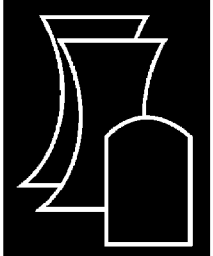
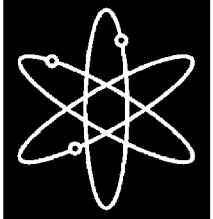
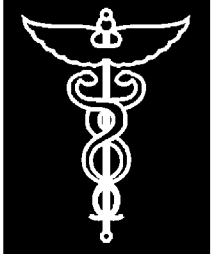
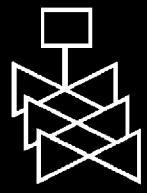
NUREG/CR-6903, Vol. 1
INL/EXT-06-11528









Human Event Repository and Analysis (HERA) System, Overview

Idaho National Laboratory

U.S. Nuclear Regulatory Commission
Office of Nuclear Regulatory Research
Washington, DC 20555-0001

NUREG/CR-6903, Vol. 1
INL/EXT-06-11528

Human Event Repository and Analysis (HERA) System, Overview

Manuscript Completed: June 2006
Date Published: July 2006

Prepared by
B. Hallbert [1], R. Boring[1], D. Gertman[1], D. Dudenhoeffer[1],
A. Whaley[1], J. Marble[1], J. Joe[1]
E. Lois[2]

[1] Idaho National Laboratory
Battelle Energy Alliance
Idaho Falls, ID 93415

E. Lois, NRC Project Manager

Prepared for
[2]Division of Risk Assessment and Special Projects
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001
NRC Job Code Y6496

ABSTRACT

The Idaho National Laboratory (INL), sponsored by the Nuclear Regulatory Commission, has developed a repository entitled Human Event Repository and Analysis (HERA). The objective of HERA is to make available empirical and experimental human performance data, from commercial nuclear power plants (NPPs) and other related technologies, in a content and format suitable to human reliability analysis (HRA) and human factors practitioners. This Volume 1 of NUREG/CR-6903, discusses the need for a systematic collection of human performance data on the basis of current regulatory HRA and human factors applications, describes the taxonomy and structure of the data in HERA, and presents examples of information extraction and coding.

This page intentionally left blank.

FOREWORD

The U.S. Nuclear Regulatory Commission (NRC), with the support of the Idaho National Laboratory, is developing a database of human events called the Human Event Repository and Analysis (HERA) system. The objective of HERA is to make available empirical and experimental human performance data, from commercial nuclear power plants (NPPs) and other related technologies, in a content and format suitable to human reliability analysis (HRA) practitioners.

The HERA project supports the NRC's "Action Plan–Stabilizing the PRA Quality Expectation and Requirements," SECY-04-0118. Practitioners have viewed HRA as contributing to the uncertainties of probabilistic risk assessment (PRA) results, primarily due to lack of quality data to support evaluations of human events under the conditions modeled in PRAs. The NRC stated in SECY-04-0118 that "such a repository will mark a significant step towards addressing the issue of quality of data for HRA, viewed by practitioners as a significant limitation of the HRA state-of-the-art."

This report, NUREG/CR-6903, Volume 1, "HERA Overview," builds a technical basis for this effort, by (a) providing a historical perspective on the use (or non-use) of data in HRA, (b) presenting examples of successful data uses in HRA (e.g., the development of the ATHEANA method on the basis of historical experience), and (c) presenting the current thinking on the use of information from various sources to enhance the analyst's ability to understand the drivers of human failure and to estimate probabilities. HERA will (a) help identify the operant performance shaping factors (PSFs) or other elements of context that will most significantly affect human performance for the plant conditions and specific actions modeled in PRA/HRA and (b) provide a quantitative measurement, or at least semi-quantitative insight, as to the effect of these contextual elements reflected in the human error probability estimates coming from HRA methods.

Specifically, this volume provides a detailed description of the event data, the sources of that data, the information extraction processes, and the format and structure of that data. This volume focuses on data from NPP operational events and simulator studies. The extraction of data from other technologies — such as chemical, military, aerospace, aviation, and the behavioral sciences — will be provided in future updates. Furthermore, detailed information on the definitions underlying the data structures, the process and quality assurance of coding HERA events, and the software implementation of HERA will be documented in Volume 2 of NUREG/CR-6903.

Beyond supporting HRA applications, HERA also will support analysts who seek to understand how context, work processes, and other determinants interact to produce the observable behavior that is part and parcel of nuclear power plant activities. In particular, HERA may inform human factors by (a) providing human performance data to support modeling and theory, (b) providing information appropriate for the design of a safe workplace, and (c) documenting cognitive and contextual factors that enhance or limit optimal performance.

Brian W. Sheron, Director
Office of Nuclear Regulatory Research

This page intentionally left blank.

CONTENTS

FIGURES

TABLES

ACKNOWLEDGEMENTS

This report documents efforts by the Idaho National Laboratory to develop the Human Event Repository and Analysis system (HERA). During its development a number of people have made significant technical contributions and suggestions to improve the quality of this effort and have helped us understand better the need and applications of the resulting system. For their efforts we gratefully acknowledge James Bongarra, Susan Cooper, Claire Goodman, Gareth Parry, Julius Persensky, June Cai, Ben Parks, Pat O'Reilly , and Autumn Szabo from the NRC; Theresa Flores, Patrick McCabe, Heather Medema, Larry Blackwood, Alan Kolaczkowski, Dennis Bley, and John Forrester, from the national laboratory and consultant sectors; Karin Laumann, Andreas Bye, and Per Oivind Braarud from Halden Reactor Project; Ali Mosleh and James Chang from the University of Maryland; and Kristen Shepherd, Scott Levin, Sankaran Mahadevan, and Candice Griffith, from Vanderbilt University.

This page intentionally left blank.

ACRONYMS

AIT	Augmented Inspection Team
AITs	Augmented Inspection Team reports
ASEP	Accident Sequence Evaluation Program
ASP	Accident Sequence Precursor
ATHEANA	A Technique for Human Error Analysis
BOP	balance of plant
BWR	boiling water reactor
CAPs	Contextually Anchored Probabilities
CAHR	Connectionism Approach for Assessing the Reliability of Human Actions
CBDT	Cause Based Decision Tree
CCFs	common cause failures
CCDP	conditional core damage probability
CCDPHE	portion of CCDP due to human error
CI	contextual information subevent
CPC	common performance conditions
CREAM	Cognitive Reliability and Error Analysis Method
EDGs	emergency diesel generators
EFC	error forcing contexts
EQA	successful equipment actuation/operation subevent
ES	engineered safeguards
HAMMLAB	Halden Man-Machine Laboratory
HCR	Human Cognitive Reliability method
HEART	Human Error Analysis and Reduction Technique
HEP	human error probability
HERA	Human Event Repository and Analysis
HFEs	human failure events
HFIS	Human Factors Information System
HMI	human machine interface
HRA	human reliability analysis
HS	successful human action subevent
IAEA	International Atomic Energy Agency
INL	Idaho National Laboratory
LER	Licensee Event Report
MERMOS	French safety analysis stressing the human factors safety mission
MFR	mean failure rate
MSIVs	main steam isolation valve
NPP	nuclear power plant
NRC	Nuclear Regulatory Commission
NSSS	nuclear steam supply system
NUREG	Nuclear Regulatory Commission Report
NUREG/CR	Nuclear Regulatory Commission Contractor Report
OECD	Organization for Economic Cooperation and Development
PRA	probabilistic risk assessment
PS	plant state subevent
PSA	probabilistic safety assessment
PSF	performance shaping factor
psig	pounds per square inch, gauge
PTS	pressurized thermal shock

RCIC	reactor core isolation cooling
RCS	reactor coolant system
RTP	rated thermal power
SGTR	steam generator tube rupture
SPAR-H	The Standardized Plant Analysis Risk-Human Reliability Analysis
SRV	safety relief valve
THERP	Technique for Human Error Rate Prediction
UAs	unsafe acts
XHE	human failure subevent
XEQ	equipment failure subevent

1 HERA OVERVIEW

1.1 Introduction

Pursuing its risk-informed regulatory framework, the Nuclear Regulatory Commission (NRC) published Regulatory Guide 1.200, "An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities," February 2004, and developed an "Action Plan–Stabilizing the PRA Quality Expectation and Requirements," SECY-04-0118, for addressing probabilistic risk assessment (PRA) quality issues. Among the technical issues recognized as needing to be addressed, are issues associated with human reliability analysis (HRA) and in particular the development of a tool entitled *Human Event and Repository Analysis (HERA*) system for both human factors and HRA applications. It is stated in SECY-04-0118 that the development of the HERA system "encompasses the development of a database structure and the collection of information from operational events or other sources suitable for HRA. Such a repository will mark a significant step toward addressing the issue of quality of data for HRA, viewed by practitioners as a significant limitation of the HRA state-of-the-art."

This volume of the multi-volume HERA report provides an overview of HERA and addresses how the HERA database may address information needs within both the HRA and human factors communities.

The Human Event Repository and Analysis (HERA) system constitutes a data analysis method, structure, and accompanying software database for recording human performance and reliability data that are relevant to nuclear power plants (NPPs). HERA accommodates both empirical data obtained from plant operations (e.g., event reports) and experimental data obtained from NPP operator studies and related research. HERA analysts analyze these raw data sources to identify a chronological progression of human actions, inactions, and interactions within the plant. Once identified, each action or inaction is individually analyzed according to the HERA analysis and encoding method to indicate how it significantly contributes to the sequence of activities identified within the total event. The HERA database includes both the original source materials and the analysts' identification of factors that influenced human performance. Ultimately, the information in HERA may be used to support qualitative analyses of human performance in realistic operational settings as well as to support activities related to estimation of quantitative HRA and PRA model parameters.

1.1.1 Compatibility with HRA

HERA can be readily understood within the classic framework of HRA. HRA serves a three-fold goal (Gertman and Blackman, 1994) to:

- *Identify* sources of human error and human failure modes to be included as human failure events (HFEs) in a PRA framework or model,
- *Develop* models in the PRA representing the specific HFEs of interest, and
- *Quantify* the human error probability (HEP) associated with each HFE including understanding the factors that may most influence the HEP estimate.

HERA likewise serves this goal, as depicted in Figure 1.1 and explained below:

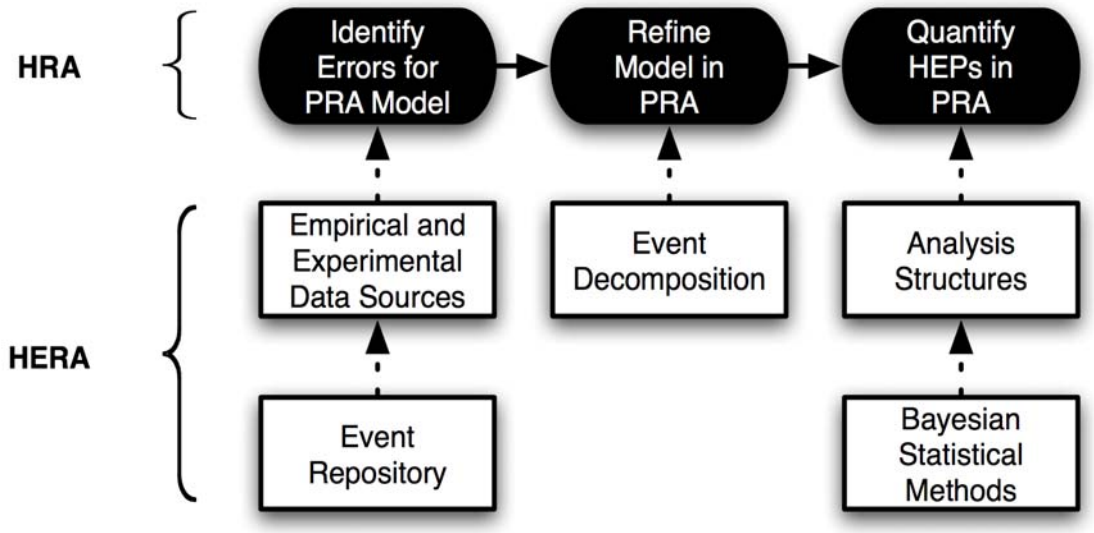


Figure 1.1 The match of HERA to the goals of HRA.

- *Identify Error Sources.* HERA provides a basis for selecting empirical and experimental data sources of human performance that is relevant to NPPs. Empirical data sources include operations and event reports, while experimental data include human performance studies such as those conducted in control room simulators. Once these sources have been selected, the HERA software database serves as a repository for these sources by capturing the source materials catalogued according to searchable plant and human performance parameters.
- *Refine Human Failure Modeling in the PRA.* HERA provides a formal method for decomposing events into a series of subevents related to plant systems or the personnel at the plant. This decomposition of events into subevents can facilitate the proper incorporation of hardware and human contributions to the evolution of an event in the PRA.
- *Quantify the HEPs*. For each human subevent, HERA provides a detailed analysis structure including information about the performance shaping factors (PSFs) that contributed to the observed human performance. The PSFs in HERA parallel those used in many HRA methods. Hence, the information provided in HERA about what PSFs are most relevant and contribute to human errors in certain contexts, should be useful to how we model the relationships between PSFs and the final HEP estimations produced by specific HRA methods. In addition, since HERA provides the opportunity to search and compare related human events, it makes it possible to use Bayesian statistical methods to update estimated HEPs based on empirical or experimental evidence.

1.1.2 Summary of HERA Content

With the above HRA relationships in mind, HERA consists of an analysis method, supporting worksheets, and a database, to support compiling, interpreting, and documenting experience relevant to NPP operations. The documentation is specifically designed to be of a content and form useful to the variety of HRA methods and the general discipline of human factors. While it is recognized that information sources covering experiential information are often incomplete or censored, such data are nevertheless of value in striving to improve the credibility and validity of human performance evaluations in NPP applications. This is particularly important since the

weakness of data available for HRA is one of the major concerns expressed by practitioners and decision makers. The validity of HEP estimates and the development and validation of human performance models used in HRA stand on the footing of the data at their disposal.

Recognizing the many differences between HRA methods, including types of inferences and explanations of human behavior, a goal of the HERA system since its inception has been to provide information designed to be of value to most methods. The sources of information include both raw, unprocessed information of source documents and additional information related to underlying human performance mechanisms in terms that can be applied directly or easily transformed to support implementation of a variety of HRA methods. The taxonomy and structure of HERA is, thus, designed to accept a variety of activities and to support numerous HRA method implementations.

.

HERA is designed to contain information from such sources as simulator experience, controlled experiments, as well as actual NPP events as those reported, for instance, in licensee event reports (LERs). Initially, the focus of HERA's content will be the latter item, LERs, and related Augmented Inspection Team (AIT) reports and other similar special reports whose subject is an operational event with human performance issues or lessons learned.

For at least these initial events that will be coded into the HERA database, the following is a summary of the information included about each event (more detail is provided in Section 3 of this volume):

- The plant/plant type (e.g., PWR) involved;
- The plant operating mode and power level at the time of the event;
- The date and time of the event;
- A description of the operational event;
- A summary of what functions, systems, and/or components were potentially or actually lost as part of the event;
- A detailed chronological breakdown of the event providing details about and timing of both human successes as well as failures, equipment successes and failures, important plant states and conditions, and other context-related descriptions to better understand the event and its evolution;
- Any important trends (e.g., a continuing disregard to follow specific procedure steps) noted about the event;
- Documentation of human failures judged to have strong dependencies among the multiple failures that occurred;
- The personnel involved in the event (e.g., control room operators, engineering personnel);
- Particularly relevant plant conditions that were important to why the event evolved the way it did and influenced any human errors or successes during the event;
- Specifics as to both positive and negative PSFs deemed to influence the human performance;
- A cataloging of the type of human error that was made (e.g., mistake or lapse) and its underlying cause(s);
- additional comments as appropriate.

The information is collected and provided in a way that maximizes flexibility so that its content can be useful to most HRA methods and the discipline of human factors. For instance:

- HERA accommodates a wide range of data sources relevant to classifying human performance in NPPs;
- Not just human failures, but successful human actions are also addressed in HERA, including recoveries from initial errors;
- The HERA data structure breaks down an overall operational event into subevents such as specific successes and failures of equipment and operator actions, thereby supporting multiple levels of granularity in task analyses;
- The information in HERA could support options for quantification. Quantification options include, for instance, using the algorithms, curves, and tables in a particular HRA method, using expert judgment based in part on the information contained in the HERA database, using a meta-analytic approach (Griffith and Mahadevan, 2006; Lipsey and Wilson, 2001) to combine multiple HEPs captured in the database, and utilizing Bayesian statistical updating to refine existing HEPs based on the additional evidence summarized for the events coded in the HERA database.

1.2 Documentation Series

Comprehensive details regarding HERA are contained in the current and forthcoming volumes in this NUREG/CR series. This series is expected to be comprised of the following two volumes:

- *NUREG/CR-6903, Volume 1, Overview of HERA.* This report provides the rationale behind and overview of HERA, while subsequent volumes provide greater detail behind the software, encoding, and quantification of HERA events.
- *NUREG/CR-6903, Volume 2, HERA Users' Guide.* This report outlines the implementation of HERA as a software database and explains tools available to review records contained in this database. This report also provides extensive definitions and illustrations regarding how events are coded into HERA. It also documents the HERA quality assurance process used to assure that HERA records are valid and that HERA analysts are consistent and reliable in their coding of events.

1.3 Overview of This Report

This current report (NUREG/CR-6903, Volume 1) documents the development of HERA and related processes for extracting information from one source, operational experience (that includes primarily event experience and also simulator studies), designed to support HRA and human factors. Future updates will include information from other sources, such as the aviation industry and behavioral sciences. The current report also provides a concise overview of HERA structures at a level of detail suitable for a person familiar with HRA and PRA to determine the type of information that is contained in HERA as well as its regulatory relevance and utility.

2 HUMAN RELIABILITY DATA NEEDS

2.1 Introduction

In accordance with the Nuclear Regulatory Commission's (NRC) risk-informed approach to regulation and its policy statement (NRC, 1995) on the use of PRA, during the last decade, the NRC has increasingly used PRA technology in "all regulatory matters to the extent supported by the state-of-the-art in PRA methods and data." Examples of risk informed initiatives include:

- Undertaking risk-informed rulemaking activities such as risk-informing 10 *Code of Federal Regulations* (CFR) 2001 Part 50, Section 69, "Risk informed categorization and treatment of structures, systems and components for nuclear power plants,"
- Generating a risk-informed framework for supporting licensee requests for changes to a plant's licensing basis (Regulatory Guide 1.174) (NRC, 2002),
- Risk-informing the reactor oversight process, performing risk studies (e.g., for steam generator tube rupture (SGTR), and pressurized thermal shock (PTS) events),
- Evaluating the significance of events, and
- Using PRA in licensing of new reactors.

For NPPs, these PRAs usually require the modeling of potential plant equipment failures and the examination of the reliability of the various systems in the plant. In today's NPPs, operations and maintenance staff play an integral part in maintaining the plant equipment with the use of periodic surveillance testing and scheduled maintenance programs. Also, through emergency response and other procedures, they monitor, direct, or even change the way the plant responds during an event that challenges normal plant operation to ensure continued safe operation or safe shutdown of the plant if necessary.

Given the above human roles in NPP operations, PRAs and similar assessments typically require modeling and analysis of human (i.e., operator or maintainer) performance as it affects the availability of plant systems and as part of the response to challenges to plant operation. HRA is the technical discipline used to analyze the reliability associated with operator action. The HRA process, which includes the use of human factors engineering principles, examines many of the influences (e.g., ergonomics, quality of procedures, fatigue, etc.) that can affect human performance and reliability. The process provides a means to understand what affects operator performance and to identify potential weaknesses and related improvements so as to lessen the likelihood and consequences of human failures that could possibly occur.

Hence, HRA involves the understanding of human performance in a NPP setting with the ultimate goal, as used in PRAs, to be able to properly identify and model human actions under various conditions and to estimate the reliability of those actions. Key outputs of the HRA process include the estimation of HEPs and knowledge about the key drivers that affect the HEPs including, for example, plant conditions that are particularly relevant with regard to the estimated HEP, as well as the most influential PSFs and associated underlying causes. In HRA, analysts attempt to model human behavior based on behavioral sciences and other inputs so as to predict the potential for human failures for prospective analyses, or to understand the underlying causes and influences for human failures in events that have already occurred for retrospective analyses (e.g., for lessons-learned purposes). Human factors and related issues represent a significant part (but not all) of the influences that are considered in a HRA.

To better understand some of the issues of concern and particularly the data needs to support HRA, it is useful to first provide a summary of current HRA practices.

2.2 Overview of the State-of-the-Art of HRA

Before discussing the data needs for HRA, it is worthwhile to provide a brief overview of the state-of-the-art for HRA.

2.2.1 A Common Categorization Scheme

HRA methods developed for NPPs use a common categorization scheme to distinguish between:

- Those HFEs postulated in the PRA as contributing to the unavailability of equipment by leaving a system or individual component in a faulty undetected state due to errors during testing and maintenance,
- Those HFEs contributing to an initiating event (that is to an abnormal event that can challenge plant safety), and
- Those HFEs contributing to the failure of a safety function, system, or component modeled in the PRA in response to an initiating event.

As a result, HFEs in an HRA are classified as (1) pre-initiator HFEs; (2) initiator-related HFEs, and (3) post-initiator HFEs. This categorization scheme helps distinguish the conditions under which a task is being performed and, therefore, identifies the influences affecting human performance that could be quite different for the different tasks modeled in a PRA.

For example, for pre-initiator actions involving normal operations such as testing and maintenance, such actions are not generally time sensitive, and hence time is typically not an important influencing factor. But pre-initiator HFEs may be related to short-cutting test and validation practices due to causes such as tedious repetition of restoration activities, tool availability or suitability, and accessibility of the component being maintained. Therefore, those types of influencing factors may be more important to take into consideration when modeling and assessing pre-initiator HFEs in a PRA.

Initiator-related HFEs involve human failures that can induce or otherwise contribute to the occurrence of an initiating event (e.g., an operator inadvertently causing shutdown of a feedwater pump, which in turn causes an automatic shutdown of the plant). It is not a common practice to model these types of HFEs in PRAs. The occurrence and the frequency of such events are captured in PRAs by the use of available statistical data on initiating event occurrences.

Post-initiator HFEs, associated with actions taken in response to an initiating event and subsequent plant transient, are modeled and analyzed in a PRA/HRA. Studies of human performance under abnormal or accident conditions have identified many influencing factors. For example, in some situations, time available to respond can be an important factor. Other factors may also be important, such as how well procedures will direct the appropriate actions to take given the postulated accident scenario and to what extent the operators have been trained on the type of scenario being addressed. As a result, the PSFs for post-initiator human events are handled differently from the PSFs for pre-initiator human events.

