuclear Power Plants (NPPs) were not originally designed to store spent fuel arising from their entire operating lives.
- The US federal government is responsible for removal/disposition of spent fuel from commercial plants for ~~reprocessing~~ and disposal.
- Discharged fuel from reactors typically stored wet in spent fuel pools (>5 years) before being transferred for dry storage at Independent Spent Fuel Storage Installations (ISFSIs).
- In-plant spent fuel pool storage is governed by the plant's 10 CFR 50 operating license
- NRC regulates storage of commercial spent nuclear fuel (10 CFR 72).

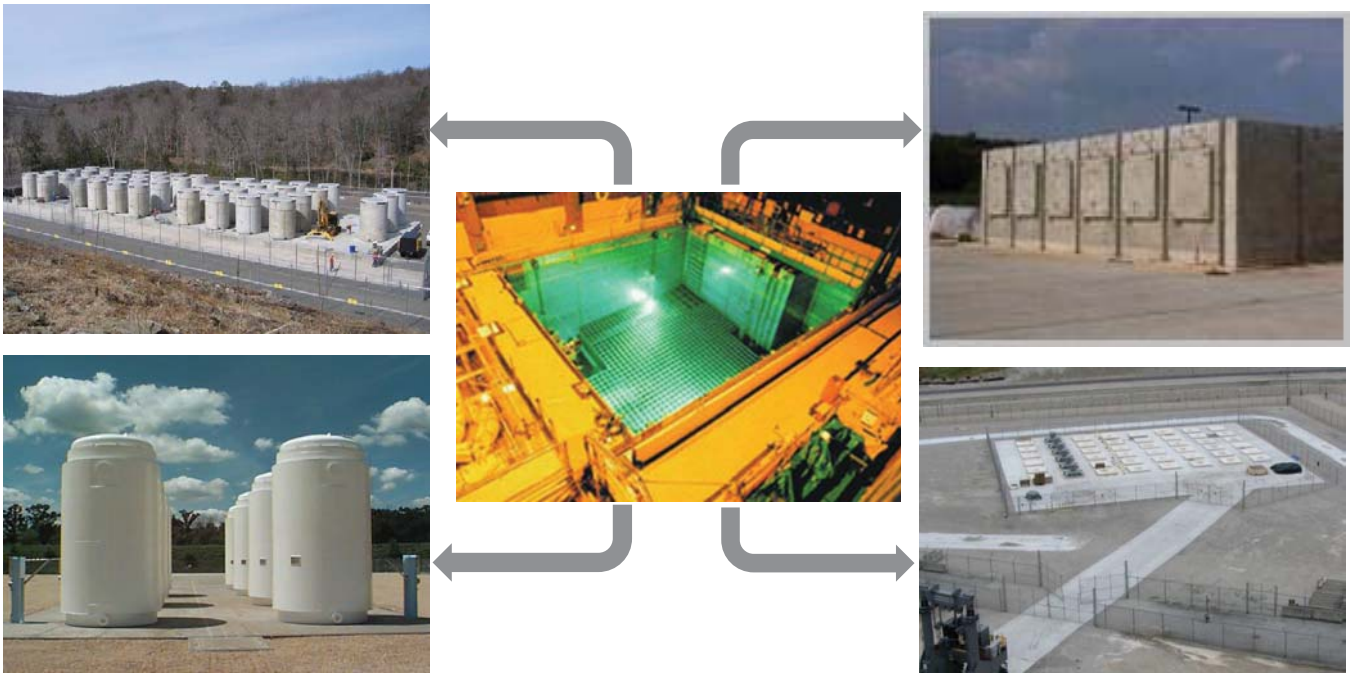


Power Plant Spent Fuel Pool

Spent Nuclear Fuel Storage (2/3) - at Commercial Plant Sites

- Why do we need additional onsite storage?
  - No reprocessing due to proliferation concerns
  - The federal government has selected, but not licensed or built, a geologic repository
- NRC regulates onsite and offsite storage of spent nuclear fuel not otherwise owned and managed by DOE
- 10 CFR 72: "Licensing Requirements for the Independent Storage of Spent Nuclear Fuel, High-level Radioactive Waste, and Reactor-Related Greater than Class C Waste"
  - Provides the regulatory framework for the NRC to grant licenses for ISFSIs and to certify storage cask designs
  - Also addresses licensing a DOE monitored retrievable storage (MRS) facility (DOE-only)

Spent Nuclear Fuel Storage (3/3) - ISFSI



ISFSI Storage—10 CFR 72 Licenses

- 10 CFR 72 currently includes specific and general licenses; until 1990, 10 CFR 72 only included rules for specific licenses

- ISFSIs away from nuclear power plant sites that are governed by a 10 CFR 50 or 52 license MUST use the specific license (SL) process:
  – Morris, INL-TMI-2, interim consolidated storage facility (in future)
- Sites governed by a 10 CFR 50 or 52 (i.e., power plants) license MAY use the SL or general license (GL) process
- 10 CFR 72.210, general license issued:
  "A general license is hereby issued for the storage of spent fuel in an independent spent fuel storage installation at power reactor sites to persons authorized to possess or operate nuclear power reactors under 10 CFR Part 50 or 10 CFR Part 52."

ISFSI Storage—10 CFR 72 Specific License

- The SL is a traditional NRC licensing process that is unique to one site
- Prepare and submit application per Subpart B of 10 CFR 72, including:
  - Safety analysis report (SAR)
  - Proposed technical specifications (TS)
  - Environmental report (ER)
  - Financial qualifications for operations and decommissioning
  - Quality assurance plan (QAP)
  - Security plan
  - Emergency response plan (ERP)
- If the NRC finds the application complete, it dockets the application and provides the public an opportunity to intervene by submitting contentions
- After iterations of requests for additional information (RAIs), the NRC develops a safety evaluation report (SER) that documents compliance with the 10 CFR 72
- NRC also prepares an environmental impact statement (EIS) to document the review of the ER and compliance with NEPA (National Environmental Policy Act)
- NRC staff recommends to the Commission that a license be granted (20/40 yrs)
- The Commissioners either grant or deny the license

ISFSI Storage—10 CFR 72 General License

- 10 CFR 72.212 sets forth 17 conditions of a GL. Key GL conditions:
  - Only store SNF licensed to be possessed on that site
  - Only store SNF in casks approved by the NRC
  - Notify NRC 90 days in advance of intent to use the GL
  - Register each cask placed in service with NRC within 30 days
  - Ensure each cask complies with the terms, specifications, and conditions of the original CoC or amendment
  - Perform written evaluations (“the 72.212 Report”)
  - Protect against a design basis threat of radiological sabotage per 10 CFR 73 (with certain exceptions)
- Revise 10 CFR 50 programs and plans to include ISFSI
- Cask designer (“applicant”) submits a SAR describing a cask design and NRC reviews and issues CoC (not a “license”), then applicant becomes the “CoC holder,” not a licensee!
- Approved cask designs are listed in 10 CFR 72.214 by CoC number

ISFSI Storage - Overview (1/2)

- Currently, there are 74 licensed ISFSIs (63 general license and 15 site-specific license) in 34 states of the US, with 72 in operation:
  - 2 licensed but never constructed
  - 15 at shut-down plant sites (and growing)
  - 2 at DOE-owned sites (Ft. St. Vrain and TMI-2 at DOE's Idaho site)
- 71 of the 72 are "dry-type" ISFSIs
  - GE Hitachi Morris facility in Illinois is a wet pool ISFSI
- As of December 31, 2017:

  ≈ 284,000 SNF assemblies (≈81,000 MTU) permanently discharged from U.S. commercial reactors
  ≈ 166,000 assemblies (≈48,000 MTU) in plant wet storage
  ≈ 118,000 assemblies (≈34,000 MTU) in ISFSI storage
  ≈ 2,698 dry storage casks placed in service since 1986
- 235 casks placed in service in 2016 (highest annual number ever)
- ~200 new casks deployed yearly in United States (≈2,000 MTU/yr)