2.2.2 Evolution of Human Performance Modeling in HRAs

HRA methods, along with the rest of PRA for assessing NPP risks, have evolved over thirty years. However, although practitioners appear to have converged on how to model and assess equipment performance in response to most initiating events modeled in a PRA, a lesser level of convergence has occurred in HRA. As mentioned above, there are many methods available, all attempting to:

- Model the anticipated human behavior through the identification of PSFs,
- Assess their relative strength for the conditions under which tasks are performed, and
- Use algorithms or experts to translate this qualitative information into HEP estimates.

Not surprisingly, early HRA methods tended to consider PSFs that could generally be easily observed and measured (e.g., poor equipment layout). They also tended to employ explicit and rather simple quantification techniques, driven largely by the assumption that the cognitive functioning of people performing the tasks was intact; i.e., less rigorously accounting for the potential for failure due to the cognitive demands involved (Straeter, 2005). Many of these earlier methods attempted to compensate for the lack of explicit modeling of cognition implicitly, by considering influences such as stress, whose strength could be justified in terms of cognitive demands.

As time went by, much of the importance of these objective-type PSFs was decreased through simple-to-fix improvements (e.g., through use of mimic boards or priority alarm schemes); while our knowledge about human behavior under accident conditions continued to grow. As a result, new HRA techniques were developed, incorporating knowledge from both the behavioral sciences and the analysis of actual events observed in NPPs and other high-risk technologies. These techniques resulted in a common recognition that the cognitive demands on humans dealing with situations that can lead to an accident can no longer be ignored or treated too simplistically because, in fact, cognition often plays a vital role in the success or failure to mitigate an event. Hence, it became increasingly important that methods guide analysts to both understand and account for the cognitive aspects of human behavior in the estimation of HEPs. As a result, the more recent HRA techniques rely on much more sophisticated underlying human performance models addressing psychological factors that can affect a person's capability to successfully deal with cognitive demands. Nevertheless, early HRA methods are still in wide use in the NPP industry and, if applied properly, can be sufficient for use in many applications.

2.2.3 A Sampling of HRA Methods

Many of the potentially risk significant HFEs postulated in PRAs include operator failures in circumstances that have not been observed (i.e., the circumstances of interest are sufficiently rare that there are few opportunities to observe human performance of interest). As a result, classical statistical methods cannot be used to directly estimate the HEPs. Hence, the evolution of HRA has resulted in numerous methods for assessing human performance in NPPs, recognizing that direct observation and measurement are not possible in many cases. A sample of methods is discussed here to provide insights as to the data needs for HRA.

In the Technique for Human Error Rate Prediction (THERP) (NUREG/CR-1278, Swain and Guttmann, 1983), the authors provide an insightful discussion of how a variety of internal and external PSFs can influence the reliability of human performance for both pre- and post-initiators and list 50 potential PSFs that could affect performance under different circumstances.

However, to estimate HEPs, THERP provides tables (i.e., Chapter 20) of tasks modeled in HRAs and associated HEPs. The tasks listed in these tables are procedure- and control-driven types which are relevant to nuclear power operations, e.g., maintenance. However, the PSFs included in the tables are mainly job- or environment-related factors. The authors do provide the ability to treat stress levels and experience, which are internal-type PSFs; however, they do not provide the capability to explicitly treat other factors and specifically PSFs related to cognitive tasks. Although some of these PSFs are implicitly treated in some of the tabled elements, such an approach does not allow human reliability analysts to identify and measure the effects of these PSFs.

In the ensuing years since the publication of THERP, more methods have been developed with the same objective of identifying error likely situations and predicting the likelihood of human failure in these situations. There are currently over 20 methods available for characterizing and predicting states of human failure. In all of these methods, human failure is characterized by humans either not performing the desired action or doing something other than the desired action. This often implies a time frame (i.e., if an action is not performed before a certain time, it can be considered a failure or error). Each of these methods provides explicit consideration of human factors and other influences that affect performance, and these methods encourage analysts to apply them to account for situational factors that, together with operator, crew, or organizational factors, may affect the likelihood of human failure.

The Cause-Based Decision Tree (CBDT) approach considers human failure modes as predominantly arising from failures at the plant information-operator interface, or at the procedure-crew interface (Singh, Parry, and Beare, 1993). Specific failure mechanisms may be accounted for through a CBDT analysis, much like accounting for PSFs used by other HRA methods. Some of these mechanisms may include or imply cognitive functions. Nevertheless, failure is largely treated as an obstacle to successful performance of an appropriately intentioned crew.

The Standardized Plant Analysis Risk-Human Reliability Analysis (SPAR-H) method (Gertman et al., 2005) provides a comparison of a few widely used methods. The conclusion of the SPAR-H developers is that most widely used HRA methods consider a limited set of similar types of PSFs, although techniques that rely on expert judgment for quantification are conceivably capable of considering a wider set of PSFs judged to be relevant by subject matter experts. Many of these HRA methods estimate HEPs by adjusting a nominal HEP with multipliers representing the strength of the effect for each PSF on the success/failure of the task analyzed (Boring and Gertman, 2005). Thus, in these methods an HEP is estimated using expressions such as:

$$\mathrm{HEP} = \mathrm{Nominal}_{\mathrm{HEP}} \times \prod_{i=1}^{n} \mathrm{PSF}_i$$

In the SPAR-H method, a nominal HEP is modified by the product of PSFs determined or postulated to be operant in the context under consideration. The PSFs in the equation serve as estimators for the effect of contextual conditions on human reliability.

The Cognitive Reliability and Error Analysis Method (CREAM) method (Hollnagel, 1998) produces screening values by employing information about common performance conditions (CPCs). CPCs are constructs similar to PSFs that are deterministically related to the control mode and, hence, the failure probability of human actions. The combined effects of CPCs may

serve to improve or reduce performance reliability. The mean failure rate (MFR) for a human action being screened is given by:

$$MFR = MFR_0 \times 10^A$$

The variable *A* is of special significance and is a logarithmic function that incorporates information provided by an analyst regarding the quantity and effects of common performance conditions on performance reliability (Fujita & Hollnagel, 2004). Screening, thus, requires information about performance conditions and how they may affect human reliability.

The quantification technique in A Technique for Human Error Analysis (ATHEANA; Cooper et al., 2000) produces estimates of human reliability for the HFE of interest by expressing its conditional probability in certain error forcing contexts (EFCs) that may manifest themselves for a postulated accident scenario *S*:

$$P(HFE \mid S) = \sum_i P(EFC_i \mid S) \times P(UA \mid EFC_i, S)$$

The ATHEANA technique requires analysts to account for the many ways that unsafe acts (UAs) may occur across a complete set of error forcing contexts that may arise in a given accident sequence (Forester et al., 2004). This approach requires information that can be used to identify and quantify the likelihood of different error forcing contexts as well as the likelihood of unsafe acts in those contexts.

2.3 Implications for Human Reliability Data Needs

HRA is a process that includes the collection and analysis of information about plant conditions, PSFs, and any other human performance influences. Through a prescribed method (of which there are many), the process then translates this information ultimately into an estimated HEP for an action of interest to NPP operations. While these methods presently have some basis for the algorithms they use and the PSFs they consider, significant judgment is used in the implementation of these methods with little relevant empirical evidence. Consequently, empirical evidence is needed to better inform HRA methods so as to validate, or at least partially support whether the appropriate influences are being considered and that the algorithms used provide HEPs that are realistic for the actions and situations that are analyzed.

As a result of the significant judgment required, there is considerable uncertainty in HRA results as well as some skepticism as to the credibility of the results. HRA is therefore considered as among the most uncertain portions of a NPP risk assessment by PRA practitioners and decision-makers. Today's risk-informed regulatory approach in the commercial nuclear industry demands that the uncertainties in HRA be reduced or at least be better understood. Additionally, decision-makers need to be able to consider the results credible and to some degree, validated. Preferably this validation should be based on experience such as that represented in the HERA database, even if that experience is partially reflective of what is being modeled and analyzed in PRAs.

However, there are insufficient data to assess operator reliability in HRA and to fully understand human factor influences that affect human performance under a variety of conditions and for a wide-spectrum of plant conditions. This lack of sufficient data is one of the concerns expressed by practitioners and decision-makers. Data are required not only to directly support HEP

estimates needed to quantify the risk significance of postulated HFEs, but also to support the development and validation of human performance models (including human factors influences) used in HRA methods.

While the details may differ, the various methods generally need relevant information to (a) identify the operant PSFs or other elements of context (some of which are human factors issues) that will most significantly affect human performance depending on the plant situation and the specific action, and (b) provide a quantitative measurement, or at least semi-quantitative insight, as to the effect of these contextual elements that can be reflected in the HEP estimates coming from these methods. The need for these qualitative and quantitative data is confirmed by studies of operator performance that have shown that performance is variable within and across contexts, and can be influenced by contextual factors (Hallbert, 1997). Knowing which factors are important in a given context is vital to understanding and predicting human performance outcomes. Beyond being able to identify these factors, measurement is necessary in order to model and predict performance.

The underlying bases for the situational factors (e.g., PSFs, human factors, and plant conditions for the scenario of interest) that are addressed by the current methods and the probability values used in the methods include both actual data and judgment. Actual data that are applicable and in a form usable for NPP risk assessment have been and continue to be sparse. What is available comes from reports and databanks involving experiments using artificial tasks (e.g., psychology experiments), experiments and field studies of actual tasks in industrial and process industry settings, military data on human failures, simulations in NPPs, and actual events in nuclear plants such as that reported in LERs. Given the nature of NPP operations and the rare opportunities to observe most failures of particular importance to NPP risk, considerable judgment has also been used not only to augment actual data, but to re-interpret the human performance data (which are generally not from nuclear experience) for NPP settings and activities. This has caused data to be used or otherwise applied beyond the purposes for which the original data were intended. Additionally, considering the potential subjective interpretation of the data for NPPs, the inclusion of judgments where data were lacking and the genuine variability in human performance even under identical conditions, there is considerable uncertainty in HRA results as well as skepticism as to the credibility of the results

Even though many sources of information on human performance exist, few are regularly employed or referenced in analyses of human reliability. For purposes of informing HRA, there has been reluctance to employ information from operating experience. This is principally due to the sensitivity of human performance to operating contexts. For instance, it is difficult to match context from operating experience (such as that captured in LERs) to rare events of more interest in PRAs. That is, although operating experience sometimes encompasses circumstances important to estimate the human contribution to NPP risk, it is not the same or even similar to many of the PRA modeled situations. Hence, HRA uses analytical methods to characterize HEPs of interest in PRA rather than using experience-based information directly.

Collecting human reliability information has also proven difficult. By most definitions, human reliability is concerned with the potential for human error. Unfortunately, there is still a stigma associated with acknowledging fallibility and error in many industries, especially when it results in damage and loss. For this reason, organizations have shied away from collecting and analyzing human performance data especially among licensed personnel. Nevertheless, operating experience provides a readily available source that includes instances of both successful human performance as well as failures. And for the more risk significant events, the

NRC typically follows up by conducting investigations using augmented inspection teams, which result in thorough descriptions of human decisions and actions as well as lessons-learned that can be used to improve future operations.

Given the increased use of HRA results in regulatory decision-making, there is a need to make greater use of the sources that are available, especially those sources related to operational experience. Efforts are especially needed to characterize the sources of information that are capable of informing HRA applications and to attempt their development and use. Recognizing that evidence from various information sources exists; efforts are also needed to develop the means and tools to support their use.

2.4 How Can the Information in HERA Be Useful?

2.4.1 General

A systematic collection of human performance information for the conditions studied in HRAs would go a long way to improve our HEP estimates and the assumptions and theoretical frameworks for modeling human performance. For example, data may be helpful in supporting the direct estimation of HEPs for some situations (e.g., perhaps some types of pre-initiator failures where reasonable estimates as to number of opportunities can also be produced and that number is large). But more likely, we will have to be satisfied with improving our methods and the human performance models that are used (which is a significant benefit in and of itself). This in turn should allow us to better (yet still analytically) predict HEPs rather than produce the HEPs directly from the operating data.

A review of the HERA database content summarized in Section 1.1.2 shows that HERA has been purposely set up to provide information directly needed by these HRA methods and many of the human factors considerations that are included among all the potential influences. The database content for each event includes plant condition and related situation information (e.g., plant type, operating mode, functioning as well as unavailable or failed equipment, plant state descriptions); information about human successes (including recovery actions); and information about human failures and the associated influences that likely contributed to those human failures (e.g., persons involved, contributing PSFs, type of human failure that was made and underlying causes). Analysts armed with the information in the HERA database for a sufficient number of events that provide a good representation of experience across the NPP industry, and with proper analysis of the data, can then compare the HRA methods and the results they produce against this experience-based knowledge. The goal of this comparison would be to see if the methods provide results that are compatible with and perhaps are even partially validated by our NPP experience. To the extent the methods do not provide such results, HRA methods could be improved so as to be better predictors of human performance based on this experience information.

There is every reason to believe that the use of experience information in HERA will be a valuable support to HRA and the discipline of human factors. This is because successful uses of available data have already been demonstrated. In fact, methods and hypotheses have been produced, in part, on the basis of examining available data. For example, ATHEANA was developed on the basis of systematic collection and analysis of NPP events and particularly on the more severe events and the types of human failures and their causes associated with those events. The NRC has performed many other HRA-type studies utilizing operational data (e.g., Barriere et al., 1994; Barriere et al., 1995; Cooper et al., 1996; NRC, 2000). Other examples include:

- The proposed development of contextually anchored probabilities (CAPs) to support those methods that rely on expert judgment for estimating HEPs (Forester et al., 2004);
- Testing hypotheses used by various methods, especially through the use of actual experiments;
- Addressing some of the important questions regarding PSFs and their interactions; and
- Investigating the ability to better estimate HEPs using, for example, Bayesian framework methods and operational experience.

As yet another example, a recent study used operating experience to characterize the way that humans influence risk in operating NPPs and to assess the ability of NRC inspection and oversight activities to identify the causes of risk-significant human-induced events prior to their triggering of such events (Gertman et al., 2002). As a result of this research, the extent of latent conditions and their influence on operating events were identified, as were some of the causes of human performance and their effects on creating error likely situations.

These uses of available data indicate that HERA should be able to provide the basis for improving our analyses of human performance in NPP settings. In fact, the HERA database is expected to be able to provide considerable qualitative insights useful to the HRA and human factors technologies by being illustrative of the kinds of situation-induced errors that occur and thus need to be accounted for in HRA, by using counting and trending type analyses of the data, by using data correlation techniques, etc. Further, at least limited quantitative insights are also likely such as using the additional consideration of the number of opportunities for the actions that are analyzed vs. the number of failures observed to provide some insight into the HEPs themselves. The next section provides examples of the types of evaluations that should be possible with the HERA database and the types of insights that could be gained. It is not possible that every conceivable type of evaluation of the HERA database and the use of the results of such evaluations can be perceived at the onset. Hence, the next section is necessarily incomplete. However, the intent of the next section is to provide glimpses, using a few broad categories of information relevant to HRA, of what may be possible and the potential value to improving the state-of-the-art in HRA and human factors so as to make the results of using these disciplines less uncertain and more credible to decision-makers and other interested parties.

2.4.2 Illustrations of Possible Uses of HERA Data

2.4.2.1 *Types of failures and contributing circumstances that should be addressed including accounting for recovery potential*

Even with just limited analysis of the data that will be available in HERA considerable insight should be gained into the types of human failures as well as recoveries that occur and the situational influences that play a role in making errors as well as recovering from previous failures. This knowledge can assist analysts in better understanding the relationships among certain situational characteristics and the potential for human error as well as recovery, and thus improving, if necessary, the ability for HRA methods to address these relationships.

For instance, consider work being carried out for the NRC (Job Code Number Y6221) in studying human performance in recent Accident Sequence Precursor (ASP) program identified events. As part of this review, a steam generator tube rupture (SGTR) event that occurred in 2000 (AIT 50-247/2000-02) was analyzed. The results of this analysis identified a number of

interesting conditions and situations related to human performance. Findings and relevant aspects of the event analysis include:

- A number of pre-existing conditions contributed to complications encountered during the response to the SGTR. These included a number of workarounds to address ongoing problems with various equipment items. In particular, the licensee had to manually monitor tank level following receipt of a safety injection actuation signal. Additionally, the licensee had changed the setpoint for residual heat removal system operation without appropriate formal review. Further the licensee removed the main condenser steam jet air ejector steam supply pressure control valve from service, instead operating it in manual mode as a long-term workaround without updating applicable procedures to reflect the workaround.
- The Emergency Operating Procedure guidance for a steam generator tube failure did not address the specific steps for placing the pressurizer auxiliary spray in service during cooldown. The needed operator actions required to isolate normal spray flow before using auxiliary spray were not added to the Emergency Operating Procedure, which resulted in problems placing the auxiliary spray in service during the event.
- Operators initiated reactor cooling system cooldown from the intact steam generators following the tube failure, using the high pressure steam dumps to the condenser. An excessive cooldown rate was established. Manual steam dump control required close operator attention to manage the cooldown rate. Operators consequently initiated a much larger steam flow rate than intended and did not effectively control the cooldown rate. Contributing human factors included:
  - The high pressure steam dump system was known to function erratically at low steam flows in the automatic pressure control mode.
  - The high pressure steam dump controller was not properly tuned.
  - The high pressure steam dump was known to have an imprecise valve position indication in the control room.
  - The control room simulator's high pressure steam dump system model did not match the actual plant response and was ten times slower than in the plant.
- Operators manually initiated safety injection due to low pressurizer level, further exacerbating the excessive cooldown rate. The operators were not certain what had caused the pressurizer level to decrease so rapidly since they did not fully correlate the lowering level with the accompanying reactor cooling system temperature and pressure indications that were available in the control room and were also lowering as a result of the rapid cooldown.
- Eventually, after considerable difficulties, the operators terminated the reactor cooling system cooldown and successfully cooled down the plant in response to the steam generator tube rupture.

As evidenced by this event, operator response is required for the recovery of systems and to prevent more serious degradations in response to initiating events. In current HRAs, operator performance is typically characterized as a procedure following activity in response to an initiating event or symptom. Often, less than ideal pre-existing conditions are not addressed, especially if such conditions are not what are normally expected based on the original design of the plant. Furthermore, many HRAs address what may be best described as "nominal" post-event plant and operator response; i.e., largely the expected performance of crews using well-practiced procedures.

This example suggests the importance of HRA methods to search and account for long-term pre-existing equipment and administrative conditions that have become the "new norm" for the

plant. Such conditions may contribute to operator failure during circumstances that make these less than ideal conditions relevant to the plant and operator response. Based on actual events such as this one, as well as simulator experience and controlled experiments that can be used to investigate some of these influences, HRA methods could be better informed as to how to address these pre-existing influences.

Additionally, this event illustrates that in spite of our symptom-driven procedures, operators do not always understand the situation as it evolves (e.g., did not understand that an excessive cooldown caused the lowering pressurizer level), in part, because the operators may not fully or correctly utilize all the information available to them. Thus in spite of indications being available in the control room, HRA should address, especially in complicated scenarios, the fact that not all indications will be equally utilized and sometimes, operators can get focused on a subset of indications possibly leading to incorrect situation assessment and potentially incorrect actions. Besides actual events, data from simulator experience and debriefings, as well as from controlled experiments, for instance, should be useful to understanding when and why operators may encounter situation assessment problems.

Also illustrative of this example is the fact that in spite of such complications and even incomplete or incorrect situation assessment, operators typically recover from prior errors. The information in the HERA database from all types of sources should, for example, allow us to tabulate and understand what conditions enhance operator recovery potential, what types of changing plant conditions, cues, or other influences (e.g., change in personnel) it takes to overcome previous but incorrect mindsets so that appropriate recovery actions are taken, and how long it typically takes to recover from previous errors. Utilizing this empirical knowledge in HRA could improve our ability to model this important aspect of operator performance and provide better data-informed estimates of recovery potential.

2.4.2.2 The relationships between PSFs and the potential for human failure

Most HRA methods model human performance on the basis of accounting for PSFs or similar influencing factors and their effects on the estimated human error rate. Thus, better understanding of the relationships among PSFs as well as between the PSFs and the human failure potential, are key to validating or otherwise improving current HRA methods and their underlying qualitative and quantitative algorithms. The event information provided in HERA will allow analysts to perform correlation studies to better understand how PSFs should be modeled in HRA.

There are many facets to understanding PSF-to-error rate relationships. Among these is the relative effect of PSFs on human failure rates. While some clues as to these effects can be gained from actual event data and simulation experience, the expected eventual incorporation into HERA of experimental research data may be particularly useful. Often, the tasks addressed in research studies using controlled experiments or even some simulated events are designed to be difficult enough either to elicit error responses or to examine the effects of independent variables on performance. This knowledge about the relative effect of various PSFs should be pertinent and of great value for the purpose of HRA; i.e., the degree that each factor increases error rates or otherwise affects performance could be used to improve our current HRA models.

Even though the experiments may not always directly correspond to the conditions and failures of most interest in PRAs and hence we might not be able to predict the exact level of

performance achieved as a function of a PSF for a task modeled in a PRA, the overall pattern of effects caused by the PSFs should be able to be better justified.

Since the purpose of experimental research studies is often to determine the effects of variables on performance, experimental data could provide more accurate reflections of these effects than other sources of data such as that obtained by observing simulator training sessions during crew training. While observations from such training sessions may provide some useful insights since such data is likely to be more ecologically valid for NPP operations than experimental data, training sessions are not specifically designed to study the effects of specific variables on performance. This is not to say that controlled simulator experiments cannot be designed to do so. For example, notable simulator research on PSFs can be found in the work at the Halden Reactor Project (e.g., Braarud et al., 2006; Laumann et al., 2006). Nevertheless, absent a broader range of such informative simulator studies, it is necessary to augment these findings with available experimental data from other sources. Therefore, multiple sources of experience information including the experimental research literature expected to be eventually incorporated into HERA, can and should be used to determine the effects of PSFs on performance. Analysis of such information should provide validation of, or ways to improve, our current algorithms in HRA methods for how PSFs qualitatively affect the human failure potential and quantitatively affect our HEP estimates.

A related area of HRA needing validation or improvement is the determination of how PSFs interact, and thereby affect the performance of a task. In a given context, two or more PSFs may interact, thereby increasing the probability of an error (e.g., operator fatigue combined with an inadequate aspect of the human-machine interface). How the HRA analyst should combine the effects of multiple PSFs is an issue to be addressed even if each PSF's relative effects on the performance of a task are generally understood. In some cases, certain PSFs could conceivably be independent of one another. For example, physical fatigue appears to have very little effect on cognitive performance in some cases. In other more complicated cases, a PSF may be influenced strongly by another PSF, but the reciprocal relationship does not exist. For example, organizational factors influence crew relationships and performance. However, crew performance and relationships do not typically affect organizational factors. Therefore, a HRA analyst could magnify the effects of crew-based PSFs if certain other organizational factors are also present. It would appear then to be naïve to assume that multiple PSFs have either additive or simple multiplicative effects on a task, which is the way HRA methods typically treat PSFs at the present time.