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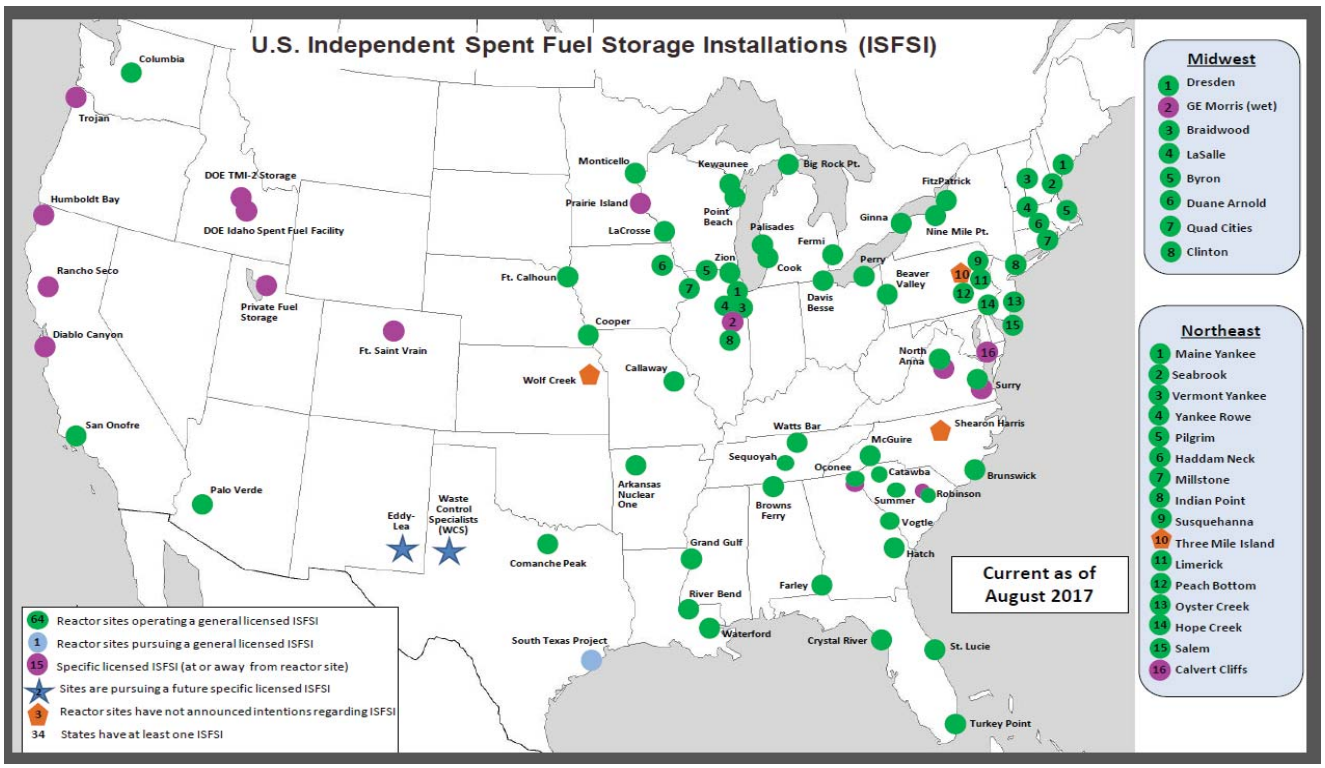
ISFSI Storage - Overview (2/2)



Dry Cask Storage Systems

Two general designs of dry cask storage systems

- Welded canister plus vertical storage cask ("overpack") or horizontal module
  - Canister typically fabricated of austenitic SS (wall thickness ≈0.5–1 in.)
  - Canister provides confinement; multi-pass closure weld gives redundant sealing
  - Fuel basket inside canister holds ≈24–37 PWR or 52–89 BWR fuel assemblies
  - Ventilated storage cask or module fabricated of concrete with an inner (and sometimes outer) steel liner and a wall thickness ≈30–36 in.
  - The HI-STAR 100 overpack is a sealed, unventilated steel overpack
  - Overpack/module provides structural support, physical protection, radiation shielding, and thermal inertia
- Bolted cask
  - Cask typically fabricated of ferritic alloy (wall thickness ≈9–17 in.)
  - Cask lid has redundant sealed, bolted lid with inter-seal helium monitoring
  - Fuel basket inside cask typically holds ≈32–40 PWR or 68 BWR fuel assemblies
  - Cask provides structural support, physical protection, radiation shielding (with added neutron absorber materials), and thermal inertia, with no need for a separate cask or module

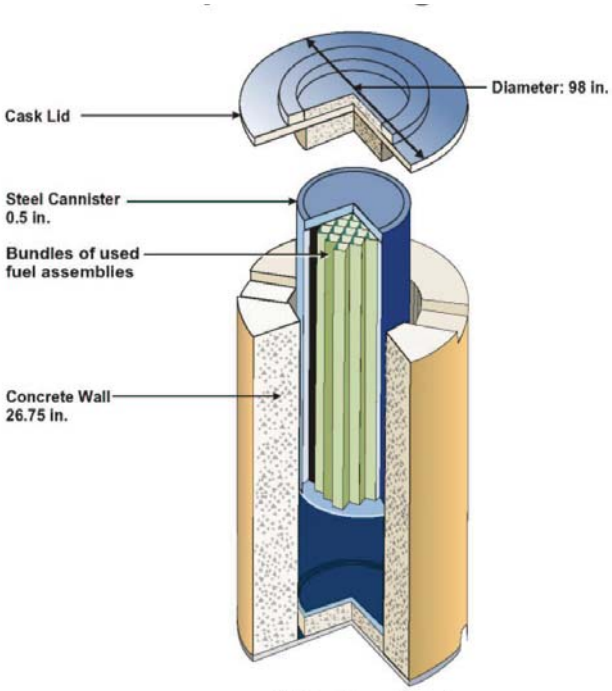
Dry Cask Storage Systems (DCSSs) in Use in the United States*

Vendor	System	Cask/Canister	Type [a]	Closure
EnergySolutions	FuelSolutions	VSC-24, W150	C/O	Welded
General Nuclear Systems, Inc.	CASTOR	V/21, X/33		Bolted
Holtec International	HI-STAR-100	MPC-68, MPC-80	C/O	Welded
	HI-STORM-100	MPC-24, MPC-32, MPC-68	C/O	Welded
	HI-STORM-FM	MPC-37, MPC-89	C/O	Welded
	UMAX	MPC-37, MPC-89	C/O	Welded
NAC International, Inc.	S/T	NAC-I28	Cask	Bolted
	MPC	MPC-26, MPC-36	C/O	Welded
	UMS	UMS-24	C/O	Welded
	MAGNASTOR	TSC-37P, TSC-87B	C/O	Welded
Areva TN	NUHOMS	52B, 61BT, 61BTH, 7P, 24P, 24PHB, 24PT, 24PTH, 24PT1, 32P, 32PT, 32PTH, 12T, HD	C/O	Welded
	TN Metal Casks	TN-24, TN-32, TN-40, TN-68	Cask	Bolted
Westinghouse	MC-10	MC-10	Cask	Bolted

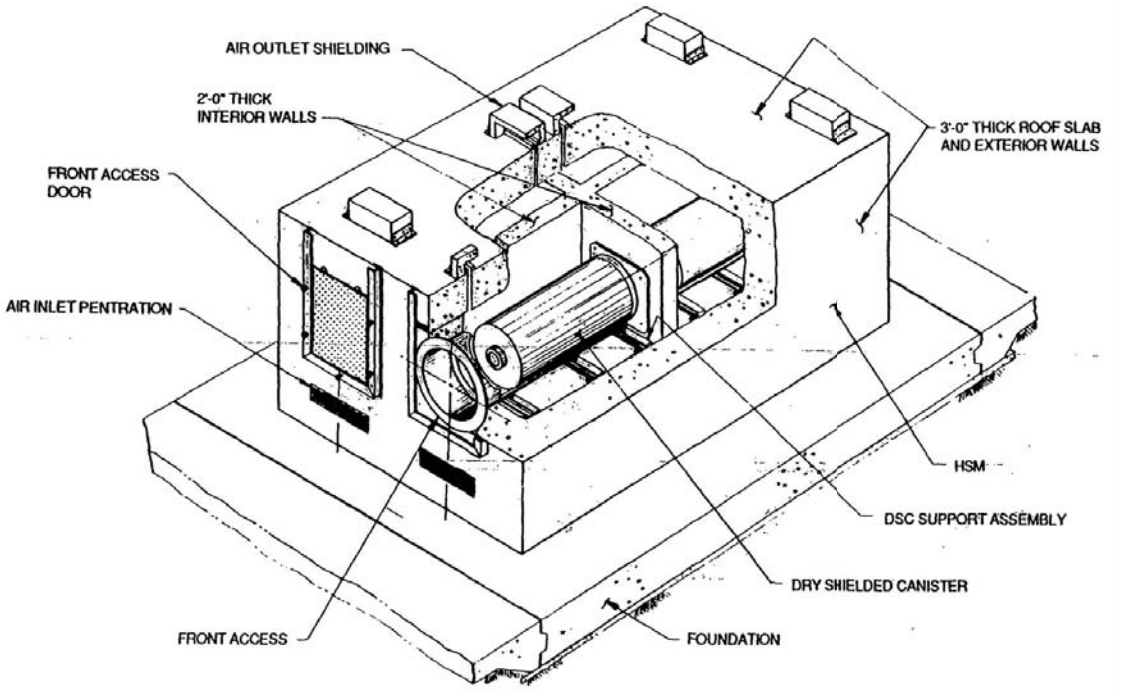
a: C/O = Canister plus Overpack, Cask = bare fuel cask

*__Source:__ Argonne Aging Management Report, Rev. 2 - *Chopra, O., D. Diercks, R. Fabian, Z. Han, and Y. Liu. "Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel." FCRD–UFD–2014–000476. ANL–13/15, Rev. 2. Washington, DC.: U.S. Department of Energy. 2014.* http://www.ipd.anl.gov/anlpubs/2014/09/107500.pdf

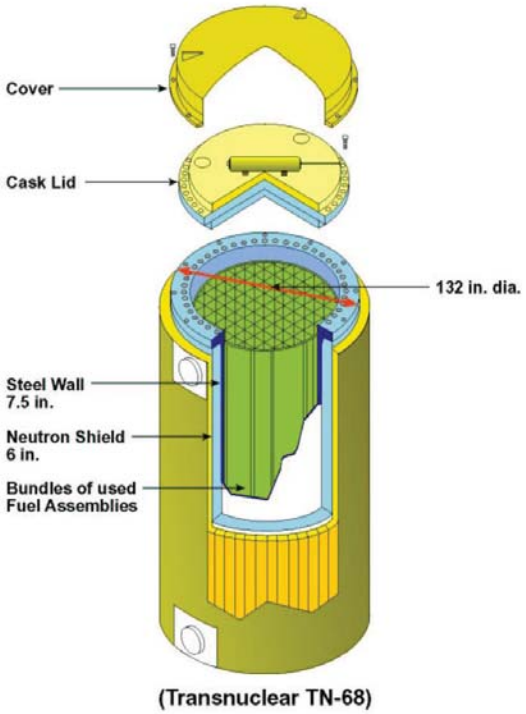
Holtec HI-STORM-100 System (Holtec)



TN NUHOMS Horizontal Modular Storage System



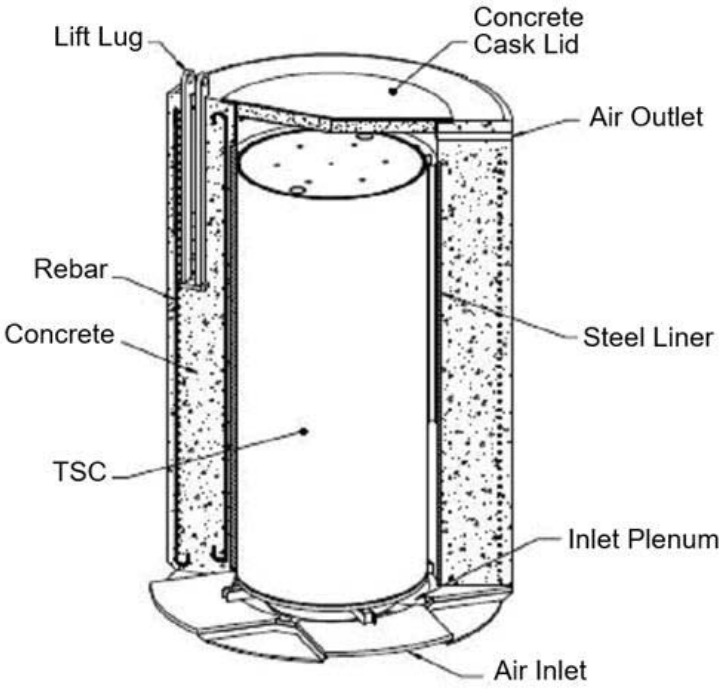
TN-68 Metal Spent-Fuel Storage Cask



(Transnuclear TN-68)

Overall Length: 178 in
Loaded Weight: 240,000 lbs.
Typical Payload: 68 BWR Bundles

NAC MAGNASTOR System



10 CFR 72 Licensing Term, License Renewal Requirements and License Renewal Process

Licensing Term

- As mandated in 10 CFR 72.42, the initial license term for an ISFSI must not exceed 40 years from the date of issuance. The initial license term was 20 years maximum until 2010; in 2010, this was changed to 40 years maximum.

- The license for an ISFSI may be renewed by the NRC at the expiration of the license term upon application by the licensee for a period not to exceed 40 years (also changed from 20 years in 2010). The license renewal process and the NRC review guidance are described in NUREG-1927, Rev. 1 (“Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel”).

Part 72 License Renewal (1/2)

- Specific license
  - 10 CFR 72.42(a) permits ISFSI specific license holders to apply for renewal of the license for up to 40 years
  - 10 CFR 72.42(c) states that, provided a license renewal application (LRA) is submitted at least 2 years before the expiration date, the license does not expire until the NRC makes a determination on the LRA—"timely renewal"
  - Eight specific ISFSI licenses have already been renewed:
    - Morris, Ft. St. Vrain, Surry, Robinson, Oconee, Calvert Cliffs, Prairie Island, and North Anna
  - Under NRC review:
    - TMI-2, Rancho Seco, Trojan

Part 72 License Renewal (2/2)

- General License
  - Part 72 general licenses are renewed via renewal of the cask CoC(s) being used at those ISFSIs
    - May be more than one cask design at the ISFSI
  - 10 CFR 72.240(a) permits the CoC holder to submit an application to renew the CoC for up to 40 years
  - If the CoC holder chooses not to submit a renewal application, other entities may do so:
    - Another licensee using that cask
    - A representative of a licensee
    - Another CoC holder
  - "Timely renewal" also applies if the CoC renewal application is submitted at least 30 days before expiration
  - Two CoCs renewed: VSC-24 and Standardized NUHOMS

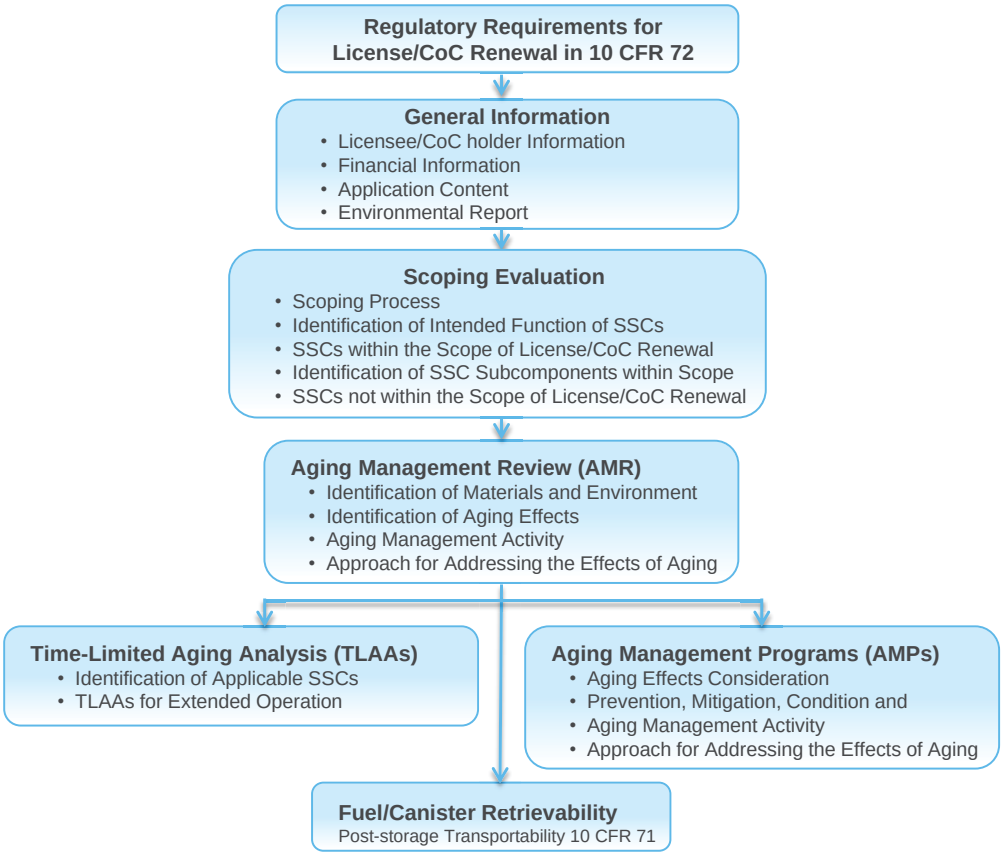
License/CoC Renewal Requirements and NUREG-1927, Rev. 1

- 10 CFR 72.42 and 72.240 state that application(s) for ISFSI license renewals must include: (1) **time-limited aging analyses (TLAAs)** that demonstrate that structures, systems, and components (SSCs) important to safety will continue to perform their intended function for the requested period of extended operation; and (2) description of the **aging management programs (AMPs)** for management of issues associated with aging that could adversely affect SSCs important to safety.

- License/CoC Renewal Applications (LRAs) are developed in accordance with NRC guidance documents, i.e. NUREG-1927, Rev. 1.

- The SRP provides licensees and CoC holders with a framework for license/CoC renewal submittals for efficient NRC review.

License and CoC Renewal Process (Adapted from NUREG-1927, Rev. 1)



Scoping Evaluation and Classification of SSCs in accordance with Importance to Safety (ITS)

- The scoping evaluation should identify SSCs of dry cask storage system (DCSS) in ISFSIs that should be reviewed for aging management activities (within the scope LR).
- SSCs within the scope of license renewal include those that are important to safety (ITS), i.e., those that:
  - Maintain the conditions required by the regulations, license, or CoC to store spent fuel safely
  - Prevent damage to the spent fuel during handling and storage
  - Provide reasonable assurance that spent fuel can be received, handled, packaged, stored, and retrieved without undue risk to the health and safety of the public
- In addition, SSCs not important to safety are within the scope of license renewal if their failure could affect the performance of SSCs that are important to safety.