There is evidence in the research literature that cognitive variables that rely on the same underlying functions will interact. However, not all variables and PSFs will necessarily interact when they influence performance. Therefore, it may be necessary to quantify the effects of common sets of variables, including determining how PSFs interact.

To some extent, actual event data may provide clues as to these interactions. For example, the HERA database may be able to demonstrate whether or not the more serious human failures typically involve combinations of PSFs and particularly which ones under what types of circumstances. From this, it may be possible to learn what combinations of PSFs lead to certain types of failures and thus account for this more formally in HRA methods. Additionally, experiments could be designed to investigate this issue with their results included in the HERA database.

As this discussion illustrates, our treatment of the ways that PSFs affect human performance could be enhanced or otherwise validated based on empirically demonstrated relationships.

Available evidence in the open literature can provide a basis upon which to build and anchor predictive estimates of the effects of these PSFs. It may support the development of models of behavior in error forcing contexts, improve our knowledge of the ways that PSFs interact, and lead to more realistic treatments of the joint effects of contextual and psychological factors. Evidence of these influences from operating experience is also needed in order to properly account for these influences in relevant contexts. The open literature may present cases of both deterministic as well as uncertain relationships between performance shaping factors and human behavior. Cases bearing out these relationships or modifying our views of them in practice are needed to assist in determining how to apply this knowledge to studies of risk and for prioritizing areas for further study.

2.4.2.3 Accounting for dependencies among human actions

Accounting for dependencies among a series of human actions performed for both pre-initiator testing and maintenance activities as well as for post-initiator actions in response to a plant transient, is a critical aspect of HRA to ensure that the likelihood of multiple human failures is not treated too optimistically. The HRA discipline has methods that embody guidance of when dependencies among multiple actions may be particularly operative and so the human failures should not be modeled as independent and quantitatively treated as such. The idea is that under certain situations, it is believed that the potential for making a second error is significantly influenced by whether a previous and related error has already been made. For example, incorrectly calibrating a level sensor might lead to an increased chance that a second level sensor will be similarly miscalibrated because, for instance, of the use of a common but incorrect calibrating device or the same error-prone procedure.

With the human action dependency information provided in HERA, while it is recognized this is subject to some interpretation on the part of the HERA analyst who is coding the event information into the database, we still should be able to partially validate or improve our treatment of human action dependency in HRA. For instance, the event data should provide insights into the types of circumstances that tend to increase the dependency among human actions as well as the underlying mechanisms that tend to make for greater dependency among human actions. This knowledge can be used to better inform the HRA guidance in this area, and perhaps even suggest the quantitative effects under certain circumstances.

2.4.2.4 *Empirically-based pre-initiator human failure rates*

As the years of operating experience of NPPs increase, more sufficient data become available that can be used to more directly predict (rather than analytically model) the causes and likelihoods of making significant errors during routine testing and maintenance activities that are frequently performed in NPPs. With many thousands of accumulated years of experience that includes similar and routine pre-initiator activities across the commercial industry, it may now be possible to more directly assess the types of serious pre-initiator errors that are made and their likelihood of occurrence. This is because reasonable estimates of the opportunities for performing these routine activities can be made, and the number of opportunities across the commercial industry is now sufficiently large that failures have been observed and the resulting statistical analyses can be somewhat robust.

It is recognized that not all pre-initiator errors are probably reported or otherwise recorded. Simple and easily recovered slips and other minor mistakes are likely to not be included in data available for inclusion in HERA. However, for the more serious errors of particular interest in PRA, such as those that went unnoticed for a long period of time and/or played a role in a

subsequent undesired response to a plant situation, reports are likely made and the data from such reports are planned to be included in the HERA database.

For these more serious events, and with the ability to reasonably estimate the number of opportunities to carry out these routine pre-initiator activities, the information in HERA may be able to provide empirically-based estimates of certain pre-initiator errors often modeled in PRAs. These estimates could be used as direct quantitative inputs into PRAs. Even if this goal cannot be achieved, the available evidence should improve our understanding of the circumstances and causes that lead to these errors of interest, thus better informing our HRA modeling of these human failure events and our estimates of the corresponding HEPs.

2.5 HERA Is Designed to Meet Data Needs for Human Reliability Studies

As Chapter 2, and in particular the previous section, illustrates that , the HERA system has been designed to provide human performance information that will allow us to validate or otherwise improve the current HRA methods for addressing the potential for human failures in NPP operations. Its focus is on the collection, interpretation, and documentation of operational experience relevant to nuclear power operations (in the broadest sense) and that can be employed by users of different HRA methods. Additionally, it is to serve as a rich information source for the discipline of human factors within NPPs. While it is recognized that information sources are available that contain experiential information, these data sources are often incomplete, proprietary, or censored. Such data are nevertheless of value in striving to improve the credibility and validity of human performance evaluations in NPP applications.

Recognizing the many differences between HRA methods, HERA's design is as a general utility for a variety of methods, structuring information in a manner that is valuable to most methods. Given the differences in the types of inferences and explanations of human behavior between HRA methods, the HERA system is designed to provide information from qualified sources that includes both raw, unprocessed information of source documents and additional information related to underlying human performance mechanisms, in a terminology that can be applied directly or easily transformed to support implementation of a variety of HRA methods.

Beyond supporting HRA applications, the HERA system is also intended to be capable of supporting reviews by analysts who seek to understand how context, work processes, and other determinants interact to produce the observable behavior that is part and parcel of nuclear power plant activities. Further, the data in HERA may inform human factors, from providing human performance data to support modeling and theory, to providing information appropriate for the design of a safe workplace, to documenting cognitive and contextual factors that enhance or limit optimal performance (e.g., Griffith and Mahadevan, 2006).

The remainder of this document includes a more detailed description of HERA and the processes associated with its implementation, including its underlying framework to meet the data needs discussed in this chapter. The data it contains, the sources of that data, as well as the format and structure of the data information are provided. More detailed information on the definitions underlying the data structures, the process and quality assurance of coding HERA events, the software implementation of HERA as a database, and Bayesian statistical methods for using HERA information may be found in the additional volumes of this NUREG/CR as noted previously in Section 1.2.

This page intentionally left blank.

3 HERA CONTENT AND DATA SOURCES

3.1 Introduction

In order to appreciate the resulting framework and content of the HERA system described later, it is appropriate to understand more specifically the information needed and available to support the HRA. This section describes the activities that were conducted to address differences among HRA methods and the sources of information that may be employed to support HRA and PRA applications.

The objective of HERA is to provide information about human performance in PRA-relevant settings, including information about the conditions that affect the outcomes of human performance in a manner that is consistent with HRA methods. This objective requires that sources of information be identified that also relate in some ways to the conditions and kinds of performance that may be encountered in accident conditions. Further, it requires the ability to relate these conditions to the outcomes of behavior, both those that are successful as well as unsuccessful, so that inferences may be drawn concerning the potential effects these have on the reliability of human performance. To be useful for HRA, the information must be structured in ways that can be employed by analysts. The method for extracting and reporting such information must also be sensitive to the differences that exist among the HRA methods that the system aims to support.

HRA methods differ in terms of how they account for variation in human behavior. This includes explaining and predicting how features of the task or job, the situation, and other features that are important in the performance environment may contribute to the likelihood and occurrence of different kinds of human failure. Analysts who employ a particular method often employ a specific taxonomy of human behavior that is linked to the method's approach to explaining human failure. The taxonomy employed by a method necessitates gathering specific information to inform a particular analysis. Differences among the methods and taxonomies of human behavior imply that an information source, such as that proposed here, needs to account for these differences and to supply information so that users of different HRA methods can employ it.

In considering the information needed to support various HRA methods and implications for the design of HERA, we reviewed a number of contemporary HRA methods including THERP, ATHEANA, CAHR, CREAM, and SPAR-H. The reviews were performed to identify the kinds of information that analysts may need in order to apply these methods. The results of these reviews were used to develop a method and rules for extracting data from a source of information, as well as a structure for coding and entering information into HERA.

Related international efforts, notably an International Atomic Energy Agency (IAEA) specialist group's recommendations for reporting of operating experience to emphasize insights into human factors aspects, were also reviewed to identify a set of information categories and a structure for reporting information and to allow for the eventual incorporation of a broader set of information sources.

3.2 Sources of Information and Applicability to HRA

There are various sources of information that are potentially useful to the needs of HRA as applied to nuclear power plants. The discussion of relevant information sources that follows is intended to point out the value of some commonly available sources of HRA data.

3.2.1 Operating Experience

Operating experience refers to data and information generated through the operation of nuclear power facilities. Operating experience is a highly relevant source for generating human reliability information since it comes from the environment to which we are attempting to generalize the results of HRAs, and includes the variables that affect human performance from that environment. Also, since many NPPs are in operation, data collected from operating experience can be used to estimate human performance parameters with higher confidence than from studies of individual topics. The regulatory agencies in member countries that oversee nuclear reactor safety have also established reporting requirements for events that have the potential to affect public safety, and many of these agencies perform independent analyses of events to assess the conditional changes in risk associated with an event's occurrence. Such experience provides information that is directly risk-relevant and may contain data on human performance that can be used to support a variety of HRA activities.

3.2.2 Plant Simulators (Training, Qualification, Special-Purpose Sessions)

Plant simulators possess high fidelity in replicating the physical appearance and behavior of nuclear plant systems. In nearly all cases, they are identical to the control rooms of the actual plants and provide the best approximation to the actual operating context for simulating control room activities. Simulators also have data logging facilities for recording system actions, human actions, control inputs, and plant parameter values. Most also provide for the ability to produce high quality audio and video recordings of crew interaction. Since they are used to train and license operators, they are also familiar to crews and are likely to produce behavior that is representative for many PRA-relevant conditions.

Consideration of simulator-based human performance data should include the characteristics of the simulator for the plant modes being evaluated. Plant simulators are notably well suited to produce conditions similar to many plant modes such as start up and full power operation. They may not, however, be capable of producing thermal-hydraulic and control room indications for some other modes, such as shutdown, refueling, or mid-loop operations. They are also well suited for producing behavior from control room crews, but may not be suitable for simulating all aspects of emergency response, especially balance of plant, ex-control room activities, and for non-control room personnel.

3.2.3 HMI Validation and Verification

The design process for NPP construction and modification includes validation and verification, especially for systems that affect operations. Verification and validation processes include activities to ensure that human actions can be performed, and that the expected behavior of the system, including human actions, is in accord with expectations of the authorization basis of the facility. This includes human actions that are necessary to be performed in PRA-relevant contexts. HMI validation and verification studies are thus able to provide data about human performance in PRA relevant situations that may be useful for HRA.

3.2.4 Controlled Studies

Controlled studies refer to efforts to collect samples of human and system performance for the purpose of evaluating the effects or relationships of specific aspects of the operating context on human performance. Such studies, as their name implies, also involve controlling for the effects of conditions such as extraneous or confounding factors that may influence the results and change or obscure the effect(s) of the conditions under study. The behavioral science literature is replete with controlled studies that have been performed to evaluate various aspects of human performance, including sensory, perceptual, behavioral, cognitive, and social processes. Many of these studies are highly relevant to the performance of NPP personnel, since they possess similar physical and mental capabilities as people in the general population. For example, many HRA methods allow analysts to account for the effects of PSFs. The behavioral science literature is an excellent source of information and data that may be used to estimate the effect(s) of PSFs on elements of performance that may be relevant to the kinds of tasks that are performed in NPPs.

The relevance of such studies for providing HRA relevant data must be carefully considered since NPP personnel have many different learned abilities and work in different environments than those in which many controlled studies are carried out. Controlled studies involving NPP personnel may provide a rich and highly relevant source of information that can be used to inform HRA activities.

3.2.5 Results of Previous Analyses

HRAs have been performed for the current generation of PRAs and already address many conditions and situations that are risk relevant. The documentation of these analyses may include data that are relevant to inform different HRA applications, such as the results of task analyses, crew performance data (e.g., times, quality, team interaction characteristics, etc.), evaluation of PSFs and other relevant performance influencing conditions, and estimated human error probabilities (HEPs). Such data may serve as useful references for other analyses, such as for providing benchmarks and anchor values for HRA methods that can make use of such data.

3.3 Data Sources for HERA

After reviewing information regarding the availability and quality of potential HRA data sources, INL established a plan to design and populate HERA. The plan and approach were discussed with NRC sponsors and potential users as well as HRA experts from the industry and academia. As a result of these discussions, the extraction of information from operating experience was assigned the initial priority for HERA. Operating experience includes information from Licensee Event Reports (LERs) and from augmented inspection team (AIT) reports. These sources have been prioritized over the other sources initially considered for a number of reasons.

Operating experience includes both successes and failures of systems and human performance. It often includes information about the conditions under which success and failure occur and, given that sufficient amounts of information can be extracted from them, can be used to derive insights into the conditions that affect human performance. Operating experience can also be related to PRA-relevant conditions. This can include initiating events and portions of event sequences that are representative of the conditions of interest in PRAs. Operating experience is realistic and actual, and requires less effort to generalize in order to derive

inferences about events or conditions of interest to PRA. Finally, operating experience is readily available and there are standards for the types and quality of information that must be reported.

3.3.1 Licensee Event Reports (LERs)

Licensee Event Reports (LERs) contain information on events that licensees are required to report per 10 CFR 50.72 and 50.73 to the NRC. Reportable events include:

- Declaration of an emergency class,
- Plant shutdown required by technical specifications,
- Operation or condition prohibited by technical specifications,
- Deviation from technical specifications,
- Degraded or unanalyzed condition,
- External threat or tampering,
- Safety system actuation,
- Event or condition that could have prevented fulfillment of a safety function,
- Common-cause inoperability of independent trains or channels,
- Radioactive release,
- Internal threat or hampering,
- Transport of a contaminated person offsite,
- News release or notification of other government agency,
- Loss of emergency preparedness capabilities, or
- Single cause that could have prevented fulfillment of the safety functions of trains or channels in different systems.

LERs contain “a clear, specific narrative description of what occurred so that knowledgeable readers conversant with the design of commercial nuclear power plants, but not familiar with the details of a particular plant, can understand the complete event.”

3.3.2 Augmented Inspection Team Reports (AITs)

The AIT process is based on the in-house principles of incident investigation provided in NRC's incident investigation training courses and the general principles described in Management Directive 8.3, “NRC Incident Investigation Program.” The AIT response emphasizes fact-finding and determination of probable cause(s), as well as the conditions and circumstances relevant to issues directly related to the event. The AIT response attempts to be sufficiently broad and detailed to ensure that the event and related issues are well defined, the relevant facts and circumstances are identified and collected, and the findings and conclusions are identified and substantiated by the information and evidence associated with the event. The inspection considers the adequacy of the licensee's actions during the event.

3.3.3 Data Extraction

Initial extraction of data into HERA has focused on four groups of LERS and AITs:

- Events involving emergency diesel generators (EDGs),
- Events involving initiating events,
- Events involving common-cause failures (CCFs), and

- Events with a conditional core damage probability (CCDP) exceeding 1E-4 and deemed risk significant per direction of the NRC's Accident Sequence Precursor (ASP) Program (see Gertman et al., 2002, for a review).

Coding efforts are ongoing and strive to create a rich store of information of use to inform HRA and PRA. While the majority of HERA coding focuses on LERs and AITs, work is also underway to code the results of NPP control room simulator studies conducted in cooperation with the Halden Man-Machine Laboratory (HAMMLAB) at the Halden Reactor Project in Halden, Norway. These analyses will be available in conjunction with the release of the HERA software database.

3.4 HERA Requirements and Top-Level Framework

Given the variety of HRA methods and their specific data needs, as well as the potential interests of human factors specialists and others who need to make decisions with human performance in mind, HERA is designed with a number of characteristics and specifications aimed at meeting this broad set of potential users. Because the initial focus is on the use of operational information, and particularly that from LERs and AITs, its framework including its design details are influenced by ensuring the extracted information is clearly tied to a specific operational event.

3.4.1 HERA Functional Requirements

Based on discussions in previous sections of this document, the INL determined that HERA needed to meet the following key functional requirements:

- It must be able to accept, with input analyst interpretation, different types of information sources particularly relevant to NPP activities and based on operational events starting with LERs and AITs.
- The terminology HERA uses (e.g., PSFs) needs to be that commonly used in the HRA and PRA communities or can at least be easily transferred/interpreted to unique terms or definitions used by specific HRA methods.
- Raw and interpreted or analyzed information needs to be supplied or referenced so that a user can decide whether the data as supplied are appropriate for the user need, or if the raw data need to be (and can be) re-interpreted to fit the specific user need.
- For an event's relevant human actions, it needs to be able to identify (to the extent practicable) the likely operant PSFs and other elements of context (e.g., influencing plant conditions) of most significance to how humans performed during the event.
- To the extent practicable, *measurable* elements of context (e.g., using scaling descriptors) need to be provided so as to relate the 'strength' of the operant PSF or other contextual element. So for example, it is not sufficient to express that the desired task was complex; but the level of complexity should also be provided.
- HERA needs to address both successful as well as failed human actions so that the most information relevant to human performance, including lessons-learned for the future, can be gleaned from each event.
- HERA needs to identify (to the extent practicable) likely dependencies among different human actions to assist in the future modeling and quantification of such effects.
- HERA needs to address both cognitive and execution aspects of human performance.
- The software and associated data format needs to be amenable to sorting and counting techniques to make HERA suited for deriving quantitative information including statistics.

3.4.2 HERA Top-Level Framework

In response to the above functional requirements, and with the initial focus being on extracting information from operational events, it became clear that the top-level framework for HERA needed a structure, which at its simplest level of description includes two basic types of information:

- Information associated with the operational event overall, and
- Information (including causal insights) important to understanding the human actions and decisions relevant to the event.

To design the remainder of the HERA structure details (described in the next chapter), an extraction process had to be implemented in order to know what specific information could be obtained from operational records (LERs and AITs) to support the above top-level framework. That extraction process is described in the next section.

3.5 Extraction Process

A typical event as described in a LER or AIT report is comprised of different kinds of information. The objective of the extraction process is to identify and describe information in the operating context that represents the contribution and impact of human activities on plant operations as well as the causes for the human activities. An extraction process was developed and is described below to meet this objective. Figure 3.1 presents the main elements of the extraction process that relate to model elements characteristic of HRA.

The operating experience sources employed in HERA include information that identifies the plant, date, specific event being reported, and the unavailability, failure, or other occurrence that met the conditions of 10 CFR 50.72/73, for reporting and analysis. From this information, one typically can piece together a timeline of the event, and derive some insight about the contingency between the actions that contributed to its occurrence and resolution.

This kind of information may correspond to the descriptive information that is customary in most HRAs—termed *Event Description* in the diagram. Most HRAs include documentation of the event (i.e., the specific failure with which human actions are associated) and conditions that an analyst has attempted to represent in an analysis. This may include initial conditions, ongoing plant activities and other information that describe the context preceding the HRA event. This characterization may also include any relevant assumptions that an analyst has made in order to perform the analysis.

Descriptions of operating events that involve human performance typically include the actions that contributed to their occurrence. These include human actions that were important in detecting and mitigating conditions as well as those that may have caused or contributed to their occurrence. HRA is principally concerned with predicting HFEs and their likelihoods in terms generally applicable to conditions of interest in PRA. Analysis of operating experience for use in HERA includes efforts to identify instances of human failure (as they may be variously termed by different HRA methods), how they were manifested in the event, their context and consequences. Judgment and operating experience are often necessary to extract this kind of

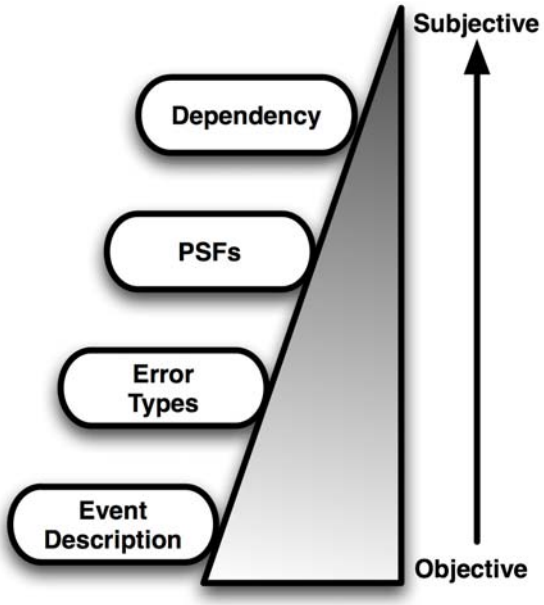


Figure 3.1 Diagram of HERA extraction process.

information. It also requires knowledge of the desired actions or conditions, as well as the action that did not occur or the performance standard that was not met. The information that is produced this way corresponds to the *Error Types* in Figure 3.1

In addition, attempts are made to identify the conditions and causal mechanisms that directly influenced the occurrence of errors. This includes consideration and judgment of factors that are known or suspected to influence human performance in these operating contexts as well as any other information that was reported by the licensee. This information is represented in Figure 3.1 as *PSFs*.

As noted earlier, many contemporary HRA methods and recent studies of operating experience have pointed out that human performance is dependent upon both the operating conditions and the cognitive context that is created by individuals and crews in NPPs. Attempts are made during the extraction process to identify instances in which dependency between actions is created. This includes conditions in which analysts' judge from the information available to them that performance of an activity was affected by a prior activity or condition, as well as the goals, beliefs, and expectations of the performers. This information corresponds to *Dependency* in Figure 3.1.

These activities are performed sequentially as shown in Figure 3.1. Beginning with activities at the bottom of the diagram they continue through to those at the top. The triangular shape depicts the relative amount of information that remains to be extracted by this process. As shown, much information remains to be extracted early on, and this is progressively reduced. By completing the analytic activities corresponding to each stage from the bottom to the top of the triangle, the analysis of a unit of operating experience is completed.

The arrow to the right side of the triangle in Figure 3.1 shows the general relationship between objectivity and subjectivity in analyses employed in the extraction process. Analyses and the results of the *Event Description* stage are likely to be the most objective, since relatively little

analyst judgment is used. Subsequent activities that include characterizing activities such as human failures, attempting to identify factors that contributed to their occurrence and that create dependency require increasing judgment on the part of the analyst. Processes were created to address quality and reliability in light of the subjectivity and the expertise that are needed to identify or estimate this information. These are addressed in the Quality Assurance Process section of Volume 2 in the HERA NUREG/CR series.

The level of detail provided in the source material also influences the level of subjectivity required to complete analyses. Some data sources may represent impoverished data that require extensive interpretation by analysts early in the coding process. Conversely, rich data sources may minimize the amount of interpretation necessary on behalf of the analyst. Generally speaking, AITs are considered a richer data source than LERs.

3.6 Information Included in HERA

Based on the top-level framework for HERA as well as the extraction process and available information from operational records such as LERs and AITs, the information provided by HERA and the structure of the HERA product were subsequently designed. This structure and information content are summarized here.