Classification of SSCs in Accordance with ITS

- NUREG-1927 Rev. 1 defines six ITS functions of SSCs as follows:
  - CB: Confinement boundary (confinement)
  - CC: Criticality control (sub-criticality control)
  - HT: Heat transfer (heat-removal capability)
  - RS: Radiation shielding (radiation shielding)
  - SS: Structural support (structural integrity)
  - FR: Fuel retrievability (retrievability)
- NUREG/CR-6407 classifies transportation and dry storage system components according to ITS:
  - Category A: Failure directly results in a condition adversely affecting public health and safety
  - Category B: Failure indirectly results in a condition adversely affecting public health and safety
  - Category C: Failure would not significantly reduce the storage effectiveness

Aging Management Review (AMR) (1/3)

- The purpose of the aging management review (AMR) is to assess the proposed aging management activities (AMAs) for structures, systems, and components (SSCs) determined to be within the scope of renewal. The AMR addresses aging effects and mechanisms that could adversely affect the ability of the SSCs (and associated subcomponents) from performing their intended functions during the period of extended operation.
- AMR in the renewal application contains the following with adequate technical bases:
  - Identification of the intended function, materials, and operating environments for the SSCs and associated subcomponents determined to be within the scope of renewal,
  - Identification of aging effects and mechanisms requiring management, and
  - Identification of time-limited aging analyses (TLAAs), if applicable, and aging management programs (AMPs) required to manage the relevant aging effects.

Aging Management Review (2/3) – Materials and Service Environments

- AMR process includes the identification of the materials of construction and the service environments for each SSC or SCC subcomponent.
- Pertinent environmental data which has a direct bearing on aging and the proposed aging management approach may include:
  - Temperature
  - Wind
  - Relative humidity
  - Relevant atmospheric pollutants and deposits
  - Exposure to precipitation
  - Marine fog, salt, or water exposure
  - Radiation field (gamma or neutron)
  - Service environment (e.g., embedded, sheltered, or outdoor)
  - Gas compositions (e.g., external: air; internal: inert gas such as helium)

Aging Management Review (3/3) – Aging Effects and Mechanisms

- AMR process also includes the analysis and identification of aging effects and mechanisms of the SSCs within the scope of renewal.
- Examples of aging effects of SSCs and their mechanisms:

Aging Effects of SSCs	Possible Aging Mechanism
Concrete Structures:	
1. Scaling, cracking, and spalling	Freeze-thaw
2. Increase in porosity and permeability	Leaching of calcium hydroxide
3. Increase in porosity and permeability, cracking	Aggressive chemical attack
4. Expansion and cracking	Reaction with aggregates
5. Loss of strength and modulus	Elevated temperature
6. Loss of strength and modulus	Irradiation of concrete
7. Deformation	Creep
8. Cracking	Shrinkage
9. Loss of material	Corrosion
10. Loss of material	Abrasion and cavitation
11. Cracking	Restrain, shrinkage, creep and aggressive environment
12. Loss of strength	Concrete interaction with aluminum
13. Cathodic protection effect on bond strength	Cathodic protection current
Structural Steels:	
1. Loss of material	Corrosion local or atmospheric
2. Loss of strength and modulus	Elevated temperature
3. Loss of fracture toughness	Irradiation
4. Crack Initiation and growth	Stress-corrosion cracking
Reinforcing Steel (Rebar):	
1. Cracking, spalling, loss of bond and material	Corrosion of embedded steel
2. Loss of strength and modulus	Elevated temperature
3. Loss of strength and modulus	Irradiation
Miscellaneous:	
1. Cracking, distortion, increase in component stress	Settlement
2. Loss of fracture toughness	Strain aging (of carbon steel)
3. Reduction in design margin	Loss of prestress
4. Loss of Material	Corrosion of steel piles
5. Loss of Material	Corrosion of tendons
Cask Internals:	
1. Loss of material	Corrosion, boric-acid corrosion
2. Change in dimension	Creep
3. Wall thinning	Erosion corrosion
4. Crack initiation and growth	Stress-corrosion cracking
5. Loss of fracture toughness	Neutron irradiation embrittlement
6. Loss of preload	Stress relaxation
7. Loss of fracture toughness	Thermal embrittlement
8. Attrition	Wear
Zircaloy Cladding (Not in NUREG-1927)	
1. Embrittlement	Radial hydride reorientation (high-burnup fuel only)

TLAAs and AMPs

Time-Limited Aging Analysis (10 CFR 72.3) (1/3)

As defined in 10 CFR 72.3, a TLAA is defined as a licensee calculation or analysis that has all six of the following attributes:

1. Involves SSCs that are within the scope of license renewal and have a predetermined lifespan.
2. Considers the effects of aging.
3. Involves time-limited assumptions defined by the current operating term (for example, 40 years).
4. Was determined to be relevant by the licensee in making a safety determination.
5. Involves conclusions or provides the basis for conclusions related to the SSCs' capability to perform their intended functions. The TLAA must show either one of the following:
   - The analyses have been projected to the end of the period of extended operation.
   - The effects of aging on the intended function(s) of the SSC will be adequately managed (by an AMP) for the period of extended operation. Component replacement is an acceptable option for managing the TLAA.
6. Finally, a TLAA should be contained or incorporated by reference in the licensing basis.

Time-Limited Aging Analysis (10 CFR 72.3) (2/3)

Consider the sixth attribute of a TLAA (i.e., should be "contained or incorporated by reference in the licensing basis").

- The TLAA can be incorporated into the licensing basis through a number of documents, including:
  - The Safety Analysis Report (SAR) developed by the licensee,
  - The Safety Evaluation Report (SER) developed by the NRC,
  - Technical specifications,
  - Correspondence to and from NRC,
  - Quality assurance (QA) plan, and
  - Topical reports included as references in the SAR.

- For aging effects not anticipated in the original licensing basis, the NRC's "backfitting rule" (10 CFR 72.62) can be applied to modify the original licensing basis. This rule states that "The Commission will require backfitting of an ISFSI or MRS if it finds that such action is necessary to assure adequate protection to occupational or public health and safety, or to bring the ISFSI or MRS into compliance with a license or the rules or orders of the Commission, or into conformance with written commitments by a licensee" (10 CFR 72.62(b)).

Time-Limited Aging Analysis (3/3)

An identified TLAA shall be dispositioned by using one of the following methods:

- Demonstrate that the existing analysis remains valid for the period of extended operation, has already considered the requested period of extended operation, and concludes that the structure, system, or component (SSC) will continue to perform its intended function through the end of the requested period of extended operation.
- Revise or update the existing analysis to demonstrate that it has been projected to the end of the requested period of extended operation and concludes that the SSC will continue to perform its intended function through the end of the requested period of extended operation.
- Manage the effects of aging on the SSC for the requested period of extended operation through an aging management program.

Example TLAAs in ANL Aging Management Report Rev. 2

- Time-Limited Aging Analyses (TLAAs):
  - III.1: Identification of Time-Limited Aging Analyses
  - III.2: Fatigue of Metal and Concrete Structure and Components
  - III.3: Corrosion Analysis of Metal Components
  - III.4: Time-Dependent Degradation of Neutron-Absorbing Materials
  - III.5: Time-Dependent Degradation of Radiation-Shielding Materials
  - III.6: Environmental Qualification of Electrical Equipment
  - III.7: Other Site-Specific Time-Limited Aging Analyses

Fatigue of Metal and Concrete Structures and Components TLAA

- The fatigue analyses for the various components of dry storage systems are based upon established industry standards:
  - For metallic casks and canisters, applicable standard is ASME Code Section III, Division 1, Subsection NB-3200, which utilizes a calculated "cumulative usage factor" (CUF) and Miner's Rule (see next slide).
  - For concrete components, applicable standard is American Concrete Institute Standard ACI-215R-74, under which the maximum allowable cyclic stress for 10^6 cycles is conservatively taken to be 50% of the static failure load.
  - For steel support structures, applicable standard is American Institute of Steel Construction Standards ANSI/AISC N690-10 and N360-10, which apply only to high-cycle fatigue.
- Where the requirements set forth in these standards cannot be met, the licensee must develop a site-specific aging management program (AMP).