First, a description of the operational event based on the source sets up and provides the underlying context for all the rest of the data provided in HERA relevant to that event. The event description, with the source of information identified, provides sufficient details to understand key initial plant conditions, and subsequent happenings including key successes and losses of functions, systems, and equipment as well as successes and failures of human performance (all called subevents in HERA terminology) that contributed to the event. Timing information, where particularly important to understanding the overall event, is also supplied. The timing information is provided in an event time line format that also includes a text summary of the sequential human failure and success subevents related to the operational event. The event time line provides a time-based event progression that includes latent or pre-initiator conditions, initiating events, and post-initiator actions and activities where applicable. The graphic time line contains the subevents most critical to the progression and termination of the event. It distinguishes between unsafe acts and other human actions where such information can be derived.

A considerable portion of the HERA structure is devoted to providing information about contextual conditions, performance conditions, PSFs and the like that were known to be present or considered likely to be operant during the operational event. Human actions are described in terms of their cognitive and behavioral components–based upon general features that can be employed by analysts using a variety of HRA methods.

Plant conditions and associated factors that influenced the situation and the resulting human performance are provided to the extent such information is known or can be inferred from the event report(s). This includes information regarding the manifestation of the failures in plant systems and the demands placed upon operational and maintenance personnel during the event.

Information about latent conditions is provided to assist in determining the nature and extent of influences upon personnel during or due to pre-initiating event conditions. This includes some factors that are similar to those associated with operations such as written procedures, training

and qualifications, and human machine interfaces. It also includes some factors that are key to effective performance of maintenance, test, and surveillance activities that are characteristic of pre-initiator performance conditions such as work planning and preparation, skill of crafts, design configuration, equipment specification, and construction.

Information about the dependency between related human actions in PRA-relevant events may be provided in a number of ways. When information points to relationships between subevents in the source, dependencies may be indicated and are evaluated and the nature of such relationships reported or characterized. Failures of individual activities may create a greater likelihood for failure of succeeding actions. Where it is possible to infer such relationships, descriptions of the nature of the dependency between human subevents are provided.

Events described in operating experience and other sources have been terminated successfully through human intervention in many cases. As important as it is to characterize the conditions that contributed to human failures, similarly well-characterized data are needed for successful human actions. Successful human actions document the actions that were taken by personnel in the performance of their tasks under normal as well as off-normal conditions. Together with information about human failures, inclusion of successful human actions provides a more complete description of human performance.

The next chapter provides a systematic walkthrough of an example event coded in HERA. The goal of this chapter is to identify the key data included in the structure of HERA.

This page intentionally left blank.

4 ILLUSTRATION OF HERA STRUCTURE AND CONTENT

4.1 Overview

HERA provides a repository of human contributions to reportable events at NPPs. The data structure in HERA comprises two separate worksheets, the *Part A Worksheet* and the *Part B Worksheet*, which can be found in Appendices A and B, respectively. The worksheet structure is mirrored in the software database. The HERA Part A Worksheet and software database include basic information about the event and plant. This information is extracted directly from the LER or other data source. The HERA Part B Worksheet includes PSF information specific to human actions or inactions. Each action or inaction, whether resulting in an error or success, is captured as a separate Part B Worksheet.

4.2 HERA Worksheet A

4.2.1 Worksheet Sections

The Part A Worksheet captures all information necessary to categorize the event at a high level. The Part A Worksheet stops short of classifying PSF information, which is the purview of the more detailed Part B Worksheet. The Part A Worksheet includes five sections:

- *Section 1. Plant and Event Overview.* This information documents basic information about the document source (e.g., LER or AIT number); the plant name, type, and operating mode; the type of event (e.g., initiating event or CCF); a description of the overall event; information about loss of functions, systems, and components; and trending data regarding the relation of the event to other events.
- *Section 2. Event Summary and Abstract.* The analyst provides a brief summary of the event or copies the event abstract here.
- *Section 3. Index of Subevents.* An event is composed of a series of subevents, the chronology of significant human or equipment related occurrences at the plant surrounding the plant upset or potential upset. In this table, the analyst provides a decomposition of the event into subevents, classified according to the following information fields for each subevent:

  Subevent codes (see Sections 4.2.2.1 and 4.2.2.2) to categorize the subevent as human or equipment related with positive or negative effects;
  - Date and time of the individual subevent;
  - Work type, extracted from the Human Factors Information System (HFIS; NRC, 2006), which describes the type of activity being performed by workers at the time of the subevent;
  - Personnel involved in the subevent, coded according to Table 4.1.
  - Status of the subevent as a pre-initiator, initiating event, or post-initiator (see Glossary for definitions);
  - Status of an error as active (apparent and/or immediate effect) or latent (no apparent or immediate effect), where applicable;
  - Status of error as either an error of omission or commission, where applicable (see Glossary for definitions);
  - A brief textual description the subevent, including what happened and, in most cases, why the subevent was significant;
  - Human action categorization number (see Table 4.2), where applicable;

  - Checkbox to signify if the subevent represents recovery;
  - Checkbox to signify a subevent is significant to the evolution of the overall event and should be include a Part B Worksheet analysis;
  - A list of related subevents that may be clustered (see Section 4.2.2.3);
  - A field for comments; and
  - A checkbox to signify that the subevent is significant to understanding the overall event and should be included in the graphical timeline (see Section 4.2.3).
- *Section 4. General Trends and Lessons Learned.* This section allows the analyst to indicate any strong, overarching trends or context across the subevents and provide a detailed explanation.
- *Section 5. Human Subevent Dependency Table.* This section allows the analyst to specify dependency between human subevents (see Section 4.2.4).

Except where noted in the next sections, additional details and definitions for these taxonomic fields in HERA are not provided in this NUREG/CR. Additional details and definitions may be found in the HERA User's Guide (Volume 2 in the HERA NUREG/CR series).

4.2.2 Subevent Decomposition

An *event* refers to the overall series of factors that leads to a reportable occurrence at a plant. This definition is somewhat broader than prescribed in 10 CFR § 50.73 (a)(2)(iv)(B), which describes specific reportable plant upset conditions. In HERA, an event comprises all activities and operations that influenced this occurrence, which include the entire chronology of significant human actions and plant operations contained in the LER. An event typically consists of *subevents*, which are any subset of actions that contributed to the overall event. A subevent may precede or follow the actions that led to the reportable occurrence.

In terms of level of granularity, or how narrow the level of analysis is when breaking the event into subevents, the HERA coder focuses on discrete but complete actions that are oriented toward a common goal. In decomposing an event into subevents, the analyst is assisted by asking several questions.

- Is this action being performed by a different person and/or crew?
- Is there a separate purpose or goal for this action than a different action?
- Does it involve different equipment or a different task?
- Are there different consequences for the actions?

If the answer to any of these questions is yes, then the action should generally be coded as a separate subevent. For example, setting the coolant flow rate would be coded as a subevent, but not all the other actions associated with it, such as turning the valve or checking the setpoint indicator.

Note that there are three crucial pieces of information that characterize the subevents in terms of their contribution to the overall progression of an event. First, there is the proper sequencing of the events. An LER or other information source will typically contain the times and dates for each subevent. For this reason, the listing of subevents is referred to as the *event timeline* in HERA. This chronological information is especially useful for identifying fault or error precursors and for determining dependencies between subevents.

Table 4.1 HERA personnel codes for Worksheet A.

O	**Operations**: includes all licensed operators, including reactor operator (RO) and senior reactor operator (SRO), regardless of position. This category also includes system specialists (SS), shift technical advisor (STA), non-licensed operators, rad-waste operators, auxiliary operators, plant equipment operators, fire department work planning, outage planning, and project management group. Use the higher level code if there is insufficient information to support using a more detailed code. Detailed codes in this category specific to use in HERA include: **O-S**: Operations Supervisors **O-C**: Control Room (CR) Operators **O-A**: Outside of CR Operators **O-T**: Technical Support Center (TSC)
M	**Maintenance and Testing**: includes all maintenance personnel, including electrical, mechanical, and instrumentation and control (I&C) technicians. Use the higher level code if there is insufficient information to support using a more detailed code. Detailed codes in this category specific to use in HERA include: **M-S**: Maintenance Supervision and/or Planning **M-M**: Mechanical maintenance technicians and personnel **M-E**: Electrical maintenance technicians and personnel **M-I**: I&C technicians and personnel
B	**Management**: includes all management personnel, including lower-level and corporate management and executives.
S	**Plant Support Personnel**: includes all departments and personnel who support plant operations, administration, training, security, and other functions external to the control room. Use the higher level code if there is insufficient information to support using a more detailed code. Detailed codes in this category specific to use in HERA include: **S-A**: Administrative Support **S-C**: Chemistry **S-D**: Emergency Planning/Response **S-G**: Engineering **S-V**: Fitness for Duty **S-F**: Fuel Handling **S-H**: Health Physics **S-P**: Procedure Writers **S-Q**: Quality Assurance (QA)/Oversight **S-R**: Security **S-T**: Training **S-Y**: Shipping/Transportation **S-S**: Specialized Task Force **S-W**: Work Control **S-L**: Licensing/Regulatory Affairs
X	**Site-Wide**: use when all work groups are involved
N	**Non-Plant Personnel**: includes all personnel not employed by the plant, including contractors, vendors, and NRC personnel. Use the higher level code if there is insufficient information to support using a more detailed code. Detailed codes in this category specific to use in HERA include: **N-C**: Contractor Personnel **N-M**: Manufacturer **N-R**: NRC/Regulator **N-V**: Vendor
Z	**Other**: use when none of the above categories apply or the work group cannot be determined from the available information. Provide an explanation in the corresponding text field.

Table 4.2 Common human action category codes for the HERA Index of Subevents.

#	Generic Human Errors - XHEs	Examples of Errors
0	Other [none]	
1	Operator fails to change or incorrectly changes electrical lineup or instrumentation configuration in response to condition	Failure to transfer load to energized bus, or to open and close breakers as needed to restore power to bus
2	Operator fails to change or incorrectly changes valve lineup in response to condition	Plant condition occurs that requires different system lineup. Operator fails to react correctly
3	Operator fails to change or incorrectly changes ventilation line-up on condition	Failure to open equipment room doors or dampers after loss of power/ventilation
4	Operator fails to properly restore or incorrectly restores system/component after maintenance	EDG assumed to be operable but control switch is out of position, or restoration valve lineup incorrect
5	Maintenance personnel return miscalibrated/inoperative instrumentation, controls or components to service	Pressure/level/flow instruments not calibrated correctly, safety relief valves lift at wrong pressure, or maintenance incomplete or erroneous
6	Operator fails to diagnose or incorrectly diagnoses condition	Failure to determine cause of condenser vacuum decreasing while at power
7	Operator fails to properly change or incorrectly changes plant condition in response to condition or diagnosis	Failure to begin power reduction in response to a noted degradation of service water system performance
8	Operator fails to trip, control, or adjust reactor / active system or component on monitored condition indication or diagnosis, or does so incorrectly	During primary system cooldown, maximum cooldown rate is exceeded, or upper limit on oil temperature is exceed on reactor coolant pump shaft bearing
9	Operator fails to or incorrectly starts or maintains standby/inactive system / component at condition/set point or diagnosis	Failure to start RCIC (BWR) on low reactor level or failure to monitor EDG key parameters or exceeding a safety limit causes component unavailability
10	Operator fails to recover or incorrectly recovers component/system that has failed/was tripped	Failure to restart pumps or other loads on bus after being re-energized
11	Operator fails to bypass/clear trip signal as needed, or does so incorrectly	Condition causing trip has cleared, but component cannot be restarted because interlock is still active
12	Failure to resolve known deficiencies in equipment, procedures, or training of plant personnel, including using workarounds	Using manual control of steam pressure when an automatic pressure regulator is not operative for an extended period
13	Failure to follow administrative, procedural, or regulatory requirements	Improper staffing or scheduling of drills, configuration management failures, or poor log-keeping or shift turnover
14	Non-plant personnel cause plant / system / component to trip or operate incorrectly	System engineer disturbs wire label in terminal box, causing short and plant trip, or crafts person bumps relay cabinet with ladder, causing trip

Table 4.2 Continued.

#	Generic Human Successes - HSs	Examples of Successes, Recoveries
0	Other [none]	
1	Operator correctly changes electrical lineup or instrumentation configuration in response to condition	Operator transfers load to energized bus, or opens and closes breakers as needed to restore power to bus
2	Operator correctly changes valve lineup in response to condition	Plant condition occurs that requires different system lineup. Operator reacts correctly
3	Operator correctly changes ventilation line-up on condition	Equipment room doors or dampers are success-fully opened after loss of power/ventilation
4	Operator correctly restores system / component after maintenance	EDG including control switch, is correctly restored to operation, or restoration valve lineup is correct
5	Maintenance personnel return properly calibrated/operative instrumentation, controls or components to service	Pressure/level/flow instruments are calibrated correctly, safety relief valves lift at correct pressure, or maintenance is complete and correct
6	Operator correctly diagnoses condition	Operators determine cause of condenser vacuum decreasing while at power
7	Operator correctly changes plant condition in response to condition or diagnosis	Operator correctly begins power reduction in response to a noted degradation of service water system performance
8	Operator correctly trips, controls, or adjusts reactor / active system or component on monitored condition indication or diagnosis	During primary system cooldown, maximum cooldown rate is not exceeded, or upper limit on oil temperature is not exceed on reactor coolant pump shaft bearing
9	Operator correctly starts or maintains standby/inactive system / component at condition/set point or diagnosis	Operator starts RCIC (BWR) on low reactor level or correctly monitors EDG key parameters or prevents exceeding a safety limit that would cause component unavailability
10	Operator correctly recovers component / system that has failed/was tripped	Successfully restarts pumps or other loads on bus after being re-energized
11	Operator correctly bypasses / clears trip signal as needed	Condition causing trip has cleared, and component can be restarted because interlock has been cleared by operator
12	Plant staff timely resolve known deficiencies in equipment, procedures, or training of plant personnel, avoiding the use of workarounds	Timely restoring a malfunctioning automatic pressure regulator, avoiding the use of manual control of steam pressure for an extended period
13	Proper adherence to administrative, procedural, or regulatory requirements	Proper staffing or scheduling of drills, accurate configuration management, or complete log-keeping or shift turnover
14	Non-plant personnel avoid or prevent causing plant/system/component trips or incorrect operation	System engineer investigates in-plant conditions without causing plant trip, or crafts person conducts sensitive work without causing trip

Second, the event timeline contains a brief *narrative description* of the subevents. This description provides adequate information so that the user of HERA will not necessarily have to read the LER or other information source in order to understand what happened.

The event timeline contains information about *the positive or negative effect* of the subevent. A subevent may have a negative effect—such as those factors that lead to the reportable event—or a positive effect—such as corrective actions taken to remedy the fault.

HERA uses *subevent codes* to categorize the negative or positive effects of the subevents. These subevent codes are borrowed and adapted from the codes often used in PRAs. HERA employs seven subevent codes—three human subevents, three plant subevents, and one plant external subevent—as depicted in Table 4.3 and explained in the next sections.

Table 4.3 HERA subevent codes.

	Negative Outcome	Positive Outcome	Context
Human	XHE	HS	CI
Plant	XEQ	EQA	PS
External	EE	EE	EE

4.2.2.1 Human Subevents

- ***XHE***—represents a human error (HE) that potentially contributes to the fault (X). An XHE is a human action or inaction that:
    - Occurs within the boundary of the nuclear steam supply system (NSSS) and balance of plant (BOP) systems; *AND*
    - Is unsafe; *OR*
    - Potentially negatively affects plant, system, equipment availability, operability, and consequences; *OR*
    - Represents a circumvention with negative impact.

- ***HS***—represents a successful human action or inaction that potentially has a positive effect on the event outcome. HS is a human action or inaction that:
    - Occurs within the boundary of the NSSS and BOP systems; *AND*
    - Potentially positively affects plant, system, equipment availability, operability, and consequences; *AND*
    - Represents activities that are not purely routine and that go beyond normal job expectations; *OR*
    - Represents a recovery action; *OR*
    - Represents a circumvention with positive impact.

- ***CI***—represents contextual information about the human action or inaction. It is any human action or inaction that isn't classified as an XHE or HS. Specifically, CI is a human action or inaction that:
    - Is associated with design errors or improper guidance; *OR*
    - Takes place outside the NSSS and BOP systems; *OR*
    - Is an engineering function including onsite engineering; *OR*
    - Represents expected human actions in response to the situation; *OR*
    - Encompasses conversations and notifications.

While engineering functions are normally considered CI, they may, at the coder's discretion, be considered XHE or HS if they are significant contributors to the event, or if they have significant consequences to plant equipment and/or people who are inside the NSSS and BOP systems. Also, contextual information may include any information that affects the quality of the human action or interaction with the plant or its systems and components.

A key issue to consider when assigning subevent codes to the subevents in the timeline is whether the subevent contributes to the event progression. This consideration will determine whether a human subevent receives Worksheet B coding. Some ways that a subevent can contribute to an event, both positively and negatively, include whether or not it:

- Affects system or component operability or availability, either by making equipment unavailable or by restoring equipment operability;
- Complicates response to the event or simplifies the situation by removing a complication;
- Distracts operators or requires operator attention to be diverted from the event, or it eliminates distractions;
- Adds to or eliminates confusion;
- Delays work that should be done immediately, or it involves completing necessary work quickly;
- Includes sufficient information in the data source for determination of appropriate assignments in Worksheet B.

Generally, if a human subevent contributes to the event progression, it is coded as an XHE or HS. Other human subevents are coded as CI. There are exceptions to this rule, however.

- If a human action is a violation of procedures, rules, requirements, or expectations of a job, it is coded as an XHE regardless of whether it directly impacts the progression of the event.
- If a person's actions are unsafe, regardless of their impact on the event, they are coded as XHE rather than CI. For example, if a control room operator should notify the operators in the turbine building to avoid an area that has a leak, but does not, this would be coded as an XHE, regardless of whether or not this situation relates to efforts in the control room to restore auxiliary feedwater to the reactor. It indicates deficiencies in safety culture and communication and should be noted accordingly in HERA.

4.2.2.2 Plant and External Subevents

- ***XEQ***—represents an equipment failure (EQ) that potentially contributes to the fault (X).

- ***EQA***—represents successful equipment actuation that potentially has a positive effect on the event outcome.

- ***PS***—represents information about the plant state that helps to explain the equipment failure, actuation, or other noteworthy factors pertaining to plant health or transients.

- ***EE***—represents events external to the plant such as extreme weather, external fires, seismic events, or transmission system events.

4.2.2.3 Subevent Clusters

Although all types of subevents can be included in the event timeline, only human errors (XHE) and successful human actions (HS) are included in the subsequent full HERA analysis utilizing the Part B Worksheets. Because subevents may be closely related, it is possible to combine them within HERA. Particularly with respect to human errors and successful human actions, clustering subevents achieves coding efficiency by reducing the number of separate Part B Worksheets that must be completed for each event.

When dealing with human subevents, it is only allowable to combine like with like subevents (e.g., XHE+XHE, HS+HS, or CI+CI, but not XHE+HS). The analyst may combine multiple human subevents into one, when:

- They represent the same goal and strategy, *AND*
- They utilize the same PSFs, *AND*
- There are no intervening influences to change the situation (e.g., no additional cues/unexpected occurrences/related condition changes/etc.), *AND*
- There are no separate downstream effects.

Basically, if human events have the same goal, strategy, and context, then it is possible to combine them. Typically, combined XHEs, HSs or CIs might involve the same system, but they could represent different equipment with the same goal and strategy. Clustered subevents typically will follow a strict chronological sequence without intervening subevents, but it is possible for clusters to bridge subevents when parallel series of events occur. Clustering then serves as a means to link those subevents related to a single train of events.

It is also possible to combine plant subevents (XEQ, EQA, and PS), although these subevents are not coded in the Part B Worksheets and clustering does not increase coding efficiency. Generally speaking, XEQs are not clustered, since it is desirable to provide as much information about equipment failures as possible. EQAs and PSs may be readily combined, especially when they capture routine plant activities. They should not, however, be combined when there are intervening human subevents.

4.2.3 Graphical Timeline

The HERA software database provides the capability to produce graphical timelines of the subevents selected for graphing. The graphical timeline affords the analyst or HERA user the ability to gain a quick overview of the progression of the most important subevents across the course of the event. Time is plotted along the horizontal axis, with positive subevents projecting upward from the axis and negative subevents projecting downward. The corresponding descriptions of the subevents are listed below the text. Optionally, dependency may be included and is depicted as lines connecting subevents.

Typically, the following subevents are included in the graphical timeline:

- All Part B subevents (XHEs, HSs, or clusters),
- All significant CIs, and
- All plant information that is significant to the event progression (XEQs, EQAs, PSs, and clusters).

Exceptions are left to the analyst's discretion. Note that it is possible for the graphical timeline

to be continued across multiple pages for those events that have a particularly detailed chronology.

4.2.4 Subevent Dependency

To complement the timeline information, the HERA coder also completes the dependency matrix, in which the relationship among human error subevents is estimated. Because HRA methods do not currently model the relationship between human errors and successful human actions, dependency is only completed for human error subevents. The approach to dependency in HERA, based on ATHEANA (Cooper et al, 2000) and other contemporary HRA methods, offers analysts the opportunity for non-parameterized dependency estimation. Early HRA methods like THERP (Swain and Guttman, 1984) provided a rubric of parameters that were known to influence dependency. With these parameters came a scale that rated dependency from zero (no dependency) to a number representing complete dependency. The approach adopted in HERA does not quantify the level of dependency, nor does it specify the parameters that need apply. Instead, HERA provides comment fields for the analyst to document his or her decision criteria for selecting dependency. A list of possible dependency parameters is embedded in the dependency matrix. These parameters are based on the discussion in the *HRA Good Practices Guide* (Kolaczkowski et al., 2005)

Subevents do not need to be contiguous to be dependent. It is possible for multiple series of subevents to occur in parallel tracks. In such a case, the dependencies should reflect the proper track of occurrence, even when subevents from different tracks commingle chronologically.

4.3 HERA Worksheet B

4.3.1 Worksheet Sections

As a repository for human performance in NPPs, HERA coders only analyze subevents containing human errors (XHE) and successful human actions (HS). General information about the overall event as described in the previous section is captured in the Part A Worksheets or the equivalent in the software database. Individual subevent analyses are captured in the Part B Worksheets or the equivalent in the software database. The HERA coder completes a separate analysis for each XHE or HS subevent or cluster.

Subevent analyses are structured by seven sections, including:

- *Section 1 Personnel Involved in Subevent.* Personnel are grouped into categories, with a category-level heading (e.g., “Plant Support Personnel”) and a more detailed description (e.g., “Security”). This allows the analyst to select at the level of detail provided in the information source. As applicable, multiple personnel may be selected for any given subevent. Note that the information contained in this section duplicates information provided in Part A in the Index of Subevents.
- *Section 2. Contributory Plant Conditions*. This list, based on Halden Reactor Project Report HWR-521 (Braarud, 1998), summarizes plant conditions that contributed to the subevent and/or influenced the decisions and/or actions of the personnel. If significant plant factors were at play in the subevent but are not listed, the analyst may specify “Other.”
- *Section 3. Positive Contributory Factors/PSF Details.* This section allows the analyst to record any details relevant in selecting PSFs. This listing provides positive contributors beyond the nominal state. The positive contributory factors are grouped according to the PSFs used in HERA (see Section 4.3.2). For each assigned contributory factor, the analyst

should indicate if the selection was made based on evidence directly from the source or based on coder inference. All assignments should also be explicated using the comment fields.

- *Section 4. Negative Contributory Factors/PSF Details.* The analyst uses this field to indicate any negative factors that contributed to the subevent. This section is the counterpart to the positive contributory factors and applies only for PSF contributors that fall below the nominal state. Items in parentheses cross-reference sections where HERA structural elements have utilized existing HFIS (NRC, 2006) structures. The parentheses identify the item in HFIS from which the HERA structure is copied.
- *Section 5. Performance Shaping Factors*. Eleven PSFs are provided, each of which is assigned as either "Insufficient Information," "Good," "Nominal," or "Poor." In addition, the analyst determines if a significant cognitive component ("Detection," "Interpretation," or "Planning") and/or an action component was part of the subevent.
- *Section 6. Error Type.* This section allows the analyst to record the error type according to two taxonomies: errors of commission vs. errors of omission; and slip or lapse, mistake, circumvention, or sabotage. Detailed assignments within these categories are also provided to provide greater demarcation of the exact error type.
- *Section 7. Subevent Comments*. This section is available as needed to record additional remarks necessary to complete or supplement the worksheet analysis for the subevent.

4.3.2 HERA PSFs

PSFs provide a quantifiable means of tracing either the detrimental or positive effect of factors on human performance. HERA's PSFs are closely modeled on the eight SPAR-H PSFs, defined as follows (Gertman et al., 2005):

- *Available Time*—refers to the time available to complete a task, often in the context of the time to complete a corrective action in a NPP.
- *Stress and Stressors*—are broadly defined to describe the mainly negative, though occasionally positive arousal that impacts human performance.
- *Complexity*—refers to how difficult the task is to perform in the given context.
- *Experience and Training*—included in this consideration are years of experience of the individual, specificity of training, and amount of time since training.
- *Procedures and Reference Documents*—refers to the existence and correct use of formal operating procedures or best practices for the tasks under consideration.
- *Ergonomics (including Human-Machine Interaction)*—refers to the equipment, displays and controls, layout, quality and quantity of information available from instrumentation, and the interaction of the operator with the equipment to carry out tasks.
- *Fitness for Duty/Fatigue*—refers to whether or not the individual performing the task is physically and mentally fit to perform the task at that time.
- *Work Processes*—refer to aspects of doing work, including inter-organizational, safety culture, work planning, communication, and management support and policies.

In reference to the *HRA Good Practices Guide* (Kolaczkowski et al., 2005), three additional PSFs are included to complement the SPAR-H PSFs:

- *Communication—refers to the quality of verbal and written interaction between personnel working together at the NPP.*

- *Environment—refers to so-called external PSFs such as ambient noise, temperature, lighting, etc., which can greatly influence the ability of personnel to carry out their prescribed tasks.*
- *Team Dynamics and Characteristics—refers to style and level of supervision, crew interactions (beyond simple communication), morale, and teamwork.*

A comparison of SPAR-H, *Good Practices*, and HERA PSFs can be found in Table 4.4. Each PSF in HERA features different degrees of performance impediment ("Poor") or enhancement ("Good"). Additionally, the coder may specify that the PSF had no effect ("Nominal"), or that the information did not provide adequate information to make the PSF assignment ("Insufficient Information"). The appropriate assignment level for each PSF is determined by the HERA coders and vetted by multiple coders to ensure validity and consistency in coding.

Table 4.4 PSF comparison between Good Practices, SPAR-H, and HERA.

Good Practices (NUREG-1792)	SPAR-H (NUREG/CR-6883)	HERA (NUREG/CR-6903)
Training and Experience	Experience/Training	Experience & Training
Procedures and Administrative Controls	Procedures	Procedures & Reference Documents
Instrumentation	Ergonomics/HMI	Ergonomics & HMI
Time Available	Available Time	Available Time
Complexity	Complexity	Complexity
Workload/Time Pressure/Stress	Stress/Stressors	Stress & Stressors
Team/Crew dynamics	--	Team Dynamics/ Characteristics
Available Staffing	Work Processes	Work Processes
Human-System Interface	Ergonomics/HMI	Ergonomics/HMI
Environment	--	Environment
Accessibility/Operability of Equipment	Ergonomics/HMI	Ergonomics/HMI
Need for Special Tools	Ergonomics/HMI	Ergonomics/HMI
Communications	--	Communication
Special Fitness Needs	Ergonomics/HMI	Ergonomics/HMI
Consideration of 'Realistic' Accident Sequence Diversions and Deviations	--	N/A—Covered in Plant Conditions and PSF Details

4.4 Example Event

In this section, we illustrate how human performance information is organized and structured in HERA, using a hypothetical, simple example of an inoperable emergency diesel generator (EDG). In our example, it is assumed that a boiling water reactor (BWR) is discovered to have had an inoperable EDG over a period of one week. This inoperability exceeded the NRC maximum allowable outage interval for an EDG, requiring the utility to complete an LER on the circumstances of the event. In the LER, the utility describes any precursors leading up to the event, the chronology of the event, and prescribes any corrective actions that the plant has

taken to remedy the problem or intends to take to prevent reoccurrence. In our example, during monthly surveillance of the EDG, the coolant flow rate is found to be 550 gallons per minute (gpm)instead of the required 900 gpm. An in-plant analysis revealed that the EDG was maintained one week prior to the event. During maintenance, the flow rate was incorrectly calculated based on the position of the flow rate valve, rather than on a measure of the actual flow rate produced by the EDG. Consequently, because the flow rate valve did not correspond to actual coolant flow rate, the EDG was placed in service with a technical specification violation. This technical specification violation was not identified until one week later, during the monthly surveillance testing. In the LER, the utility identified an incorrect EDG maintenance procedure as the root cause of the reportable event. The coolant flow rate was promptly corrected and the EDG was declared operable. The utility identified corrective action through planned revisions to the procedure for verifying coolant flow rate during maintenance.

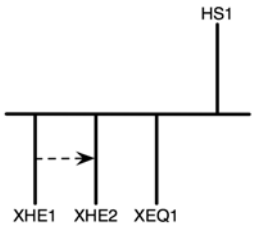


Figure 4.1 Sample graphical timeline

Our hypothetical example helps illustrate the distinction between an event and its subevents. The overall event is the inoperability of the EDG. This event is comprised of the subevents presented in the sample event timeline from the Part A Worksheet, Section 3:

- The subevent features two human errors (XHE1 and XHE2), an equipment failure (XEQ), and a successful human recovery action (HS1).
- The event timeline classifies the work type for both XHEs as maintenance (M), while the recovery action has a testing (T) work type.
- The personnel are classified as maintenance technicians (M-M) across the subevents.
- All subevents are classified as pre-initiators, since an initiating event did not occur throughout the event. The event was nonetheless reportable, since the insufficient coolant flow rate resulted in a technical specifications violation.
- Both XHEs were latent failures, since the EDG was not called into service. In contrast, the XEQ and HS1 were active conditions.
- XHE1 was an error of commission (the maintenance crew set the flow rate incorrectly), while XHE2 was an error of omission (the maintenance crew failed to check the flow rate).
- XHE1 was classified according to human action error category 4, signifying an incorrect restoration of a component after maintenance. XHE2 pertained to human action error category 13, signifying a failure to follow procedural requirements. HS1 was classified as human action success category 2 (Second page of Table 4.2) to signify that the plant staff correctly changed the valve lineup.
- The human subevents—XHE1, XHE2, and HS1—are designated for further analysis using the Part B Worksheets.
- XHE1, XHE2, and XEQ are related subevents, although the comments do not indicate that XHE1 and XHE2 are clustered into a single subevent for subsequent analysis in the Part B Worksheets.

For the present purposes, all subevents are included in the graphical timeline, as seen in Worksheet A.

Table 4.5 Sample list of subevents from HERA

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
XHE1	3/15/04	M	M-M	PRE	L	C	During maintenance of EDG 3, the coolant flow rate valve was set too low.	4	☐	☒	XHE2, XEQ		☒
XHE2	3/15/04	M	M-M	PRE	L	O	Maintenance failed to perform post flow rate valve test per expectations.	13	☒	☒	XHE1, XEQ	Not required in procedures, but part of standard practices	☒
XEQ	3/15/04			PRE	A		The EDG is inoperatble at the required coolant flow rate should it be nneded, violating tech spec		☐	☐	XHE1, XHE2		☒
HS1	3/22/04	T	M-M	PRE	A		During routine monthly testing of EDG, the coolant flow rate was found to be in tech spec violation; coolant flow rate valve was corrected.	2	☒	☒			☒

Subevent Code	XHE1	XHE2													
XHE1		☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Common		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Dependency Factors:			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Similar Task				☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same person/people					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Close in time						☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same location/same equipment							☐	☐	☐	☐	☐	☐	☐	☐
	• No independent oversight								☐	☐	☐	☐	☐	☐	☐
	• Same cues									☐	☐	☐	☐	☐	☐
	• Action prompts next incorrect action										☐	☐	☐	☐	☐
	• Similar environmental conditions											☐	☐	☐	☐
	• Unreliable system feedback												☐	☐	☐
	• Prior human failures on same equipment													☐	☐
	• Lack of intervening human success														☐
	• Cultural dependency														
	• Mindset														
	• Work Practices														
	• Other (explain)														

Figure 4.2 Sample dependency table.

Dependency between human errors is indicated in Worksheet A, Section 5, the dependency table. For the example event, the assignment of dependency between XHE1 and XHE2 is illustrated in Figure 4.1. Dependency is assigned in this case because XHE1 and XHE2 share the same staff and occurred close in time and at the same location. This dependency is also indicated in the graphical timeline (see Figure 4.1) by a dashed line connecting XHE1 to XHE2. Upon completion of the Part A Worksheet, the HERA analyst completes separate Part B Worksheets for each human subevent. In this case, three Part B Worksheets would be completed, corresponding to XHE1, XHE2, and HS1. To illustrate select fields from the Part B Worksheet, we will examine the Part B Worksheet coding for XHE1.

Part B Worksheet, Section 1, specifies the personnel involved in the subevent. As the example in Figure 4.3 illustrates, XHE1 involved maintenance and testing personnel, specifically those involved with mechanical systems such as the EDG.

☐ Operations (OPS) ☐ OPS Supervisors ☐ Control Room (CR) Operators ☐ Outside of CR Operators ☐ Technical Support Center (TSC)	☐ Plant Support Personnel ☐ Administrative Support ☐ Chemistry ☐ Emergency Planning / Response ☐ Engineering	☐ Security ☐ Training ☐ Shipping / Transportation ☐ Specialized Task Force ☐ Work Control
☒ Maintenance and Testing ☐ Maintenance Supervision / Planning ☒ Mechanical ☐ Electrical ☐ I&C	☐ Fitness for Duty ☐ Fuel Handling ☐ Health Physics ☐ Procedure Writers ☐ QA / Oversight	☐ Licensing / Regulatory Affairs ☐ Non-Plant Personnel ☐ Contractor Personnel ☐ Manufacturer ☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Figure 4.3 Sample personnel involved in subevent.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☒ Installation workmanship inadequate	Failure to set EDG coolant flow control valve to right level
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Figure 4.4 Sample contributory plant factors.

Part B Worksheet, Section 2, specifies contributory plant factors or conditions that influenced the subevent. As can be seen in Figure 4.4, the event implicates a single plant condition, namely that the installation workmanship was inadequate. In this case, installation refers to maintenance on the EDG and the failure to set the coolant flow control valve to the correct level.

Part B Worksheet, Section 3, refers to the positive PSF details. In the case of XHE1, no positive PSF details were identified, and the analyst would not check any boxes in this section.

Part B Worksheet, Section 4, refers to negative PSF details. For XHE1, only the Procedures & Reference Documents PSF is implicated. In Section 4, the analyst would check the box signifying that the procedures contained human factors deficiencies (see Figure 4.5).

Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☒ Procedure / reference document technical content less than adequate (LTA) (P 111)	☒ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

Figure 4.5 Sample PSF detail.

PSFs	PSF Levels	Comment
Available Time	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Stress & Stressors	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Complexity	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Experience & Training	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inadequate procedures for checking flow valve level identified in LER.
Ergonomics& HMI	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Work Processes	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Communication	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	
Team Dynamics / Characteristics	☐Insufficient Information ☐Good ☒Nominal ☐Poor	

Figure 4.6 Sample PSF assignment.

Part B Worksheet, Section 5, contains the HERA PSFs. In XHE1, in which procedural problems were noted, the appropriate assignment the Procedures & Reference Documents PSF is "Poor." Note that the other PSFs are assigned a "Nominal" level, indicating they were not identified positively or negatively in the source materials. Note that "Insufficient Information" would be used in cases where a non-nominal PSF level was suspected by the analyst but in which the source materials do not explicitly identify a non-nominal PSF level.

Finally, note that the error type was determined to be a "Mistake" by the analyst in Part B Worksheet, Section 6 (see Figure 4.6). It is assumed that the maintenance personnel intended to set the correct coolant flow rate but did not fully understand the proper way to set the valve due to poor procedures.

☒	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	

Figure 4.7 Sample error type.

5 SUMMARY

5.1 Improving the Quality of HRA

As presented earlier and discussed extensively, there is a need to improve the quality of HRA. Uncertainty is key to understanding and employing the results of PRAs conducted for today's complex, high consequence systems like NPPs. Together with other activities and elements that contribute to PRA uncertainty, the processes and results of HRAs can be improved to reduce the overall uncertainty and credibility of analyses. One way to achieve improvements in HRA is by improving the availability and quality of data that can be employed in analyses.

A number of challenges currently confront HRA practitioners regarding the use of information that is available for HRA. These include uncertainties regarding the actual source(s) used to generate data, the suitability of sources for specific applications, and limitations on the ability to draw inferences or generalize from specific sources. The relative paucity of sources of HRA data together with these uncertainties have led to an over reliance on very few sources and their widespread use in applications beyond those originally intended.

Most of the HRA methods in use are based upon differing models and assumptions of human performance. A single, general, or unified human reliability theory that encompasses the behavioral and physical domains to which HRA applies has not been put forth. At the very least, there is no consensus regarding the methods that may be best suited to different applications. Differences between HRA methods, as well as the ways that they are applied, contribute to variability and, thus, uncertainty in results.

Industry-wide, such uncertainties are important as they affect the confidence that can be placed in importance measures and other risk metrics. Global measures of risk are affected by the quality and scope of PRA. Improvements in the quality and quantity of data to inform HRA processes will improve the quality of HRAs that can be performed and used to predict those uncertain and important measures of risk used in PRA. Improvements in HRA technology can be made through efforts that supply data about human performance:

- For a broad range of conditions that are applicable to PRA;
- That illustrate the conditional nature of successful and unsuccessful behavior; and
- That can be incorporated into analyses employing existing HRA methods or other reliability techniques.

The benefits of these improvements will be to provide a stronger technical basis for the identification, modeling, and quantification of human actions and inactions that are important in the reliability of nuclear power systems. This includes improvements in our abilities to characterize pre-initiator conditions that can influence the reliability of recovery actions, incorporate greater realism into our assessment of initiating events, and to better model and quantify the likelihood of post-initiator actions.

A common need of the HRA methods in use today concerns validation. Efforts to demonstrate or provide partial validation of most methods are largely anecdotal–involving illustrations of previous events and operating experience to show how a model or method accounts for the factors that affect human performance. Although such illustrations are useful and may demonstrate the retrospective explanatory power of a HRA method, additional validation efforts are needed. It is especially important that validation and benchmarking efforts are capable of

not only explaining the reasons behind the occurrence of an incident but, more importantly, can identify causative mechanisms that are predictive – not merely descriptive. Data sources can be used to test the hypotheses and assumptions of HRA methods and to derive empirical relationships between the accident conditions postulated in PRA and the performance reliability of plant personnel.

Furthermore, data sources can support benchmarking activities of HRA methods. This includes benchmarking of model input, requirements of analyst use of methods and data, and method output. In this way, we can better characterize activities for informing existing HRAs, and how to make use of information to produce better estimates of human error likelihood.

Beyond HRA, qualified data sources currently support regulatory activities involving consideration of human factors. For example, the NRC's HFIS makes use of operating experience to identify when individual factors and aspects of the work environment (e.g., procedures, training, etc.) influence human performance in reported events. Supplemental detailed information that can be used to characterize such things as the error potential of human performance, causative mechanisms, and dependencies may improve the quality of insights derived from analyses of operating experience.

5.2 Progress To Date

Based upon these needs, the HERA system is being developed. The development of HERA is based upon a review of many HRA methods, their structural features and model parameters, and an analysis of the information that is recommended for their use. Although its use may differ among HRA methods, a set of common information needs were identified.

A number of potential sources of information were also identified. Each of them has strengths relative to the other sources identified, including their availability and applicability. Operating experience sources were prioritized for use at this stage of HERA development owing to their relevance to regulatory applications, relationship to PRA, availability, and clear standards that relate to their documentation.

The methods for extracting information from operating experience were developed to emphasize the dynamic and stochastic nature of human-system interactions in the complex operational environments that characterize nuclear power operations. This includes an approach to processing operating experience events that includes objective information about the event as well as judgment and assessments of the factors that influenced performance, contributing to errors and successes alike.

A number of operating experience events have been analyzed to date, resulting in a number of records. These correspond to risk-relevant events involving emergency diesel generators, initiating events, and common cause failures. This work is also being coordinated with a wide variety of the NRC's risk databases, which are used to collect and maintain information about system and component reliability.

Additional data beyond those that are provided by operating experience is being pursued. For example, the use of the behavioral science literature, which contains a largely untapped body of evidence concerning human performance, is being pursued. Collaborative arrangements have also begun between this program and the Halden Reactor Project to employ the results from their focused simulator-based studies of licensed reactor operators. This may require additional data transformation and treatment beyond those typically carried out in support of Halden's

research program. Nevertheless, simulator data employing realistic, PRA-relevant scenarios may provide additional and important insights into the performance of crews.

In parallel, the deveoplment of tools is being pursued to support analytic methods that can make use of HERA information in quantitative analyses. Bayesian methods, for instance, support the quantification of inference about stochastic conditions using available information. Some HRA methods permit incorporation of data and evidence from sources and could readily use information from HERA. Others, however, do not and would possibly require adaptation of other reliability techniques, such as the use of Bayesian methods, in order to combine information from HERA with information already provided in an individual HRA method.

Data of the type addressed through this project are intended to provide a stronger technical basis for predicting the kinds of successful and unsuccessful human actions that may occur in relevant operational contexts. Using such qualitative sources, estimates of the likelihood of human error can be produced using, for example, Bayesian approaches. Data of these types may also be used to support the development of HRA methods through formal analyses of human performance in representative operating contexts. They may also be used to support benchmark evaluations and comparisons of different HRA methods. By improving the strength of available data, the accuracy and completeness of PRAs may be improved, permitting greater confidence to be placed in the use of PRA results.

Estimates of plant reliability and risk may differ in the industry due, in part, to differences in the results of HRAs that arise from differences in scope, identification, modeling, and quantification. Each of these activities depends on data and sources of information as well as formal methods for employing information in analyses. A number of methods have been developed for identifying and characterizing the human contribution to system performance and reliability. They encourage analysts to consider how features of the environment and context, as well as individual factors, may create conditions that result in errors and human failure events.
A number of factors affect the uncertainty of HRA results. These include systematic factors such as those introduced by the methods themselves, as well as unsystematic factors. A key to reducing uncertainty and to standardizing some of the processes for conducting human reliability analysis is the development and use of information from qualified sources. For example, event analysis may serve to illustrate the conditions under which successful and unsuccessful performance occurs in contexts of specific interests to nuclear power plant reliability analysis.

Since its inception, the HERA system has been designed to support a variety of HRA method implementations by providing sources of information that are directly relevant to nuclear power operations (in the broadest sense) and that can be employed by users of different HRA methods. Beyond supporting HRA applications, the HERA system is capable of supporting reviews by analysts who seek to understand how context, work processes, and other determinants interact to produce the observable behavior that is part and parcel of NPP activities, and how such things, taken together, are vital to the safety of these facilities.

This page intentionally left blank.

REFERENCES

Atwood, C.L., LaChance, J.L., Martz, H.F., Anderson, D.J., Englehardt, M., Whitehead, D., & Wheeler, T., *Handbook of Parameter Estimation for Probabilistic Risk Assessment*, NUREG/CR-6823, U.S. Nuclear Regulatory Commission, Washington, D.C., September 2003.

Barriere, M.T., Luckas, W.J., Whitehead, D.W., & Ramey-Smith, A.M., *An Analysis of Operational Experiences During LP&S and Plan for Addressing Human Reliability Assessment Issues*, NUREG/CR-6093, U.S Nuclear Regulatory Commission, Washington, D.C., June 1994.

Barriere, M.T., Luckas, W.J., Wreathall, J., Cooper, S.E., Bley, D.C., & Ramey-Smith, A.M., *Multidisciplinary Framework for Analyzing Errors of Commission and Dependences in Human Reliability Analysis,* NUREG/CR-6265, U.S. Nuclear Regulatory Commission, Washington, D.C., August 1995.

Boring, R.L., & Gertman, D.I., "Atomistic and holistic approaches to human reliability analysis in the US nuclear power industry", *Safety & Reliability*, v. 25, no. 2, pp. 21-37, 2005.

Braarud, P.Ø., "Complexity Factors and Prediction of Crew Performance" (HWR-521), OECD Halden Reactor Project, Norway, 1998.

Braarud, P.Ø., "Impact of an ambiguous secondary task on primary task performance in accident operation", *Proceedings of Probabilistic Safety Assessment and Management (PSAM8)*, New Orleans, LA., May 2006.

Cooper, S., Ramey-Smith, A., Wreathall, J., Parry, G., Bley, D., Luckas, W., Taylor, J., & Barriere, M., *A Technique for Human Error Analysis (ATHEANA) – Technical Basis and Methodology Description,* NUREG/CR-6350, U.S. Nuclear Regulatory Commission, Washington, D.C., April 1996.

Dougherty, E.M., "Is human failure a stochastic process?" *Reliability Engineering and System Safety*, v. 55, pp. 209-215, 1997.

Forester, J., Bley, D., Cooper, S., Lois, E., Siu, E., Kolaczkowski, A., & Wreathall, J., "Expert elicitation approach for performing ATHEANA quantification", *Reliability Engineering and System Safety*, v. 83, pp. 207-220, 2004.