Fatigue TLAA Illustration (1/2)

- ASME Code Section III, Division 1, Subsection NB-3200, requires a fatigue analysis for all Class 1 components. A cumulative usage factor (CUF) is used to determine fatigue damage; crack initiation is predicted when the CUF = 1.
- Assume a situation in which, during the initial 20-year licensing period, a metallic component ITS is subject to 20 loading cycles at a stress amplitude for which 200 cycles would result in crack initiation (CUF = 20/200 or 0.10) plus 1,000 cycles at a lower stress amplitude for which crack initiation occurs at 20,000 cycles (CUF = 1,000/20,000 or 0.05). The total CUF for the initial 20-year operating period is therefore 0.10 + 0.05, or 0.15.
- During the subsequent 40-year period of extended operation, the licensee determines that this same component is subject to 40 additional loading cycles at the higher stress amplitude (CUF = 40/200, or 0.20) plus 2,000 cycles at the lower stress amplitude (CUF = 2,000/20,000 or 0.10). The total CUF for the period of extended operation is thus 0.30.
- These calculated CUFs are linearly added ("Miner's Rule") to obtain a cumulative CUF of 0.45 for the entire 60-year operating period (0.15 + 0.30).
- This TLAA has thus demonstrated that the CUF will remain below 1 during the 40 years of extended operation, and no further aging management is required.

Fatigue TLAA Illustration (2/2)

- A valid fatigue TLAA must include the following:
  - CUF calculations for ASME Code Class 1 components designed to ASME Section III requirements or to other codes that are based on a CUF calculation.
  - Maximum stress range values and associated numbers of loading cycles, as well as fabrication procedures and techniques employed to reduce susceptibility to fatigue failure for concrete components designed in accordance with the general guidance given in ACI 215R-74.
  - Maximum stress range values and associated numbers of loading cycles, as well as fabrication procedures and techniques employed to reduce susceptibility to fatigue failure for other steel support structures designed in conformance with Appendix 3 of ANSI/AISC 360-10.

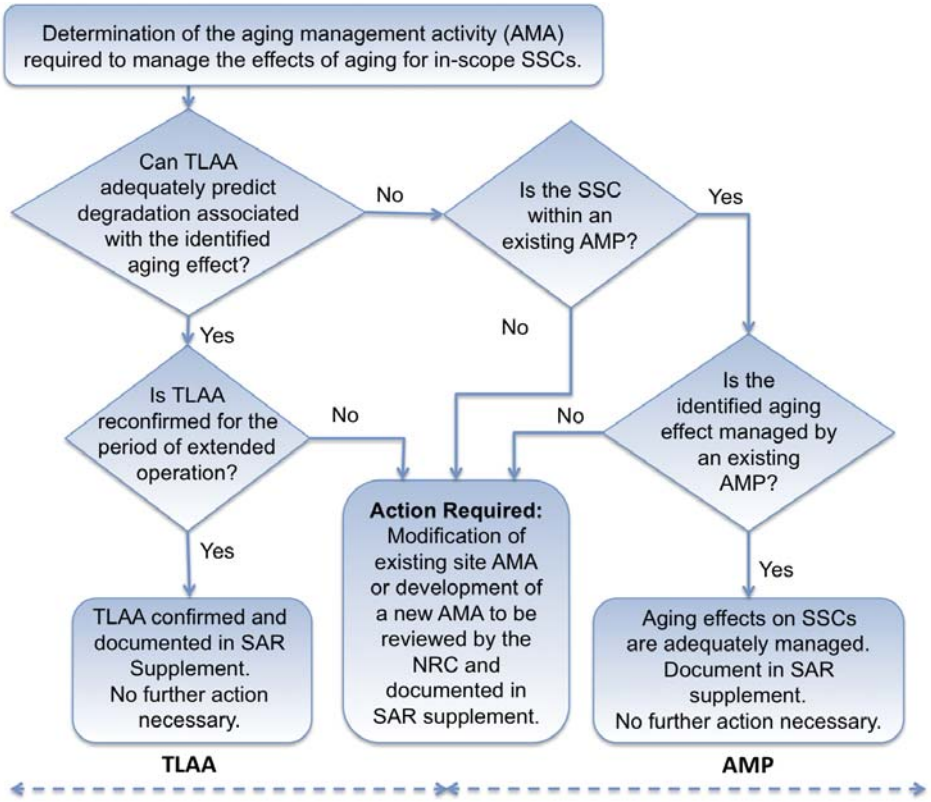
TLAA Summary

- A TLAA is a calculation or an analysis that demonstrates that a structure, system, or component that has a time-limited operating life will continue to perform its intended function for the period of extended operation.
- 10 CFR 72.3 defines the six attributes of a TLAA.
- For dry cask storage facilities, TLAAs may be used to assess fatigue life, loss of material due to corrosion, and time-dependent degradation of neutron-absorbing and radiation-shielding materials.
- A successful TLAA analysis typically eliminates the need for an ongoing aging management program to deal with a given degradation process, though periodic surveillance and monitoring may still be required to confirm the TLAA assumptions and conclusions.

Aging Management Programs

- For SSCs that do not have a time-limited operating life, an AMP must be developed to ensure that aging is being properly managed over the period of extended operation.
- To develop an AMP: (1) the material(s) of construction must be identified, (2) the operating conditions and environments anticipated during the period of extended operation must be understood in detail, and (3) the potential aging-related degradation processes must be identified.
- A typical AMP involves one or more of the following four types of activities: (1) prevention, (2) mitigation, (3) condition monitoring, and (4) performance monitoring.
- Each AMP has 10 elements, as follows: (1) scope of program, (2) preventive actions, (3) parameters monitored or inspected, (4) detection of aging effects, (5) monitoring and trending, (6) acceptance criteria, (7) corrective actions, (8) confirmation process, (9) administrative controls, and (10) operating experience.

Aging Management Review (AMR) - Summary



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Argonne NATIONAL LABORATORY

Tutorial TW-2-8: Aging Management for Spent Fuel Dry Storage and Subsequent Transportation

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Work sponsored by U.S. Department of Energy
Office of Packaging and Transportation

July 16, 2018

U.S. DEPARTMENT OF ENERGY

EM Environmental Management
safety · performance · cleanup · closure
DOE PACKAGING CERTIFICATION PROGRAM

Outline

- Aging Management Programs (AMPs)
- Examples of Aging Management Programs
- Aging Management Operating experience
- Monitoring and Inspection

Aging Management Programs

Aging Management Programs (AMPs) (1/3)

- AMPs monitor and control the degradation of SSCs within the scope of the renewal so that aging effects do not result in a loss of intended safety function during the period of extended storage.
- An AMP includes all activities that are credited for managing aging mechanisms or effects for specific SSCs, including activities conducted during the initial storage period.
- An effective AMP prevents, mitigates, or detects the aging effects and provides for the prediction of the extent of the effects of aging and timely implementation of corrective actions before there is a loss of intended function.
- AMPs should be informed, and enhanced when necessary, based on the ongoing review of both site-specific and industrywide operating experience, including relevant international and non-nuclear operating experience.
- An AMP typically includes one or more of the four approaches, e.g. prevention, mitigation, condition monitoring and performance monitoring, and should consist of 10 elements.

Aging Management Programs (2/3)

- Scope of program: the specific SSCs and subcomponents covered by the AMP and the intended functions to be maintained, in addition to stating the specific materials, environments, and aging mechanisms and effects to be managed.
- Preventive actions: actions used to prevent aging or mitigate the rates of aging for SSCs through the activities in the AMP.
- Parameters to be monitored or inspected: the specific parameters that will be monitored or inspected and a description of how those parameters will be capable of identifying degradation before a loss of intended function.
- Detection of aging effects: the inspection and monitoring details, including method or technique, frequency, sample size, data collection, and timing of inspections.
- Monitoring and trending: how data will be evaluated and trended to ensure timely corrective actions

Aging Management Programs (3/3)

- Acceptance criteria: against which the need for corrective action will be evaluated.
- Corrective actions: the measures to be taken when the acceptance criteria are not met, including root cause determination and prevention of recurrence, as appropriate.
- Confirmation process: processes in place to verify that preventive actions are adequate and that appropriate corrective actions have been completed and are effective.
- Administrative controls: processes in place that provide a formal review and approval process for activities related to the AMP (e.g., inspector requirements, instrument calibration).
- Operating experience: a review of operational experience that supports the determination that the AMP is capable of maintaining SSC functions in the period of extended operation.

Examples of Aging Management Programs

Example AMPs in ANL Aging Management Report Rev. 2 and NRC NUREG-2214 (MAPS)

Example AMPs in ANL Report (Chapter IV):

- IV.S1: Concrete Structures Monitoring Program
- IV.S2: Monitoring of Protective Coatings on Carbon Steel Structures
- IV.M1: External Surfaces Monitoring of Mechanical Components
- IV.M2: Ventilation System Surveillance Program
- IV.M3: Welded Canister Seal and Leakage Monitoring Program
- IV.M4: Bolted cask Seal and Leakage Monitoring Program
- IV.M5: Canister/Cask Internals Structural and Functional Integrity

Example AMPs in NUREG-2214 (Chapter 6):

- 6.5 Localized Corrosion and Stress Corrosion Cracking of Welded Stainless Steel Dry Storage Canisters
- 6.6 Reinforced Concrete Structures
- 6.7 External Surfaces Monitoring of Metallic Components
- 6.8 Ventilation Systems
- 6.9 Bolted Cask Seal Leakage Monitoring
- 6.10 Transfer Casks
- 6.11 High-Burnup Fuel Monitoring and Assessment

Ventilation System Surveillance AMP (1/3)

The objective of this program is to manage the loss of cooling capabilities of the ventilation systems of the dry cask storage system designs due to obstructions. The program is based on system inspections and walkdowns.