Forester, J., Kolaczkowski, A., & Lois, E., *Evaluation of Human Reliability Analysis Methods Against Good Practices*, NUREG-1842, U.S. Nuclear Regulatory Commission, Washington, D.C., March 2006.

Fujita, Y., & Hollnagel, E., "Failures without errors: quantification of context in HRA", *Reliability Engineering and System Safety*, v. 83, pp. 145-151, 2004.

Gertman, D.I., & Blackman, H.S., *Human Reliability & Safety Analysis Data Handbook*, Wiley Interscience, New York, NY., 1994.

Gertman, D., Blackman, H., Byers, J., Haney, L., Smith, C., & Marble, J., *The SPAR-H Method*, NUREG/CR-6883, U.S. Nuclear Regulatory Commission, Washington, D.C., 2005.

Gertman, D.I., Hallbert, B.P., Parrish, M.W., Sattison, M.B., Brownson, D., & Tortorelli, J.P., *Review of Findings for Human Error Contribution to Risk in Operating Events*, NUREG/CR-6753, U.S. Nuclear Regulatory Commission, Washington, D.C., March 2002.

Griffith, C.D., & Mahadevan, S., "Sleep Deprivation Effect on Hum Performance: A Meta-analysis Approach", *Proceedings of Probabilistic Safety Assessment and Management (PSAM8)*, New Orleans, LA., May 2006.

Hallbert, B.P., "Situation awareness and operator performance: Results from simulator-based studies", *Proceedings of the 5th IEEE Conference on Human Factors and Power Plants*, Orlando FL., June 1997.

Hallbert, B., Gertman, D., Lois, E., Marble, J., Blackman, H., & Byers., J., "The use of empirical data sources in HRA", *Reliability Engineering and System Safety*, v. 38, pp. 139-143, 2004.

Hollnagel, E., *Cognitive Reliability and Error Analysis Method (CREAM)*, Elsevier, Amsterdam, 1998.

Hollnagel, E., "Reliability analysis and operator modeling", *Reliability Engineering and System Safety*, v. 52, pp. 327-337, 1996.

IAEA, *Guidelines for Describing of Human Factors in the IRS, Human Actions and Related Causal Factors and Root Causes*, IAEA J4-CD-10, IAEA, Vienna, 2001.

IEEE, *IEEE Recommended Practice for Conducting Human Reliability Analysis for Nuclear Power Generating Stations*, Draft Standard P-1574, Document in Preparation under the Direction of the IEEE Power Engineering Society, Nuclear Power Engineering Committee, Human Factors Subcommittee.

Kolaczkowki, A., Forester, J., Lois, E., & Cooper, S., *Good Practices for Implementing Human Reliability Analysis (HRA), Draft Report for Comment*, NUREG-1792, U.S. Nuclear Regulatory Commission, Washington, D.C., July 2004.

Laumann, K., Braarud, P.Ø., Svengeren, H., & Bye, A., "A study on how time pressure and information load affects operators performance in accident scenarios", *Proceedings of Probabilistic Safety Assessment and Management (PSAM8)*, New Orleans, LA., May 2006.

Le Bot, P., Desmares, E., Bieder, C., Cara, F., & Bonnet, J.L., "MERMOS: un projet d'EDF pour la mise à jouer de la méthodologie EPHF", *Revue Générale Nucléaire*, v. 1, 1998.

Lipsey, M.W., & Wilson, D.B., *Practical Meta-Analysis*, Sage Publications, Thousand Oaks, CA., 2001.

Perrow, C., *Normal Accidents: Living with High Risk Technologies*, Basic Books, New York, NY., 1984.

Polawski, J.P., Knudesn, J.K., Atwood, C.L., & Galyean, W.J., *Reliability Study: High Pressure Safety Injection Systems, 1987-1999*, NUREG/CR- 5500, Volumes 1-9, U.S. Nuclear Regulatory Commission, Washington, D.C., October 2000.

Reason, J., *Human Error*, Cambridge University Press, Cambridge, England, 1990.

Reason, J., *Managing the Risks of Organizational Accidents*, Ashgate Press, Brookfield, VT., 1997.

Reer, B., "Retrospective event analysis using CODA and perspectives on human error prediction", *Proceedings of the International Topical Meeting on Probabilistic Safety Assessment (PSA '99)*, American Nuclear Society, LaGrange Park, IL., Vol 2, pp. 1337-1345, 1999.

Singh, A., Parry, G.W., & Beare., A. "An approach to the analysis of operating crew responses for use in PSAs", *Proceedings of the Probabilistic Safety Assessment Conference*, Clearwater Beach, FL., January 26-29, 1993.

Straeter, O., *Cognition and Safety. An Integrated Approach to Systems Design and Assessment*, Ashgate Press, Brookfield, VT, 2005.

Straeter, O., "The CAHR Method", NEA/CSNI/R(2000)17: *Errors of Commission in Probabilistic Safety Assessment*, Organization for Economic Cooperation and Development, Nuclear Energy Agency, Paris, France, July 2000.

Swain, A. D., *Accident Sequence Evaluation Program (ASEP) Human Reliability Analysis Procedure*, NUREG/CR-4772, U.S. Nuclear Regulatory Commission, Washington, D.C., 1987.

Swain, A.D., & Guttman, H., *The Technique for Human Error Rate Prediction*, NUREG/CR-1278, U.S. Nuclear Regulatory Commission, Washington, D.C., 1984.

U.S. Nuclear Regulatory Commission, *Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants,* WASH-1400 (NUREG-75/014), U.S. Nuclear Regulatory Commission, Washington, D.C., 1975.

U.S. Nuclear Regulatory Commission, "Use of probabilistic risk assessment methods in nuclear activities: Final policy statement", *Federal Register*, v. 60, U.S. Nuclear Regulatory Commission, Washington, D.C., p. 42622, August 16, 1995.

U.S. Nuclear Regulatory Commission, *Technical Basis and Implementation Guidelines for A Technique for Human Event Analysis (ATHEANA),* NUREG-1624, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, D.C., May 2000.

U.S. Nuclear Regulatory Commission, "An approach for using probabilistic risk assessment in risk-informed decisions on plant-specific changes to the licensing basis", *Regulatory Guide 1.174*, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, D.C., November 2002.

U.S. Nuclear Regulatory Commission, *Human Factors Information System (HFIS) Codes*, ML060930293, Rev. 2, U.S. Nuclear Regulatory Commission, Washington, D.C., April 2006.

Williams, J. C., "Toward an Improved Evaluation Analysis Tool for Users of HEART", *International Conference on Hazard Identification and Risk Analysis, Human Factors and Human Reliability in Process Safety*, Orlando, FL., January 15–17, 1992.

Woods, D.D., Pople, H.E., & Roth, E.M., The Cognitive Environment Simulation as a Tool for Modeling Human Performance and Reliability, NUREG/CR-5213, Vol. I and II, U.S. Nuclear Regulatory Commission, Washington, D.C., 1990.

This page intentionally left blank.

Appendix A
HERA WORKSHEET PART A

Human Event Repository & Analysis (HERA) Worksheet, Part A

Coder:	2nd Checker:	Ops Review:	HF Review:
Date:	Date:	Date:	Date:

Section 1: Plant and Event Overview

Document identifying plant and event information.

1. Primary Source Document:
2. Other Source Document(s):
3. Plant Name:
4. Plant Type: ☐BWR ☐PWR Other:
5. Plant Operating Mode:
5a. Plant Power Level:
6. Event Type:
   Initiating Event: ☐Yes ☐No
   Common Cause: ☐Yes ☐No
6a. Event Date / Time:
6b. Event Description:
7. Potential Loss of Function(s):
8. Actual Loss of Function(s):
9. Potential Loss of System(s):
10. Actual Loss of System(s):
11. Component(s) Unavailable:
12. Source:
    ☐ LER ☐ ASP Analysis CCDP / ΔCDP: ☐ AIT ☐ Other
13. Similar to other events: ☐Yes ☐No
    Comment:

Section 2: Event Summary / Abstract

Write a brief summary of the event, or copy in the event abstract. Discuss aspects of the event that are important from a HRA perspective. See Coding Manual for guidance.

Section 3: Index of Subevents

Provide a brief description of all subevents as well as subevent codes (XHE, HS, EE, XEQ, EQA, PS, or CI), date and time, work type and personnel involved (for all human subevents; see manual for codes), whether the subevent was pre-initiator (PRE), initiator (INIT), or post-initiator (POST), whether the subevent was active (A) or latent (L),and, if the subevent is an XHE, if it was an error of omission (O) or commission (C) or indeterminate (I). Indicate the Human Action Category number for XHEs and HSs (see manual), indicate whether a HS is a recovery, indicate whether the XHE or HS receives Worksheet B coding, list any related subevents, both prior and following the subevent, any comments (e.g., why a subevent is not receiving Worksheet B coding, contributing performance shaping factors), and whether the subevent will be included on the graphical timeline. See the coding manual for guidance on subevent breakdown and subevent code assignment. Use additional sheets as necessary.

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐
									☐	☐			☐

Section 4: General Trends Across Subevents / Lessons Learned

Part A: General Trends ☐ ***Not Applicable***

Indicate any strong, overarching trends or context across the subevents and provide a detailed explanation. This section is optional and only used when an issue is seen repeatedly throughout the event, to highlight the trend that may not be readily evident from the separate Worksheet B coding.

Trend	Comment
☐ Procedures (e.g., repeated failure to use or follow procedures)	
☐ Workarounds (e.g., cultural acceptance of workarounds contributes to multiple subevents)	
☐ Strong mismatch (e.g., between operator expectations compared to evolving plant conditions; between communications goals compared to practice; between complexity and speed of event compared to training and procedural support; between operator mental model and actual event progression)	
☐ Deviation from previously analyzed or trained scenarios	
☐ Extreme or unusual conditions	
☐ Strong pre-existing conditions	
☐ Misleading or wrong information, such as plant indicators or procedures	
☐ Information rejected or ignored	
☐ Multiple hardware failures	
☐ Work transitions in progress	
☐ Poor safety culture	
☐ Configuration management failures including drawings and tech specs, such as incorrect room penetrations, piping or equipment configurations	
☐ Failure in communication or resource allocation	
☐ Other: _____	

Part B: Lessons Learned ☐ ***Not Applicable***

Explain any key lessons learned from this event and / or any key corrective actions taken as a result of this event.

_____

Section 5: Human Subevent Dependency Table

Place only the XHEs that receive Worksheet B coding on the top row and in the left column of the pyramid table. Check the appropriate boxes to indicate dependency between subevents. See the coding manual for guidance on assigning dependency. Provide explanation in the Comment table below to explain the factors that caused the subevents to exhibit dependency. Common dependency factors are listed in the pyramid table. Use additional sheets as necessary.

Subevent Code															
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Common		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	Dependency Factors:			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Similar Task				☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same person/people					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Close in time						☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same location/same equipment							☐	☐	☐	☐	☐	☐	☐	☐
	• No independent oversight								☐	☐	☐	☐	☐	☐	☐
	• Same cues									☐	☐	☐	☐	☐	☐
	• Action prompts next incorrect action										☐	☐	☐	☐	☐
	• Similar environmental conditions											☐	☐	☐	☐
	• Unreliable system feedback												☐	☐	☐
	• Prior human failures on same equipment													☐	☐
	• Lack of intervening human success														☐
	• Cultural dependency														
	• Mindset														
	• Work Practices														
	• Other (explain)														

Row Subevent	Column Subevent	Affects >1 subsequent subevent	Comment
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	

APPENDIX B

HERA WORKSHEET PART B

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Subevent Code:
Description: _____

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☐ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure / malfunction	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☐ Other:	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☐ **Interpretation**	☐ **Planning**	☐ **Action**	☐ **Indeterminate**
Comment: _____				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Stress & Stressors	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Complexity	☐Insufficient Information ☐Good ☐Nominal ☐Poor	

PSF	PSF Level	Comment
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Ergonomics & HMI	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Communication	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Environment	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Team Dynamics / Characteristics	☐Insufficient Information ☐Good ☐Nominal ☐Poor	

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	

	Error Type	Comment
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

APPENDIX C

SAMPLE HERA ANALYSIS 1

Introduction to Analysis

On February 28, 1996, James A. FitzPatrick was in cold shutdown during a refueling outage. At approximately 1800 hours, a nitrogen leak was discovered in the exhaust port of Safety Relief Valve (SRV) G. Upon investigation, foreign material was discovered in the pilot solenoid valve exhaust port. Efforts to determine the extent and source of the foreign material problem resulted in the discovery of foreign material in either the pneumatic supply lines or pilot solenoid valves for five SRV s (C, E, G, H, J, and L), and improper operation of three SRV pilot solenoid valves (H, E, and L). Based on this information, the licensee determined that a condition existed with the Main Steam Safety Relief Valves that alone could have prevented the Automatic Depressurization System from functioning properly.

Over the next few days, the licensee began to flush and blowdown the system in order to purge all foreign material, but they stopped before the valves were completely clear. As a result, SRV J failed to reseat when cycled. The licensee then replaced seven SRV pilot solenoid valves (A, B, F, H, J, K, and L) and rebuilt four SRV pilot solenoid valves (C, D, E, and G). One of those, SRV G, was rebuilt with excess Loctite. When the plant began power ascension on March 5, 1996, SRV G failed to open when cycled from the control room. SRV G was replaced and tested successfully, and all other SRVs cycled successfully.

The cause of the foreign material intrusion was a failure to flush the system after installing new fittings and tubing on pilot solenoid valves F, H, J, K, and L during the prior refueling outage. This activity involved cutting of 300 series stainless steel with either a hacksaw or an aluminum oxide grinding wheel directly at or upstream of the affected locations. A flush was not performed following this maintenance. Two of the SRV pilot solenoid valves (E and L) operated improperly due to improper assembly by the vendor (plunger jam nuts were not torqued to specifications and Loctite was not used). This was also found to affect SRV H.

The HERA analysis of this event is based on Licensee Event Report 333-1996-004-00, and includes the error that caused the foreign material intrusion into the SRVs, all instances of SRV failure or improper operation, the error during rebuilding SRV G, contextual information about the incorrect vendor assembly and plant status, and human successes of replacing the affected SRV assemblies.

Human Event Repository & Analysis (HERA) Worksheet, Part A

Coder: AW	2nd Checker:	Ops Review: MH	HF Review: DG
Date: 3/28/2006	Date:	Date: 4/6/2006	Date: 5/8/2006

Section 1: Plant and Event Overview

Document identifying plant and event information.

1. Primary Source Document: LER 333-1996-004-00
2. Other Source Document(s): None
3. Plant Name: James A. FitzPatrick Nuclear Power Plant
4. Plant Type: ☒BWR ☐PWR Other:
5. Plant Operating Mode: N
5a. Plant Power Level: 0%
6. Event Type:
   Initiating Event: ☐Yes ☒No
   Common Cause: ☒Yes ☐No

6a. Event Date / Time: 2/28/1996, 0930

6b. Event Description: Multiple Safety Relief Valve Pilot Solenoid Failures Due to Foreign Materials, Vendor Deficiencies, and Maintenance Errors

7. Potential Loss of Function(s): Automatic Depressurization System (ADS) safety function
8. Actual Loss of Function(s): None
9. Potential Loss of System(s): ADS
10. Actual Loss of System(s): None
11. Component(s) Unavailable: SRVs A, B, C, D, E, F, G, H, J, K, L
12. Source:
    ☒ LER ☐ ASP Analysis CCDP: ☐ AIT ☐ Other
13. Similar to other events: ☐Yes ☒No
Comment:

Section 2: Event Summary / Abstract

Write a brief summary of the event, or copy in the event abstract. Discuss aspects of the event that are important from a HRA perspective. See Coding Manual for guidance.

On 2/28/96 at 0930 hours, with the plant shutdown in the cold condition and Mode Switch in REFUEL it was determined that a condition existed with Main Steam Safety Relief Valves (SRVs) [SB] that alone could have prevented the fullfilment of the Automatic Depressurization System safety function. This determination was based on discovery of foreign material in either the pneumatic supply lines or pilot solenoid valves for five SRVs, and improper operation of three SRV pilot solenoid valves. Further investigation revealed that two of the three pilot solenoid valves had failed to open due to a loose plunger on the stem assembly apparently caused by inadequate jam nut torquing and absence of required Loctite. The loose plunger condition is being reported under 10 CFR Part 21. The third pilot solenoid valve failed to fully reseat due to foreign material intrusion. An additional pilot solenoid valve failed to reseat during subsequent testing. Nitrogen supply system cleanliness was established and all pilot solenoid valves were rebuilt or replaced with new assemblies.

On 3/5/96, at 1104 hours with the plant at 19 percent power, SRV G failed to open while attempting to cycle from the control room. The failure cause was pilot solenoid valve sticking due to excess Loctite internal to the valve. The pilot solenoid valve was replaced with another rebuilt assembly and subsequent testing was satisfactory.

The primary issue involved in this event was poor maintenance practices.

Section 3: Index of Subevents

Provide a brief description of all subevents as well as subevent codes (XHE, HS, EE, XEQ, EQA, PS, or CI), date and time, work type and personnel involved (for all human subevents; see manual for codes), whether the subevent was pre-initiator (PRE), initiator (INIT), or post-initiator (POST), whether the subevent was active (A) or latent (L),and, if the subevent is an XHE, if it was an error of omission (O) or commission (C) or indeterminate (I). Indicate the Human Action Category number for XHEs and HSs (see manual), indicate whether a HS is a recovery, indicate whether the XHE or HS receives Worksheet B coding, list any related subevents, both prior and following the subevent, any comments (e.g., why a subevent is not receiving Worksheet B coding, contributing performance shaping factors), and whether the subevent will be included on the graphical timeline. See the coding manual for guidance on subevent breakdown and subevent code assignment. Use additional sheets as necessary.

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
CI 1	~1992	M	N-V	PRE	L		Safety Relief Valves (SRVs) rebuilt at Wyle (vendor) test facility incorrectly. Plunger jam nuts were not torqued adequately to the valve stem, and Loctite threadlock compound was not used as required by vendor assembly instructions.		☐	☐	XEQ 2		☒
XHE 1	~1994-1995	M	M-M	PRE	L	O	New fittings installed on the SRV pilot solenoid valve connections and tubing replaced on F, H, J, K, and L pilot solenoid valves, which involved cutting of 300 series stainless steel with either a hacksaw or an aluminum oxide grinding wheel directly at or upstream of the affected locations. A flush was not performed following this maintenance.	5	☐	☒	XEQ 1, XEQ 2,		☒
XHE 2	~1995-1996	O	S-P	PRE	L	O	Control Room drawings not updated in response to MODS 95-173 and 96-044.	13	☐	☐	None	Not eligible for Worksheet B coding because error did not contribute to the the progression of the event.	☐
XEQ 1	2/26/96, ~1800			PRE	A		Nitrogen leak discovered and foreign material found in pilot solenod valve of G SRV.		☐	☐	XHE 1, XEQ 2		☒
XEQ 2	2/26/96, TNS			PRE	A		Additional solenoid valve failures found (SRVs H, E, and L).		☐	☐	CI 1, XHE 1, XEQ 1		☒
XHE 3	~2/26/96 -3/5/96	M	M-M	PRE	A	I	Licensee began efforts to clear the lines: disconnect, blowdown, reconnect, recycle. Blowdown efforts and/or test acceptance criteria inadequate, as flush was stopped before all SRVs were clear of foreign material.	5	☐	☒	XEQ 3		☒
CI 2	2/28/96, TNS	O	O	PRE	A		Licensee determined they had a condition with five of the main SRVs that could prevent ADS safety function. 4-hour notification issued to NRC at 1130.		☐	☐	XEQ 1, XEQ 2		☒

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
XEQ 3	2/29/96, TNS			PRE	A		J SRV valve failed to reseat.		☐	☐	XHE 3		☒
HS 1	2/29/96 -3/5/96	M	M-M	PRE	A		7 SRV pilot solenoid valves replaced (A, B, F, H, J, K , and L) and 4 SRV pilot solenoid valves rebuilt (C, D, E, and G).	5	☒	☒	XHE 4	Recovery of XHE 1	☒
XHE 4	~2/29/96 -3/5/96	M	M-M	PRE	A	C	Excessive Loctite used when rebuilding G SRV.	5	☐	☒	HS 1, XEQ 4		☒
PS 1	3/5/96, TNS			PRE	A		Plant begins power ascension.		☐	☐	None		☒
XEQ 4	3/5/96, 1104			PRE	A		G SRV fails to open.		☐	☐	XHE 4, HS 2		☒
PS 2	3/5/96, 2120			PRE	A		Remaining SRVs cycle satisfactorily.		☐	☐	None		☒
HS 2	~1992	M	M-M	PRE	A		G SRV replaced.	5	☒	☒	XHE 4, XEQ 4	Recovery of XHE 4.	☒
PS 3	~1994-1995			PRE	A		G SRV tested satisfactorily.		☐	☐	HS 2		☒

Section 4: General Trends Across Subevents / Lessons Learned

Part A: General Trends ☒ ***Not Applicable***

Indicate any strong, overarching trends or context across the subevents and provide a detailed explanation. This section is optional and only used when an issue is seen repeatedly throughout the event, to highlight the trend that may not be readily evident from the separate Worksheet B coding.

Trend	Comment
☐ Procedures (e.g., repeated failure to use or follow procedures)	
☐ Workarounds (e.g., cultural acceptance of workarounds contributes to multiple subevents)	
☐ Strong mismatch (e.g., between operator expectations compared to evolving plant conditions; between communications goals compared to practice; between complexity and speed of event compared to training and procedural support; between operator mental model and actual event progression)	
☐ Deviation from previously analyzed or trained scenarios	
☐ Extreme or unusual conditions	
☐ Strong pre-existing conditions	
☐ Misleading or wrong information, such as plant indicators or procedures	
☐ Information rejected or ignored	
☐ Multiple hardware failures	
☐ Work transitions in progress	
☐ Poor safety culture	
☐ Configuration management failures including drawings and tech specs, such as incorrect room penetrations, piping or equipment configurations	
☐ Failure in communication or resource allocation	
☐ Other: _____	

Part B: Lessons Learned ☒ ***Not Applicable***

Explain any key lessons learned from this event and / or any key corrective actions taken as a result of this event.