Program Elements:

1. ***Scope of Program:*** This program visually inspects and monitors the external surfaces of the components in the ventilation system, such as air inlets and outlets and other components, to ensure they are blockage-free. The inspection covers all accessible external surfaces of all the storage units at a site. Alternatively, the program may continuously monitor the temperatures at the inlet and outlet vents of all storage systems to detect anomalous changes in the system temperature.
2. ***Preventive Actions:*** The continuous monitoring of temperatures at the inlet and outlet vents or daily visual inspections and walkdowns verify that the inlet and outlet vents are free from obstruction and other aging effects, thereby ensuring that temperatures do not exceed the maximum allowable values defined in the facility's technical specifications. This measure prevents thermally induced damage to concrete components and overheating of the canister and fuel cladding.

Ventilation System Surveillance AMP (2/3)

3. ***Parameters Monitored or Inspected:*** The Ventilation System Surveillance Program utilizes continuous temperature monitoring of the inlet and outlet vents or daily system inspections and walkdowns to monitor ventilation system blockages.

4. ***Detection of Aging Effects:*** Using air vent temperature monitoring and/or visual inspections of the ventilation system, the program manages aging effects, including reductions in heat transfer capability due to blockages of the air inlet and outlet openings. Visual inspections are performed daily unless longer inspection intervals can be justified.

5. ***Monitoring and Trending:*** Visual inspections are performed daily, except as noted in program element 4 above, and associated personnel are qualified in accordance with site-controlled procedures and processes as prescribed in 10 CFR 72.158. Deficiencies are documented using approved processes and procedures, such that results can be trended.

Ventilation System Surveillance AMP (3/3)

6. ***Acceptance Criteria:*** For each component/aging-effect combination, the acceptance criteria are defined to ensure that the need for corrective actions will be identified before loss of intended functions. Any detected indications of relevant degradation should be evaluated for continued service in the corrective-action program.

7. ***Corrective Actions:*** Site QA procedures, review and approval processes, and administrative controls are implemented according to the requirements of 10 CFR 72, Appendix G.

8. ***Confirmation Process:*** See program element 7.

9. ***Administrative Controls:*** See program element 7.

10. ***Operating Experience***: The ventilation systems at ISFSIs are monitored by means of system inspections and walkdowns or temperature measurements of the inlet and outlet air. Such monitoring has been proven to be effective in maintaining the cooling capabilities of the DCSS designs with ventilation systems (see Oconee ISFSI License Renewal Application, ML081280084).

Quizzes (1/2)

Determine each of the following AMAs would be in support of an AMP or a TLAA:

- Periodic visual inspections of the accessible exterior surfaces of used fuel dry cask storage system concrete structures and structural components that are important to safety.

  Answer: AMP–condition monitoring

- Remote inspection of the interior surfaces of concrete horizontal storage modules by video camera or fiber optic technology.

  Answer: AMP–condition monitoring

- Avoiding the use of embedded aluminum in combination with steel in concrete to preclude accelerated corrosion effects.

  Answer: AMP–prevention

- Applying protective coatings to carbon and low-alloy steel components to retard general corrosion.

  Answer: AMP–mitigation

- Determining the maximum anticipated general corrosion rate for a carbon or low-alloy steel components during the 40-year period of extended operation.

  Answer: TLAA-corrosion

Quizzes (2/2)

- Visual inspections of the exterior surfaces of polymeric sealing materials for indications of surface cracking, crazing, dimensional change, discoloration, and hardening.

  Answer: AMP–condition monitoring

- Temperature monitoring at the outlet vents of concrete overpacks for indications of air-flow blockages.

  Answer: AMP–performance monitoring

- Counting or estimating an upper bound for the number of vibrational stress cycles to which a transport cask is subjected during a rail shipment.

  Answer: TLAA–fatigue analysis

- Measurement of temperature, gamma, and neutron dose rates at selected used fuel cask or canister locations to detect any deviations from established data trends that might indicate possible aging degradation of the internal fuel assemblies or the basket assembly.

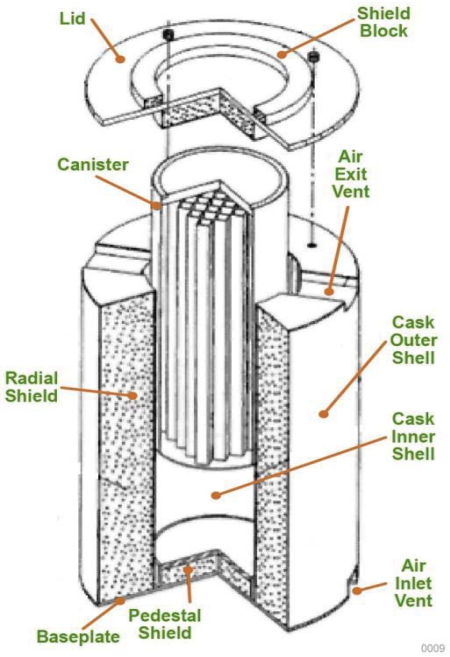
  Answer: AMP–performance monitoring

- Opportunistic replacement of the O-ring seals in bolted cask systems.

  Answer: AMP-prevention

HI-STORM 100 System

Diablo Canyon



V.2.A1 HI-STORM 100 System: Storage Overpack

Table V.2.A1 HI-STORM 100 System: Storage Overpack

Item	Structure and/or Component	Intended Function	Material	Environ	Aging Effect/ Mechanism	Aging Management Program (AMP)	Program Type
V.2.A1-4	Ventilation air openings: Air ducts, screens, gamma shield cross plates **(A)**	HT	Carbon or low-alloy steel	Air – inside the module, uncontrolled or Air – outdoor	Reduced heat convection capacity due to blockage	IV.M2, "Ventilation System Surveillance Program"	Generic program
V.2 A1-5	Anchor Studs (for anchored cask) **(A)**	SS	SA-193, SA-354, SA-479, SA-540, SA-564, SA-574, SA-638	Air – outdoor or marine environ (if applicable)	Loss of preload due to self-loosening; loss of material due to corrosion; cracking due to SCC	IV.M1, "External Surfaces Monitoring of Mechanical Components"	Generic program
V.2.A1-6	Anchor Studs (for anchored cask) **(A)**	SS	SA-193, SA-354, SA-479, SA-540, SA-564, SA-574, SA-638	Air – outdoor	Cumulative fatigue damage due to cyclic loading	Fatigue is a TLAA to be evaluated for the requested period of extended operation. See III.2 "Fatigue of Metal and Concrete Structures and Components" for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.	TLAA

V.2.B HI-STORM 100 or HI-STAR 100 System: MPC

Table V.2.B HI-STORM 100 or HI-STAR 100 System: Multipurpose Canister (MPC)

Item	Structure and/or Component	Intended Function	Material	Environ	Aging Effect/ Mechanism	Aging Management Program (AMP)	Program Type
V.2.B-1	MPC: Baseplate, shell, lid, port cover, closure ring, and associated welds; fuel basket and fuel spacer **(A)**	CB, CC, HT, SS, FR	Stainless steel: 304 SS, 304LN SS, 316 SS, 316LN SS	Air – inside the overpack, uncontrolled (external); Helium (internal)	Cumulative fatigue damage due to cyclic loading	Fatigue is a TLAA to be evaluated for the requested period of extended operation. See III.2, "Fatigue of Metal and Concrete Structures and Components," for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.	TLAA
V.2.B-2	MPC (access requires extra effort): Baseplate, shell, lid, closure ring, and associated welds; shield lid and bolting **(A)**	CB, CC, HT, SS, FR	Stainless steel: 304 SS, 304LN SS, 316 SS, 316LN SS	Air – inside the storage overpack, uncontrolled (external)	Cracking and leakage due to stress corrosion cracking when exposed to moisture and aggressive chemicals in the environment	IV.M1, "External Surfaces Monitoring of Mechanical Components" IV.M3, "Welded Canister Seal and Leakage Monitoring Program"	Generic Programs.
V.2.B-3	MPC Internals: Fuel basket, spacer, basket support; heat conduction elements; drain pipe, vent port; neutron absorber panels (in stainless steel sheathing) **(A)**	CC, CB, HT, SS, FR	Stainless steel, aluminum alloy, borated aluminum or boron carbide /aluminum alloy plate or BORAL composite	Helium, radiation, and elevated temperature	Degradation of heat transfer, criticality control, radiation shield, confinement boundary, or structural support functions of the MPC internals due to extended exposure to high temperature and radiation.	IV.M5, "Canister/Cask Internals Structural and Functional Integrity Monitoring Program" Degradation of neutron-absorbing materials is a TLAA to be evaluated for the requested period of extended operation. See III.4, "Time-Dependent Degradation of Neutron-Absorbing Materials," for acceptable methods for meeting the acceptance criteria in Section 3.5.1 of NUREG-1927.	Generic program TLAA