_____

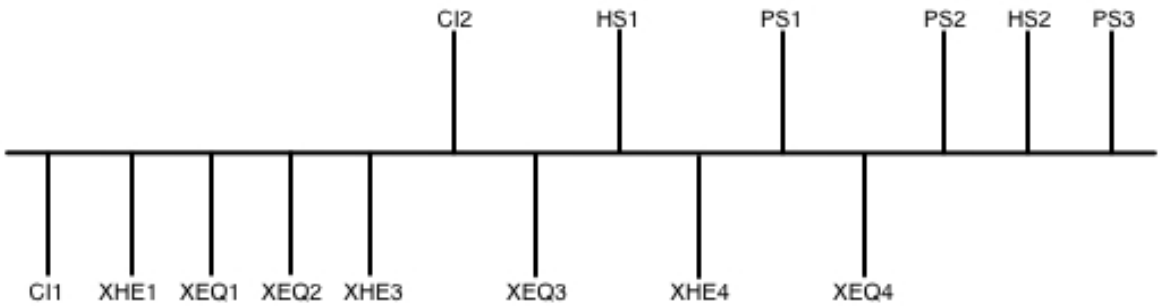
Section 5: Human Subevent Dependency Table

Place only the XHEs that receive Worksheet B coding on the top row and in the left column of the pyramid table. Check the appropriate boxes to indicate dependency between subevents. See the coding manual for guidance on assigning dependency. Provide explanation in the Comment table below to explain the factors that caused the subevents to exhibit dependency. Common dependency factors are listed in the pyramid table. Use additional sheets as necessary.

Subevent Code	XHE 1	XHE 3	XHE 4												
XHE 1		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE 3	**Common**		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE 4	**Dependency Factors:**			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Similar Task				☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same person/people					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Close in time						☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same location/same equipment							☐	☐	☐	☐	☐	☐	☐	☐
	• No independent oversight								☐	☐	☐	☐	☐	☐	☐
	• Same cues									☐	☐	☐	☐	☐	☐
	• Action prompts next incorrect action										☐	☐	☐	☐	☐
	• Similar environmental conditions											☐	☐	☐	☐
	• Unreliable system feedback												☐	☐	☐
	• Prior human failures on same equipment													☐	☐
	• Lack of intervening human success														☐
	• Cultural dependency														
	• Mindset														
	• Work Practices														
	• Other (explain)														

Row Subevent	Column Subevent	Affects >1 subsequent subevent	Comment
		☐	There is no information provided in the LER that suggests that any dependency exists between subevents.
		☐	
		☐	
		☐	
		☐	
		☐	
		☐	

FITZPATRICK GRAPHICAL TIMELINE



Code	Description
CI1	Safety Relief Valves (SRVs) rebuilt at Wyle (vendor) test facility incorrectly. Plunger jam nuts were not torqued adequately to the valve stem, and Loctite threadlock compound was not used as required by vendor assembly instructions.
XHE1	New fittings installed on the SRV pilot solenoid valve connections and tubing replaced on F, H, J, K, and L pilot solenoid valves, which involved cutting of 300 series stainless steel with either a hacksaw or an aluminum oxide grinding wheel directly at or upstream of the affected locations. A flush was not performed following this maintenance.
XEQ1	Nitrogen leak discovered and foreign material found in pilot solenod valve of G SRV.
XEQ2	Additional solenoid valve failures found (SRVs H, E, and L).
XHE3	Licensee began efforts to clear the lines: disconnect, blowdown, reconnect, recycle. Blowdown efforts and/or test acceptance criteria inadequate, as flush was stopped before all SRVs were clear of foreign material.
CI2	Licensee determined they had a condition with five of the main SRVs that could prevent ADS safety function. 4-hour notification issued to NRC at 1130
XEQ3	J SRV valve failed to reseat.
HS1	7 SRV pilot solenoid valves replaced (A, B, F, H, J, K , and L) and 4 SRV pilot solenoid valves rebuilt (C, D, E, and G).
XHE4	Excessive Loctite used when rebuilding G SRV.
PS1	Plant begins power ascension.
XEQ4	G SRV fails to open.
PS2	Remaining SRVs cycle satisfactorily.
HS2	G SRV replaced.
PS3	G SRV tested satisfactorily.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: LER 333-1996-004-00 Subevent Code: XHE 1
Description: New fittings installed on the SRV pilot solenoid valve connections and tubing replaced on F, H, J, K, and L pilot solenoid valves, which involved cutting of 300 series stainless steel with either a hacksaw or an aluminum oxide grinding wheel directly at or upstream of the affected locations. A flush was not performed following this maintenance.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☐ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☒ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☒ Manufacturer fabrication / construction inadequate	There were manufacturing problems with the SRVs that made the work necessary. However, the failure on-site was the plant's alone.
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	

Plant Condition	Comment
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☒ Other: Plant in refueling outage	Maintenance performed during previous refueling outage
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.

PSF	Positive Contributory Factor	Source / Inference	Comment
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☒ Training LTA (T 100)	☒ Source ☐ Inferred	Corrective actions included training maintenance personnel on proper foreign material exclusion (FME) controls and flushing/blowdown of tubing following maintenance that could produce foreign materials.
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

PSF	Negative Contributory Factor	Source / Inference	Comment
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☒ Work package quality LTA (W1 182)	☐ Source ☒ Inferred	The work package should have a caution or explicit steps to flush the lines. (MH)
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

PSF	Negative Contributory Factor	Source / Inference	Comment
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☒ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☒ Inferred	Failure to realize that a flush was necessary to remove any foreign material
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☐ **Interpretation**	☐ **Planning**	☐ **Action**	☒ **Indeterminate**
Comment: No information was provided in the LER to make this determination				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Corrective actions included training on FME and flushing following maintenance that could produce foreign materials.
Procedures & Reference Documents	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	No caution about foreign material intrusion in work package, failure to recognize an adverse condition
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Environment	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	
☒	**Error of Omission:** Failure to perform an action is an error of omission.	Failure to perform flush following maintenance
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☒	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	Inferred that maintenance personnel did not understand that a flush was necessary following maintenance
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	

	Error Type	Comment
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

The LER provides no information about why a flush was not performed following maintenance.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: LER 333-1996-004-00 Subevent Code: XHE 3
Description: Licensee began efforts to clear the lines: disconnect, blowdown, reconnect, recycle. Blowdown efforts and/or test acceptance criteria inadequate, as flush was stopped before all SRVs were clear of foreign material.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS) ☐ OPS Supervisors ☐ Control Room (CR) Operators ☐ Outside of CR Operators ☐ Technical Support Center (TSC)	☐ Plant Support Personnel ☐ Administrative Support ☐ Chemistry ☐ Emergency Planning / Response ☐ Engineering ☐ Fitness for Duty ☐ Fuel Handling ☐ Health Physics ☐ Procedure Writers ☐ QA / Oversight	☐ Security ☐ Training ☐ Shipping / Transportation ☐ Specialized Task Force ☐ Work Control ☐ Licensing / Regulatory Affairs
☐ Maintenance and Testing ☐ Maintenance Supervision / Planning ☒ Mechanical ☐ Electrical ☐ I&C		☐ Non-Plant Personnel ☐ Contractor Personnel ☐ Manufacturer ☐ NRC / Regulator ☐ Vendor
☐ Management	☐ Site-Wide	
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☒ Equipment failure	Multiple Safety Relief Valve malfunctions due to foreign material, nitrogen leak in exhaust port of SRV G
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	

Plant Condition	Comment
☐ Reactor scram / plant transient	
☒ Other: Refueling Outage	Plant shut down in refueling outage
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☒ Action implementation LTA (W2 187)	☒ Source ☐ Inferred	Blowdown stopped before system fully flushed. 5 SRVs still showed particles.
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☒ Test acceptance criteria inadequate	☐ Source ☒ Inferred	Engineering-determined acceptance criteria for foreign material allowed flushing to stop before foreign material fully eliminated.
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☐ **Interpretation**	☐ **Planning**	☐ **Action**	☒ **Indeterminate**
Comment: No information provided in the LER to make this determination				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Experience & Training	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Procedures & Reference Documents	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Blowdown stopped before system fully flushed. Acceptance criteria for foreign material inadequate.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Environment	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	Blowdown stopped before system fully flushed.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	

	Error Type	Comment
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☒	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	Stopping blowdown before the system was fully flushed suggests improper understanding of system function and the necessary actions to remedy the problem.
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: LER 333-1996-004-00 Subevent Code: HS 1
Description: 7 SRV pilot solenoid valves replaced (A, B, F, H, J, K , and L) and 4 SRV pilot solenoid valves rebuilt (C, D, E, and G).

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☐ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☒ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☒ Equipment failure	Multiple Safety Relief Valve malfunctions due to foreign material, nitrogen leak in exhaust port of SRV G
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☐ Reactor scram / plant transient	

Plant Condition	Comment
☒ Other: Refueling Outage	Subevent occurred during refueling outage.
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☒ Safety implications identified and understood in a way that was important to success	☐ Source ☒ Inferred	Crew clearly understood the nature of the problem, the potential ramifications of the problem (ADS system failure), the common mode failure aspect of the problem, and the actions necessary to resolve it.
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.

PSF	Negative Contributory Factor	Source / Inference	Comment
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☐ **Interpretation**	☐ **Planning**	☐ **Action**	☒ **Indeterminate**
Comment: Insufficient information provided in the LER to make this determination.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Experience & Training	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Procedures & Reference Documents	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Work Processes	☐Insufficient Information ☒Good ☐Nominal ☐Poor	Crew clearly understood the nature of the problem, the potential ramifications of the problem (ADS system failure), the common mode failure aspect of the problem, and the actions necessary to resolve it.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Environment	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	

Section 6: Error Type ☒ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	

	Error Type	Comment
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: LER 333-1996-004-00 Subevent Code: XHE 4
Description: Excessive Loctite used when rebuilding G SRV.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☐ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☒ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☒ Equipment failure	Multiple SRV malfunctions
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☒ Other: Refueling outage	Plant shut down in refueling outage
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.

PSF	Positive Contributory Factor	Source / Inference	Comment
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular XHE.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☒ Not familiar with job performance standards	☐ Source ☒ Inferred	G pilot solenoid valve rebuilt inadequately; excess Loctite used
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☒ Action implementation LTA (W2 187)	☒ Source ☐ Inferred	G pilot solenoid valve rebuilt inadequately; excess Loctite used
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☐ **Interpretation**	☐ **Planning**	☒ **Action**	☐ **Indeterminate**
Comment: Inferred that this was an error in response implentation.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	

PSF	PSF Level	Comment
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Not familiar with job performance standards--inferred from use of excessive Loctite during SRV G pilot solenoid valve rebuild.
Procedures & Reference Documents	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Reviews of the work package indicated it was adequate, but the G pilot solenoid valve was rebuilt with excessive Loctite.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Environment	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	Excess Loctite used during rebuild of G SRV pilot solenoid valve.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☒	Response implementation error	Because the work package was adequate, it is inferred that this was a response implementation error.
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	

	Error Type	Comment
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

At the time the LER was written, a human performance root cause analysis was being performed to determine the cause of excess Loctite in the G1 pilot solenoid valve. Conclusions of that analysis were not provided in the LER.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: LER 333-1996-004-00 Subevent Code: HS 2
Description: G SRV replaced.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☐ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☒ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☐ Control problems	
☐ Plant / equipment not in a normal state	
☒ Plant transitioning between power modes	Plant beginning power ascension at time of subevent.
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☐ Other: _____	

Plant Condition	Comment
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☒ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	The crew responded appropriately to the SRV failure given the previous SRV malfunctions, but this is nominally expected and therefore not extraordinary enough to indicate a positive PSF.
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☐ **Interpretation**	☐ **Planning**	☒ **Action**	☐ **Indeterminate**
Comment: Diagnosis activity not required for this success: the SRV malfunctioned, and based on the previous SRV problems, it was rebuilt. The success therefore occurred in action.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Experience & Training	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Procedures & Reference Documents	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Work Processes	☐Insufficient Information ☐Good ☒Nominal ☐Poor	No extraordinary work processes; the crew responded appropriately to the SRV failure given the previous SRV malfunctions, and this is nominally expected.
Communication	☐Insufficient Information ☐Good ☐Nominal ☐Poor	
Environment	☒Insufficient Information ☐Good ☐Nominal ☐Poor	
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	

Section 6: Error Type ☒ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	

	Error Type	Comment
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

APPENDIX D

SAMPLE HERA ANALYSIS 2

Introduction to Analysis

On December 8, 1991, Crystal River Unit 3 was being returned to power operation. As reactor power was being increased from 11% rated thermal power (RTP) to 15% RTP, reactor coolant system (RCS) pressure increased to the open setpoint for the pressurizer spray valve, RCV-14. RCV-14 opened, but two critical equipment faults occurred. The "closed" indicating lamp for RCV-14 did not extinguish, and on decreasing RCS pressure, RCV-14 did not close, resulting in a continued slow decrease in RCS pressure.

In response to the decreasing pressure, the operators inappropriately continued to raise power, believing there was a power-steam demand mismatch causing a cooldown event. Nevertheless, a plant trip occurred due to the continuing decreasing pressure, and prior to RCS pressure reaching the engineered safeguards (ES) actuation setpoint, an operator inappropriately bypassed ES. Eventually shift supervision directed ES out of bypass and ES actuation was initiated. After ES was reset, and while attempting to diagnose the source of the decreasing RCS pressure, a plan was subsequently implemented which bypassed ES and used high pressure injection to raise RCS pressure. Eventually, RCV-14 was manually isolated, terminating the event.

The breakdown of the event in HERA includes the two important equipment faults that made it hard to diagnose the source of the decreasing RCS pressure, the series of inappropriate increases in reactor power by the operating crew, the ES bypass error, and numerous other plant states, equipment successes, and human successes that collectively make up the evolution of this 2+ hour event. The sources of information about the event include the licensee event report written by the licensee (LER 302-91-018-00) and a follow-up NRC-led special onsite trip report (EGG-HFRU-10085) based on a special inspection concerning the event.

Human Event Repository & Analysis (HERA) Worksheet, Part A

Coder: AMK	**2nd Checker:**	**Ops Review:** PHM	**HF Review:** DG
Date: 4/20/2006	**Date:**	**Date:** 4/21/2006	**Date:** 4/21/2006

Section 1: Plant and Event Overview

Document identifying plant and event information.

1. Primary Source Document: Onsite Trip Report EGG-HFRU-10085

2. Other Source Document(s): LER 302-91-018-00

3. Plant Name: Crystal River Unit 3

4. Plant Type: ☐BWR ☒PWR Other:

5. Plant Operating Mode: 1

5a. Plant Power Level: 11%-15%

6. Event Type:

Initiating Event: ☒Yes ☐No

Common Cause: ☐Yes ☒No

6a. Event Date / Time: 12/08/1991 / 02:47

6b. Event Description: Reduction in reactor coolant system (RCS) pressure due to failure of pressurizer spray valve and failure of its position indication

7. Potential Loss of Function(s): Not applicable

8. Actual Loss of Function(s): Loss of RCS pressure control and temporary bypass of emergency safeguards (ES) actuation for high pressure injection (HPI)

9. Potential Loss of System(s): Not applicable

10. Actual Loss of System(s): Temporary operator bypass of ES actuation

11. Component(s) Unavailable: Failed pressurizer spray valve and all HPI (when bypassed)

12. Source:

☐ LER ☐ ASP Analysis CCDP: ☐ AIT ☒ Other Onsite Trip Report EGG-HFRU-10085

13. Similar to other events: ☐Yes ☒No

Comment:

Section 2: Event Summary / Abstract

Write a brief summary of the event, or copy in the event abstract. Discuss aspects of the event that are important from a HRA perspective. See Coding Manual for guidance.

On December 8, 1991, Crystal River Unit 3 was being returned to power operation. As reactor power was being increased from 11% rated thermal power (RTP) to 15% RTP, reactor coolant system (RCS) pressure increased to the open setpoint for the pressurizer spray valve, RCV-14. RCV-14 opened; however, the "closed" indicating lamp did not extinguish. On decreasing RCS pressure, RCV-14 did not close, resulting in a continued slow decrease in RCS pressure. Prior to RCS pressure reaching the engineered safeguards (ES) actuation setpoint, an operator inappropriately bypassed ES. Subsequently, shift supervision directed ES out of bypass and ES actuation was initiated. After ES was reset, a plan was implemented which bypassed ES and used high pressure injection (HPI) to raise RCS pressure. Eventually, RCV-14 was manually isolated, terminating the event.

Section 3: Index of Subevents

Provide a brief description of all subevents as well as subevent codes (XHE, HS, EE, XEQ, EQA, PS, or CI), date and time, work type and personnel involved (for all human subevents; see manual for codes), whether the subevent was pre-initiator (PRE), initiator (INIT), or post-initiator (POST), whether the subevent was active (A) or latent (L),and, if the subevent is an XHE, if it was an error of omission (O) or commission (C) or indeterminate (I). Indicate the Human Action Category number for XHEs and HSs (see manual), indicate whether a HS is a recovery, indicate whether the XHE or HS receives Worksheet B coding, list any related subevents, both prior and following the subevent, any comments (e.g., why a subevent is not receiving Worksheet B coding, contributing performance shaping factors), and whether the subevent will be included on the graphical timeline. See the coding manual for guidance on subevent breakdown and subevent code assignment. Use additional sheets as necessary.

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
PS1	12/8/91 0247			PRE	A		Rated thermal power had just been bumped up to 12% on the way to 15% to prepare to roll main turbine after a short maintenance outage.		☐	☐			☒
PS2	12/8/91 0247			PRE	L		No pressurizer spray line flow indication was available in the plant design (not standard practice to have such an indication). An indication would have allowed much easier diagnosis of the cause for the event since flow in the spray line would have indicated an open spray valve.		☐	☐			☐
XEQ1	12/8/91 0247			PRE	A		It is suspected that at the power bump in PS 1, RCS pressure rose to the setpoint for pressurizer spray valve RCV-14, which opened accordingly, but the valve failed to reclose (i.e., stuck-open) when pressure decreased again.		☐	☐	XEQ2	The stuck-open valve (XEQ1) and the failed/misleading position indication (XEQ2) combined to cause the RCS depressurization event that was difficult to diagnose.	☒
XEQ2	12/8/91 0247			PRE	A		The closed light indicating the position of pressurizer spray valve RCV-14 never extinguished and the 40% open and full open lights remained dark (thus the valve always appeared closed to the operators).		☐	☐	XEQ1	The stuck-open valve (XEQ1) and the failed/misleading position indication (XEQ2) combined to cause the RCS depressurization event that was difficult to diagnose.	☒
PS3	12/8/91 0249			PRE	A		Reactor pressure increased slightly in response to the rod bump, but then began to decrease slowly; observed by the operators.		☐	☐			☒

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
XHE1	12/8/91 0251	O	O-C	PRE	A	C	Operators perform another power bump (incremental rod withdrawal) in attempt to keep RCS pressure up in response to continuing falling pressure indications. This was inappropriate especially considering that Tavg was not decreasing yet the bump was made without checking for a decreasing Tavg but instead simply on the word of one of the operators. Bumping the power was initially based on the incorrect premise that the reactor was cooling down because power was less than the steam load.	6	☐	☒	XHE3, XHE4	Three successive power bumps (XHE1, XHE3, XHE4) were performed based on the incorrect premise that a RCS cooldown was in progress. All 3 bumps are considered highly dependent and are clustered together here for Worksheet B coding and representation on the graphical timeline.	☒
PS4	12/8/91 025147-025325			PRE	A		Reactor pressure increased to 2223 psig and then begins to decrease. Tavg went from 567.3F to 568.5F and pressurizer level went from 176 inches to 190 inches. Observed by an operator monitoring strip chart recorders that, because of the scales, were hard to read but trends were readable. Reactor low pressure alarm annunciates at 02:53:25.		☐	☐			☒
HS1	12/8/91 025325	O	O-C	PRE	A		In response to the low pressure alarm, control room staff begin a concerted effort to find the cause of the decreasing pressure. They successfully rule out various possible causes of the low pressure and they move the control switch for RCV-14 to the closed position in an attempt to check it was closed (a good practice) even though the closed light continued to be illuminated.	2	☐	☐		While a positive development (i.e., ruling out various causes of the event), this troubleshooting is expected and did not significantly affect the evolution of the event. Hence, HS1 is not coded on a Worksheet B.	☒
XHE2	12/8/91 025330	O	O-C	PRE	A	C	Operators do not pull out and implement the alarm response procedure (AR-502), as the intent of procedure is for dealing with suspected control circuit faults such as the spray valve indicating open. But the pressurizer spray valve RCV-14 was showing closed and the operators had no cause to suspect faulty circuitry including an incorrect valve position, so this action was not pursued. Had they looked at the procedure, they would have been instructed to manually close the pressurizer spray valve isolation valve and to notify maintenance to check for faulty circuitry, which would have identified the incorrect indication and would have terminated the event.	6	☐	☒		Based on the intent of the procedure and related training, one might view this as not being an error. However, operators did not pull out any procedures, and instead relied on their memory of the procedures and plant response. If the procedure had been implemented, isolation of RCV-14 is likely to have occurred and the event would have been terminated.	☒

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
XHE3	12/8/91 025459	O	O-C	PRE	A	C	Operator performs a power bump based on the continued belief (incorrect) that RCS temperature was decreasing. It is noted that there was no procedure available to directly support the diagnosis and correction of the situation involving only decreasing RCS pressure (i.e., troubleshooting was knowledge-based).	7	☐	☐	XHE1, XHE4	Three successive power bumps (XHE1, XHE3, XHE4) were performed based on the incorrect premise that a RCS cooldown was in progress. All 3 bumps are considered highly dependent. Clustered with XHE 1.	☐
XHE4	12/8/91 030029	O	O-C	PRE	A	C	With continued falling RCS pressure, operator performs another power bump. After the initial power bump at 0247 (see PS1), this is the 3rd successive power bump in an attempt to raise reactor pressure (XHE1, XHE3, and this XHE4) while incorrectly believing there was a RCS cooldown.	7	☐	☐	XHE1, XHE3	Three successive power bumps (XHE1, XHE3, XHE4) were performed based on the incorrect premise that a RCS cooldown was in progress. All 3 bumps are considered highly dependent. Clustered with XHE 1.	☐
EQA1	12/8/91 030917			INIT	A		Reactor properly trips on low RCS pressure (1800 psig) followed within one minute by a pressurizer low level alarm.		☐	☐			☒
HS2	12/8/91 030917	O	O-C	POST	A		Operators appropriately enter reactor trip procedure AP-580 and begin performing immediate actions.	13	☐	☐		As an expected response to the reactor trip, this does not qualify for Worksheet B coding and is not displayed on the graphical timeline.	☐
PS5	12/8/91 031137			POST	A		"ES (Engineered Safeguards) A and B NOT bypassed" alarm annunciates (annunciates at 1640 psig). This allows operators to choose to use the bypass switches to block high pressure injection (HPI) initiation as well as partial containment isolation, emergency feedwater operation, and starting of the emergency diesel generators (EDGs). This step is specified normal cooling/shutdown procedures.		☐	☐			☒