Aging Management Operating Experience

Evolution of Cask Designs

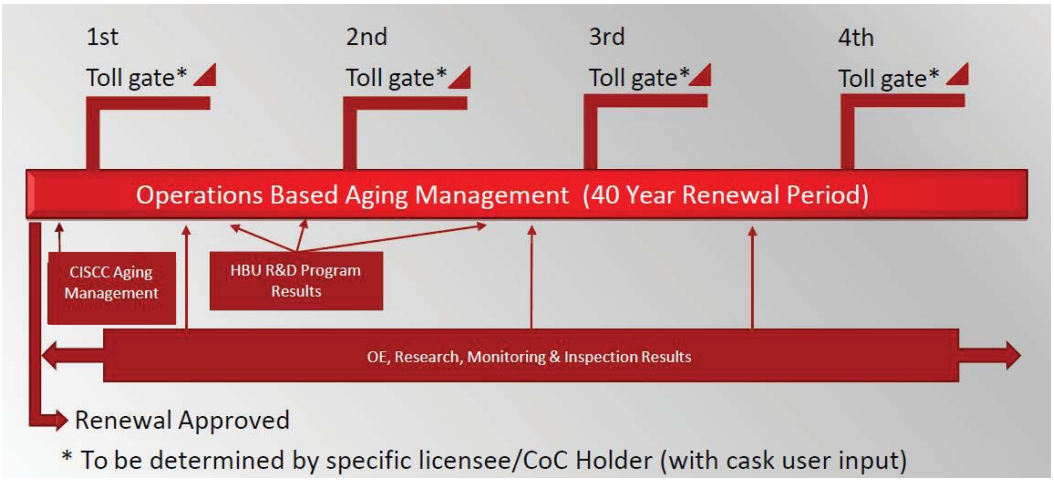
- First storage cask designs were bolted lid, bare fuel casks (BFCs), with no internal canister
  - Storage-only, relatively easy to return to spent fuel pool and repackage
  - Spent fuel being stored was low-burnup (≤45 GWd/MTU); research data were available on cladding condition after storage
  - For BFCs, the confinement boundary and external surfaces are easily inspected
  - Fuel cavity and contents did not require inspection due to helium environment
- Canister-based systems became the norm mid-1990s
  - Stainless steel canister is the confinement boundary
  - Placed inside ventilated overpack or module
  - Canister exterior surface subjected to ambient environment—chlorides, other contaminants
  - In-situ canisters inaccessible to personnel due to small clearances and high radiation fields
- Burnups of spent fuel being stored eventually went beyond the research data (>45 GWd/MTU, high burnup [HBU])
- Larger capacity, higher heat load brings focus to HBU fuel cladding issues

Regulatory Landscape

- NRC remained confident of 20 years initial service without inspections for canister-based systems
  - Low-burnup fuel in a helium environment
  - Early renewed licenses did not require canister inspections
- Unique technical issues arose pertaining to HBU fuel cladding integrity after time in dry storage
  - Hydride reorientation, embrittlement
- Chloride-induced stress corrosion cracking (CISCC) also became a regulatory concern for storage periods beyond 20 years
- Landscape for renewing ISFSI licenses (and subsequently CoCs) changed significantly
- NRC coined the phrase “learning aging management”:
  - Approved aging management program (AMP) should be periodically evaluated for effectiveness and modified accordingly
  - Use cask aging management operating experience (OPEX) and other inputs to continually (or periodically) evaluate the effectiveness of AMPs
  - Little cask OPEX exists for material degradation
  - OPEX for cask materials used in other applications does exist

Tollgates and Tollgate Assessments

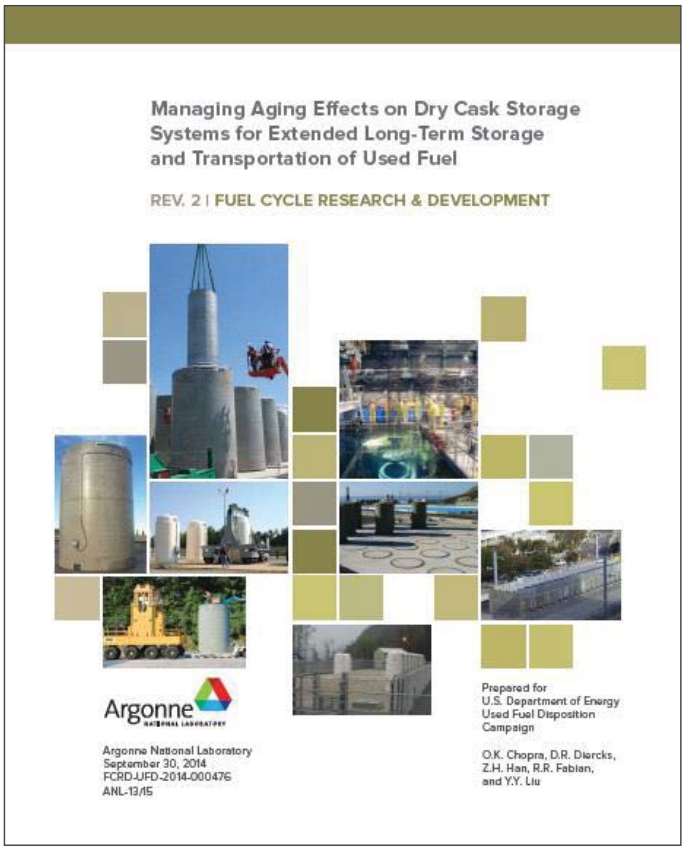
- “Tollgate” mentioned in both NEI 14-03, Rev. 1 and NUREG-1927, Rev. 1 is a structured approach for assessing operating experience and data from applicable research and industry initiatives.
- Tollgates are points in time in the period of extended operation (PEO) at an ISFSI when licensees perform tollgate assessments.
- Tollgate assessments document an integrated look at relevant information and determine whether any AMPs should modified or augmented
- OPEX plus inspections, monitoring, and research results



Aging Management Guidance

- In June 2012, Argonne National Laboratory published a report developed for the DOE Used Fuel Disposition Campaign entitled *Managing Aging Effects on Dry Cask Storage Systems for Extended Long-Term Storage and Transportation of Used Fuel* (FCRD-USED-2012-000119). Updates were subsequently published in September 2013 (Rev. 1; FCRD-UFD-2013-000294) and September 2014 (Rev. 2; FCRD-UFD-2014-000476).
- In September 2014, the Nuclear Energy Institute published NEI 14-03 (*Guidance for Operations-Based Aging Management for Dry Cask Storage*), which addresses the preparation of ISFSI license renewal applications and includes specific guidance on aging management.
- In June 2016, the NRC published an updated version of NUREG-1927 (*Standard Review Plan for Renewal of Specific Licenses and Certificates of Compliance for Dry Storage of Spent Nuclear Fuel*) that includes three sample aging management programs.
- The NRC is currently developing a detailed guidance document on aging management entitled *Managing Aging Processes in Storage (MAPS) Report (NUREG-2214)* that includes a comprehensive set of suggested AMPs and TLAAs for license renewal. A draft of the report was released for public comment in August 2016.

ANL Aging Management Report Rev. 2



http://www.ipd.anl.gov/anlpubs/2014/09/107500.pdf

Inspection and Monitoring

Spent Fuel Cask Inspection (1/2)

- In-service inspection has not been required for spent fuel storage casks because they were only expected to be in service for 20 years
- Age-related degradation was considered not applicable originally
  - Low pressures and temperatures
  - Insignificant cyclic fatigue
  - Stainless steel material used for confinement boundary
- Cask licenses and CoCs are now being renewed for 20 or 40 more years of service and must address age-related degradation
- Challenges include inspections of canisters with no predesigned access for inspections and very high radiation fields

Spent Fuel Cask Inspection (2/2)

- Late 2014: NRC requested and ASME agreed to develop a Code Case under Section XI to establish rules for canister inspections during the period of extended operation (after 20 years)
- ASME agreed and commissioned a Section XI Task Group (TG) to develop a Code Case N860 for inspection techniques, acceptance criteria, flaw evaluation, and repair for metallic storage and transportation containment systems that are in continuous service
- Intent is to permit the NRC to remove specific inspection requirements from renewed ISFSI licenses and CoCs and refer to the Code Case
  - This is consistent with NRC's mandate to use consensus codes and standards wherever possible

Scope of Code Case N-860 (1/2)

- ASME Section XI created a Task Group (TG) to develop the DSS inspection Code Case composed of participants from the non-destructive examination (NDE) field, Electric Power Research Institute (EPRI), industry, and NRC
- The charter for the TG is as follows, in part:

  "The Task Group is responsible for developing and proposing Code revisions and Code Cases for Inservice Inspection of spent nuclear fuel storage and transportation containment systems for Section XI, Division 1 of the ASME Boiler and Pressure Vessel Code..."
- "Storage and transportation containment vessels" means:
  - The cask body, lid, bolts, and lid seals for bare fuel casks (BFCs) used for storage
  - The canister pressure boundary for canister-based DSS
  - The cask body, lid, bolts, and lid seals for all transportation casks

Scope of Code Case N-860 (2/2)

- The inspections are intended to be applied to canisters and casks already in service during the period of extended operation (PEO), not during the initial term of service as part of aging management programs (AMPs)
- For new canisters, optional preservice inspection rules are given to provide baseline data that are not available for inservice canisters
- Applies to accessible, exterior, metallic portions of BFCs and canisters providing the containment boundary for the contents
- The TG is choosing to address stainless-steel canisters first because of the susceptibility to chloride-induced stress corrosion cracking (CISCC)
- The Code Case will evolve over time to include BFCs
- Too few carbon steel canisters are in service, none are being added, and all will soon be under license- or CoC-specific aging management programs

Monitoring (1/2)

10 CFR 72.44 (b)(6)(ii)(c)

(1) *Functional and operating limits and monitoring instruments and limiting control settings*.
- Functional and operating limits for an ISFSI or MRS are limits on fuel or waste handling and storage conditions that are found to be necessary to protect the integrity of the stored fuel or waste container, to protect employees against occupational exposures and to guard against the uncontrolled release of radioactive materials; and
- Monitoring instruments and limiting control settings for an ISFSI or MRS are those related to fuel or waste handling and storage conditions having significant safety functions.

(2) *Limiting conditions*. Limiting conditions are the lowest functional capability or performance levels of equipment required for safe operation.

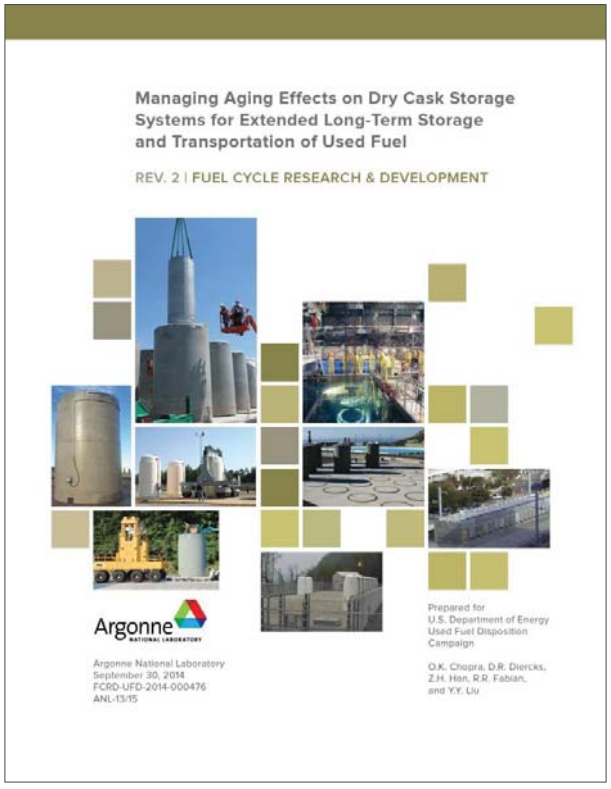
(3) *Surveillance requirements*. Surveillance requirements include:
- Inspection and monitoring of spent fuel, high-level radioactive waste, or reactor-related GTCC waste in storage;
- inspection, test and calibration activities to ensure that the necessary integrity of required systems and components is maintained;
- confirmation that operation of the ISFSI or MRS is within the required functional and operating limits; and
- confirmation that the limiting conditions required for safe storage are met.

Monitoring (2/2)

10 CFR 72.122 (h) *Confinement Barriers and Systems*:

- Storage confinement systems must have the capability for continuous monitoring in a manner such that the licensee will be able to determine when corrective action needs to be taken to maintain safe storage conditions.
- For dry spent fuel storage, periodic monitoring is sufficient, provided that periodic monitoring is consistent with the dry spent fuel storage cask design requirements.
- The monitoring period must be based upon the spent fuel storage cask design requirements.
- Condition monitoring and performance monitoring Aging Management Programs

Generic AMPs in Argonne Rev. 2 Report



S1: Concrete Structures **Monitoring** Program

S2: **Monitoring** of Protective Coatings on Carbon Steel Structures

M1: External Surfaces **Monitoring** of Mechanical Components

M2: Ventilation System **Surveillance** Program

M3: Welded Canister Seal and Leakage **Monitoring** Program

M4: Bolted Cask Seal and Leakage **Monitoring** Program

M5: Canister/Cask Internals Structure and Functional Integrity **Monitoring** Program

Available at http://www.osti.gov/scitech/biblio/1159908

Temporary Instruction 2690/011 (01/30/2018): Review of AMPs at ISFSIs

- NRC has developed Temporary Instruction (TI) 2690/011 for review of AMPs at ISFSIs. The purpose of this TI is to verify, **through inspection**, whether licensees have adequate processes or procedures planned or in place to implement AMPs provided in the renewed license or CoC.

Summary (1/2)

- Currently in United States, the spent nuclear fuel will be placed in storage in dry casks made of steel and concrete (aka dry-type ISFSI) after sufficient cooling in spent fuel pools. These casks are stored outdoors on concrete pads and cooled by natural convection.
- The license for an ISFSI may be renewed by the US NRC at the expiration of the license term upon application by the licensee for a period not to exceed 40 years, and 10 CFR 72.42 and 72.420 state that applications for ISFSI license renewal must include: (1) time-limited aging analyses (TLAAs) that demonstrate that structures, systems, and components (SSCs) important to safety will continue to perform their intended function for the requested period of extended operation; and (2) description of the aging management programs (AMPs) for management of issues associated with aging that could adversely affect SSCs important to safety.
- For a TLAA is not applicable to demonstrate a SSC will continue to perform its intended function for the requested license renewal period, an AMP must be developed to ensure that aging is being properly managed over the period of extended operation.
- NRC NUREG-1927 Rev. 1 and NEI 14-03 provide licensees and CoC holders guidance evaluation of the aging effects and mechanisms and exemplary generic TLAAs and AMPs that may be used for license/CoC renewal.

Summary (2/2)

- The US NRC and the industry are implementing learning aging management, to periodically evaluate and improve the effectiveness of the approved AMPs through aging management operating experience and other obtained inputs early detection of aging effects on important-to-safety SSCs is key to aging management, and inspection and monitoring of dry cask storage systems is codified in regulations, with guidance provided by NRC based on ASME Section IX (Code Case N 860 for dry cask storage and transportation containments).
- Early detection of aging effects on important-to-safety structures, systems, and components is key to aging management
- NRC developed Temporary Instruction (TI 2690/011) for AMP reviews of ISFSIs. The objective of TI is to verify, through inspection, the adequacy of licensee's implementation of AMPs.
- Argonne has developed ARG-US RAMM - Remote Area Modular Monitoring System—for "continuous" monitoring of helium integrity inside welded canisters of vertically oriented dry storage casks*

* Monitoring Helium Integrity in Welded Canisters," Y.Y. Liu et al., ASME 2015 Pressure Vessels and Piping Conference (PVP2015), Boston, MA, July 19–23, 2015.

Types of Radioactive Waste (1/3)

- 10 CFR 72 only governs spent fuel, HLW, and GTCC storage
- Low-level waste (LLW) storage is governed by the license for the facility (e.g., Parts 30, 40, 50, 70)
- LLW disposal is governed by 10 CFR 61
  - Includes radioactively contaminated protective clothing, tools, filters, rags, medical tubes, etc.
  - Further divided into classes based on the types and concentrations of radionuclides present, physical form, and stability criteria (10 CFR 61.55)
    - A (decays to background in 100 years),
    - B (300 years), and
    - C (500 years)
  - LLW is generally acceptable for near-surface disposal at three licensed facilities:
    - EnergySolutions Barnwell Operations (Barnwell, SC),
    - U.S. Ecology, (Richland, WA),
    - Waste Control Specialists (Andrews, TX).
  - EnergySolutions Clive Operations (Clive, UT) accepts Class A LLW waste only

Types of Radioactive Waste (2/3)

- Mill tailings waste
  - Residues from processing natural ore to extract uranium and thorium
  - Most disposed of in place or near the mill
  - Barrier needed to prevent radon release and cover mill tailings pile to prevent erosion
- Greater than Class C (GTCC) LLW
  - Activated metals and other contaminated debris with radionuclide concentrations and/or half-lives exceeding NRC limits for Class C LLW
    - Reactor internals subject to high neutron flux
    - No disposal facilities currently licensed for GTCC waste
    - 10 CFR 72 permits storage of GTCC waste in ISFSIs under specific licenses
    - Part 72 CoCs do not address GTCC

Types of Radioactive Waste (3/3)

- High-level waste (HLW)—10 CFR 72.3 definition
  1. Liquid and solid radioactive material produced or derived from reprocessing spent fuel containing fission products in “sufficient concentrations”
  2. Other highly radioactive material the NRC determines requires permanent isolation
- HLW may not be disposed of in near-surface facilities
- HLW is not permitted for storage at an ISFSI
- HLW may be stored by only DOE at an MRS
- No HLW has yet been disposed of; it remains in storage at DOE facilities

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