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
XHE5	12/8/91 031249	O	O-C	POST	A	C	One of the operators bypasses engineered safeguards (ES) logics A and B supposedly announcing the bypass but without receiving either direct permission or apparently an acknowledgement (though there is some confusion that the Senior Reactor Operator was aware of the bypass). This was not in conformance with the procedures as bypassing the ES is allowed and intended when in normal cooling/shutdown procedures. However, this was a non-routine situation with loss of pressure control, and the operators were clearly not in shutdown procedures, as they were still trying to diagnose the cause of the depressurization and the condition of the plant was in doubt. This condition (bypassed ES) remained the status quo for the next 6+ minutes as discussed under CI1 below and was not challenged by anyone until the Operations Superintendent did so (see CI1 below).	7	☐	☒		This action was later judged by the utility to be inappropriate since the reason for the ongoing RCS depressurization was not diagnosed and management concurrence was not clearly obtained.	☒
CI1	12/8/91 031249-031904		O-S, O-C	POST	A		Upon observation by the Operations Superintendent of the bypass after completing phone notification of the Plant Manager, the Superintendent recommends that the senior reactor operator (SRO) have the bypass removed. This is discussed for almost 6 minutes, and eventually leads to the recovery in HS3.		☐	☐	HS3		☒
EQA2	12/8/91 031904			POST	A		ES initiation bistables trip on low-low RCS pressure (~1550 psig).		☐	☐			☒
HS3	12/8/91 031916	O	O-C	POST	A		The bypass is directed to be removed based on the bistables trip and the bypass is removed promptly, letting HPI, emergency feedwater, and EDGs start. Operators appropriately enter the ES actuation procedure (AP-380) though it is noted that the procedure listed 1500 psig or manual actuation as entry conditions but not an auto ES which because of bistable setpoints, actually occurs above 1500 psig.	7	☒	☒	CI1	This is an important recovery of the earlier inappropriate ES bypass and so this subevent is covered by Worksheet B and shown on the graphical timeline.	☒
EQA3	12/8/91 031916			POST	A		HPI, emergency feedwater, and EDGs start and function appropriately (EDGs do not load since there is no normal power loss).		☐	☐			☐

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
HS4	12/8/91 031916-035346	O	O-C	POST	A		Operators go through a series of actions involving bypassing ES (allowed per the procedure once auto initiation has occurred) and manually controlling/throttling/temporary stopping HPI flow, securing emergency feedwater since main feedwater was operating normally, resetting the ES bistables when RCS pressure was temporarily recovered, and closely monitoring subcooling margin which was more than adequate but decreasing. A decision is made and carried out to establish a controlled HPI flow to the RCS to maintain adequate subcooling, increase RCS pressure, and increase pressurizer level.	7	☐	☐		While somewhat complicated, the actions are reasonably expected as a means to at least temporarily/partially stabilize the plant. Hence this is not covered by Worksheet B but is displayed on the graphical timeline as affecting approximately 25 minutes of the event evolution.	☒
XHE6	12/8/91 031916-035346	O	O-C	POST	A	C	While operators successfully entered the ES actuation procedure (AP-380), they exited it and carried out the manual HPI flow process without checking all the sections for potential applicability, which would have been appropriate, given that the plant was still not stabilized and the cause of the upset was not yet corrected. (Note: The Admin Control procedure had no caution against exiting such a procedure before checking the remaining sections of the procedure). Section 3.14 of the ES actuation procedure (AP-380) has actions to isolate possible sources of low RCS pressure including closing RCV-13, the isolation valve for pressurizer spray valve RCV-14. Step 3.14 is preceded by step 3.6 involving low pressure injection at 500 psig and since the pressure never was so low, the operators did not execute step 3.14 that would have terminated the event.	13	☐	☒			☒
PS7	12/8/91 035346			POST	A		RCS pressure was 1675 psig and pressurizer level indication was at the top of the scale following a pressurizer high-high level alarm that successfully annunciated almost 9 minutes earlier.		☐	☐			☒

Subevent Code	Date / Time	Work Type	Personnel	Pre / Initiator / Post	Latent / Active	Omission / Commission	Description	Human Action Category	Recovery	Worksheet B	Related Subevents	Comments	Graph
XHE7	12/8/91 035346	O	O-C	POST	A	C	While carrying out the process described under HS 4 above, the operators stopped all HPI flow to avoid eventual pressurizer relief valve operation. There is some concern expressed by the trip report team that this was bad judgment since this left considerable pressure margin before the relief valve setpoints would be reached but left much less margin (and hence was not conservative) for losing subcooling at ~1500 psig. It is noted that the ES actuation procedure did not address the priorities in such a situation.	7	☐	☒			☒
HS5	12/8/91 0354	O	O-C	POST	A		Operations Superintendent suggests closing pressurizer spray line isolation valve RCV-13 without any specific indication other than the fact that RCS pressure was starting to drop again after HPI termination. The valve is closed, and this action terminated the depressurization caused by the stuck-open (unknowingly) RCV-14 pressurizer spray valve.	2	☒	☒		This is an important recovery of the entire event in that it terminated the RCS depressurization. Hence, this subevent is covered by Worksheet B and shown on the graphical timeline.	☒
HS6	12/8/91 0402-0532	O	O-C	POST	A		Operators subsequently stabilized the plant with control of the pressurizer heaters. Various declarations (e.g., unusual event) and notifications to the state and NRC are made.	7	☐	☐	XHE8	As expected actions, this is not covered by Worksheet B and is not specifically displayed on the graphical timeline.	☐
XHE8	12/8/91 0455-0532	O	O-C	POST	A	O	The action level determination and notification of state/NRC occurred much later than the time specified in plant emergency operating procedures. These notifications are intended to allow for others to take appropriate action while in-plant actions are in progress (not after the event is done and stable conditions are reached). The action level determination and notification of NRC were made without checking procedures for the appropriate timeliness of these actions in accordance with the emergency plan for the site which required such actions be taken upon initiation of emergency safeguards (ES).	13	☐	☒	HS6	While more of an administrative error that did not affect the evolution of this event, under different circumstances, this error could have affected necessary planning and actions of outside entities and so qualifies for Worksheet B coding and is shown on the graphical timeline.	☒

Section 4: General Trends Across Subevents / Lessons Learned

Part A: General Trends ☐ **Not Applicable**

Indicate any strong, overarching trends or context across the subevents and provide a detailed explanation. This section is optional and only used when an issue is seen repeatedly throughout the event, to highlight the trend that may not be readily evident from the separate Worksheet B coding.

Trend	Comment
☒ Procedures (e.g., repeated failure to use or follow procedures)	A common theme for many of the subevents is that procedures (1) were not available to directly address the situation, or (2) even when available, were sometimes not pulled out, or (3) were not implemented completely even when they were explicitly used. And in the case of the ES bypass, it was performed for a situation different than that intended by the shutdown procedures. This lack of proper use of procedural guidance, either because it was not available or not used properly when available, was a common trend throughout the duration of the event and resulted in many of the actions being performed (sometimes inappropriately) on the basis of operator knowledge/skill at ~3am in the morning.
☐ Workarounds (e.g., cultural acceptance of workarounds contributes to multiple subevents)	
☐ Strong mismatch (e.g., between operator expectations compared to evolving plant conditions; between communications goals compared to practice; between complexity and speed of event compared to training and procedural support; between operator mental model and actual event progression)	
☐ Deviation from previously analyzed or trained scenarios	
☐ Extreme or unusual conditions	
☐ Strong pre-existing conditions	
☒ Misleading or wrong information, such as plant indicators or procedures	The failed spray valve position indication was a significant contributor to the continued difficulty associated with properly diagnosing the cause of the RCS depressurization and being able to terminate the event quickly.
☐ Information rejected or ignored	
☐ Multiple hardware failures	
☐ Work transitions in progress	
☐ Poor safety culture	
☐ Configuration management failures including drawings and tech specs, such as incorrect room penetrations, piping or equipment configurations	
☐ Failure in communication or resource allocation	
☐ Other: ____	

Part B: Lessons Learned ☒ ***Not Applicable***

Explain any key lessons learned from this event and / or any key corrective actions taken as a result of this event.

____

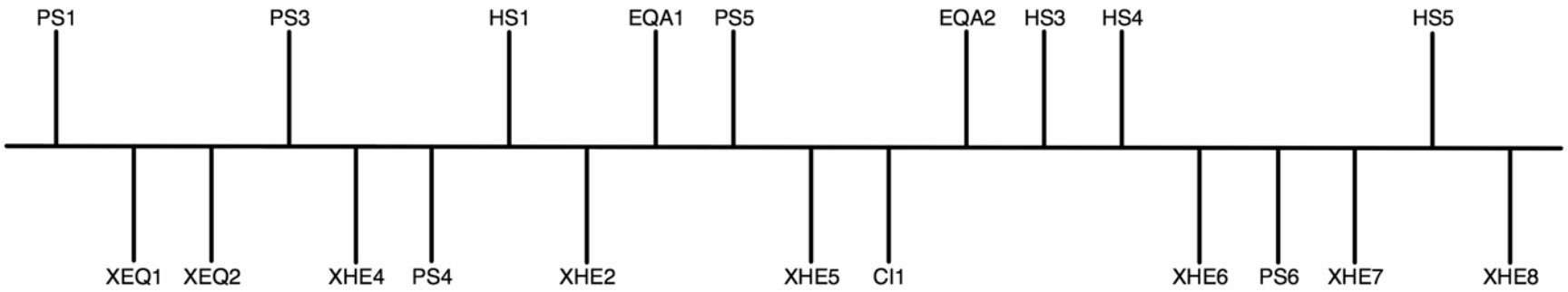
Section 5: Human Subevent Dependency Table

Place only the XHEs that receive Worksheet B coding on the top row and in the left column of the pyramid table. Check the appropriate boxes to indicate dependency between subevents. See the coding manual for guidance on assigning dependency. Provide explanation in the Comment table below to explain the factors that caused the subevents to exhibit dependency. Common dependency factors are listed in the pyramid table. Use additional sheets as necessary.

Subevent Code	XHE1	XHE2	XHE5	XHE6	XHE7	XHE8									
XHE1		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE2	**Common**		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE5	**Dependency Factors:**			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE6	• Similar Task				☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE7	• Same person/people					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
XHE8	• Close in time						☐	☐	☐	☐	☐	☐	☐	☐	☐
	• Same location/same equipment							☐	☐	☐	☐	☐	☐	☐	☐
	• No independent oversight								☐	☐	☐	☐	☐	☐	☐
	• Same cues									☐	☐	☐	☐	☐	☐
	• Action prompts next incorrect action										☐	☐	☐	☐	☐
	• Similar environmental conditions											☐	☐	☐	☐
	• Unreliable system feedback												☐	☐	☐
	• Prior human failures on same equipment													☐	☐
	• Lack of intervening human success														☐
	• Cultural dependency														
	• Mindset														
	• Work Practices														
	• Other (explain)														

Row Subevent	Column Subevent	Affects >1 subsequent subevent	Comment
		☐	The XHEs, as grouped above, are not considered to have strong dependencies among them. However, the various pulling of rods (inappropriate) addressed by XHE1, XHE3, and XHE4 and all captured under the XHE1 subevent, were all similar tasks close in time, performed by the same persons, and all based on the same but faulty premise that an RCS cooldown was occurring and more power was needed (i.e., all dependent on the same incorrect mindset).
		☐	
		☐	
		☐	

CRYSTAL RIVER GRAPHICAL TIMELINE



Code	Description
PS1	Rated thermal power had just been bumped up to 12% on the way to 15% to prepare to roll main turbine after a short maintenance outage.
XEQ1	It is suspected that at the power bump in PS 1, and perhaps for subsequent bumps thereafter, RCS pressure rose to the setpoint for pressurizer spray valve RCV-14 which opened accordingly but the valve failed to reclose (i.e., stuck-open) when pressure decreased again.
XEQ2	The closed light indicating the position of pressurizer spray valve RCV-14 never extinguished and the 40% open and full open lights remained dark (thus the valve always appeared closed to the operators).
PS3	Reactor pressure increased slightly in response to the rod bump, but then began to decrease slowly; observed by the operators.
XHE4	With continued falling RCS pressure, operator performs another power bump. After the initial power bump at 0247 (see PS1), this is the 3rd successive power bump in an attempt to raise reactor pressure (XHE1, XHE3, and this XHE4) while incorrectly believing there was a RCS cooldown.
PS4	Reactor pressure increased to 2223 psig and then begins to decrease. Tavg went from 567.3F to 568.5F and pressurizer level went from 176 inches to 190 inches. Observed by an operator monitoring strip chart recorders that, because of the scales, were hard to read but trends were readable. Reactor low pressure alarm annunciates at 02:53:25.

HS1	In response to the low pressure alarm, control room staff begin a concerted effort to find the cause of the decreasing pressure. They successfully rule out various possible causes of the low pressure and they move the control switch for RCV-14 to the closed position in an attempt to check it was closed (a good practice) even though the closed light continued to be illuminated.
XHE2	Operators do not pull out and implement the alarm response procedure (AR-502) since intent of procedure is for dealing with suspected control circuit faults such as the spray valve indicating open. Procedure addresses need to manually close the pressurizer spray valve isolation valve, which if operators had performed the isolation, the event would have been terminated. But since the pressurizer spray valve RCV-14 was showing closed and the operators had no cause to suspect faulty circuitry including an incorrect valve position, this action was not pursued. [Based on the intent of the procedure and related training, one might view this as not being an error. However, if the procedure had been implemented, isolation of RCV-14 is likely to have occurred and the event would have been terminated].
EQA1	Reactor properly trips on low RCS pressure (1800 psig) followed within one minute by a pressurizer low level alarm.
PS5	"ES (Engineered Safeguards) A and B NOT bypassed" alarm annunciates (annunciates at 1640 psig). This allows operators to choose to use the bypass switches to block high pressure injection (HPI) initiation as well as partial containment isolation, emergency feedwater operation, and starting of the emergency diesel generators (EDGs). Its intent is for use while cooling/shutting down and not this situation involving startup.
XHE5	One of the operators bypasses engineered safeguards (ES) logics A and B supposedly announcing the bypass but without receiving either direct permission or apparently an acknowledgement (though there is some confusion that the Senior Reactor Operator was aware of the bypass). This was not in conformance with the procedures as bypassing the ES is allowed and intended when cooling/shutting down and hence is in the shutdown procedures (not for this type of situation where startup is in progress). This condition (bypassed ES) remained the status quo for the next 6+ minutes as discussed under CI1 below and was not challenged by anyone until the Operations Superintendent did so (see CI1 below). This action was later judged by the utility to be inappropriate since the reason for the ongoing RCS depressurization was not diagnosed and management concurrence was not clearly obtained.
CI1	Upon observation by the Operations Superintendent of the bypass after completing phone notification of the Plant Manager, the Superintendent recommends that the senior reactor operator (SRO) have the bypass removed. This is discussed for almost 6 minutes.
EQA2	ES initiation bistables trip on low-low RCS pressure (~1550 psig).
HS3	The bypass is directed to be removed based on the bistables trip and the bypass is removed promptly, letting HPI, emergency feedwater, and EDGs to start. Operators appropriately enter the ES actuation procedure (AP-380) though it is noted that the procedure listed 1500 psig or manual actuation as entry conditions but not an auto ES which because of bistable setpoints, actually occurs above 1500 psig.
HS4	Operators go thru a series of actions involving bypassing ES (allowed per the procedure once auto initiation has occurred) and manually controlling/throttling/temporary stopping HPI flow, securing emergency feedwater since main feedwater was operating normally, resetting the ES bistables when RCS pressure was temporarily recovered, and closely monitoring subcooling margin which was more than adequate but decreasing. A decision is made and carried out

	to establish a controlled HPI flow to the RCS to maintain adequate subcooling, increase RCS pressure, and increase pressurizer level.
XHE6	While operators successfully entered the ES actuation procedure (AP-380), they exited it and carried out the manual HPI flow process without checking all the sections for potential applicability especially when the plant was still not stabilized and the cause of the upset was not yet corrected. (Note: The Admin Control procedure had no caution against exiting such a procedure before checking the remaining sections of the procedure). Section 3.14 of the ES actuation procedure (AP-380) has actions to isolate possible sources of low RCS pressure including closing RCV-13, the isolation valve for pressurizer spray valve RCV-14. Step 3.14 is preceded by step 3.6 involving low pressure injection at 500 psig and since the pressure never was so low, the operators did not execute step 3.14 that would have terminated the event.
PS6	RCS pressure was 1675 psig and pressurizer level indication was at the top of the scale following a pressurizer high-high level alarm that successfully annunciated almost 9 minutes earlier.
XHE7	While carrying out the process described under HS 4 above, the operators stopped all HPI flow to avoid eventual pressurizer relief valve operation. There is some concern expressed by the trip report team that this was bad judgment since this left considerable pressure margin before the relief valve setpoints would be reached but left much less margin (and hence was not conservative) for losing subcooling at ~1500 psig. It is noted that the ES actuation procedure did not address the priorities in such a situation.
HS5	Pressurizer spray line isolation valve RCV-13 is closed without any specific indication other than the fact that RCS pressure was starting to drop again after HPI termination. This action terminated the depressurization caused by the stuck-open (unknowingly) RCV-14 pressurizer spray valve.
XHE8	The above mentioned action level determination and notification of NRC (see HS6) were later than intended since such declarations/notifications are to allow for others to take appropriate action while in-plant actions are in progress (not after the event is done and stable conditions are reached). The action level determination and notification of NRC were made without checking procedures for the appropriate timeliness of these actions in accordance with the emergency plan for the site which required such actions be taken upon initiation of emergency safeguards (ES).

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: XHE1
Description: With falling RCS pressure, operators performs three successive power bumps (this worksheet contains coding for the cluster of XHE1, XHE3, and XHE4) in an attempt to raise reactor pressure while incorrectly believing there was a RCS cooldown.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS) ☐ OPS Supervisors ☒ Control Room (CR) Operators ☐ Outside of CR Operators ☐ Technical Support Center (TSC)	☐ Plant Support Personnel ☐ Administrative Support ☐ Chemistry ☐ Emergency Planning / Response ☐ Engineering ☐ Fitness for Duty ☐ Fuel Handling ☐ Health Physics ☐ Procedure Writers ☐ QA / Oversight	☐ Security ☐ Training ☐ Shipping / Transportation ☐ Specialized Task Force ☐ Work Control ☐ Licensing / Regulatory Affairs
☐ Maintenance and Testing ☐ Maintenance Supervision / Planning ☐ Mechanical ☐ Electrical ☐ I&C		☐ Non-Plant Personnel ☐ Contractor Personnel ☐ Manufacturer ☐ NRC / Regulator ☐ Vendor
☐ Management	☐ Site-Wide	
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	

Plant Condition	Comment
☒ Instrumentation problems / inaccuracies	Faulty/misleading position indication for the pressurizer spray valve, RCV-14 (valve incorrectly appeared closed though it was open), made it difficult to diagnose this was the cause of the RCS depressurization. This contributed to the incorrect assertion that a RCS cooldown was in progress due to a power-steam demand mismatch. Further, lack of a pressurizer spray line flow indication (though not typical in plants) added to the difficulty to diagnose that the stuck-open RCV-14 was the source of the RCS depressurization contributing to the belief that pulling the control rods was the appropriate action to take (which it was not).
☒ Control problems	There was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

PSF	Positive Contributory Factor	Source / Inference	Comment
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☒ Time pressure to complete task	☐ Source ☒ Inferred	Recognition of the recurring RCS pressure reduction after each control rod pull, and in attempting to avoid a reactor trip, probably resulted in time pressure to diagnose and correct the problem.
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Stress & Stressors	☒ High stress	☒ Source ☐ Inferred	The combination of time limitation to avoid a reactor trip and limited (and even misleading) data availability to diagnose the cause of the RCS depressurization likely led to some stress. The reliance on impaired cognitive skills at 3am may have also added to the stress level.

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☒ Ambiguous or misleading information present	☒ Source ☐ Inferred	The pressurizer spray valve, RCV-14, was open but falsely indicating as "closed" so was not suspected as the cause for the RCS depressurization.
	☒ Information fails to point directly to the problem	☒ Source ☐ Inferred	RCS depressurization may occur for several reasons and with the misleading pressurizer spray valve position indication and with no spray line flow indication, there was nothing to point directly to the cause of the RCS depressurization.
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☒ General ambiguity of the event	☒ Source ☐ Inferred	All available information suggested that the RCS pressure should not be decreasing. The behavior of the RCS pressure was seen as illogical and implausible.
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☒ Training LTA (T 100)	☒ Source ☐ Inferred	Based on management's decision to review and supplement existing training for this event as reported in section 2.3.5 of the trip report, presumably there was training for RCS depressurization events but not sufficiently adequate.
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☒ Not familiar / well practiced with task	☒ Source ☐ Inferred	Two of the operators involved were relatively inexperienced in responses to unplanned transients.
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☒ No procedure / reference documents (P 110)	☒ Source ☐ Inferred	Trip report has multiple mention of no procedure to directly deal with decreasing RCS pressure and providing a diagnostic procedure was being considered by management as one of the corrective actions.
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☒ Displays LTA (H3)	☒ Source ☐ Inferred	There was: (1)no pressurizer spray line flow indication (not typical), (2) the spray line valve, RCV-14, was erroneously indicating closed, and (3) the scale on the temperature recorder made trending RCS temperature somwhat difficult.
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☒ Circadian factors / individual differences (F 127)	☒ Source ☐ Inferred	Time of event (~3am) may have meant crew was not at their best in accordance with more normal, daylight, work rhythm. Crew had to use considerable knowledge skills, which are the most impaired in the early morning hours, to deal with the event.
	☐ Impairment (F 129)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☒ Inadequate supervision / command and control (O1 130)	☒ Source ☐ Inferred	The supervisor did not question (may not have even realized) one or more of the power bumps.
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☒ Progress not adequately monitored	☒ Source ☐ Inferred	Operators were not supervised as closely as they should have been, given their inexperience with unplanned transients.
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☒ Information present but not adequately used	☒ Source ☐ Inferred	The fact that temperatures (Tavg) were not dropping was not checked/verified. This may have ruled out the early mindset that a RCS cooldown was in progress leading to the inappropriate pulling of the control rods. Also, the strip chart recorders showed increasing, not decreasing pressurizer level and RCS temperature, but instead operators attended to a report of steam flow from the steam generators to the deaerating feed tank, which supported their hypothesis.
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☒ Failure to access available sources of information	☒ Source ☐ Inferred	Operators did not refer to any procedure during their investigation of the depressurization, but instead relied on their recall of procedures and plant behavior.
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☒ No communication / information not communicated (C 160)	☒ Source ☐ Inferred	It isn't clear that there was sufficient communication between the board operators and the shift supervisors to allow proper collaboration of actions to be taken (at least during the initial power bumps where it is not clear supervision even knew of the original power bump after RCS depressurization was evident).
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☒ Team interactions less than adequate (W2 191)	☐ Source ☒ Inferred	It appears as though interactions between the board operators and the shift supervision was not sufficient to alert all parties to what actions were being taken and why.
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☒ **Detection**	☒ **Interpretation**	☐ **Planning**	☒ **Action**	☐ **Indeterminate**
Comment: This XHE involves failure to sufficiently detect/check that RCS temperatures were not dropping leading to the subsequent incorrect interpretation that a RCS cooldown was in progress, resulting in the inappropriate decision/implementation to bump the control rods.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred time pressure; see section 4.
Stress & Stressors	☐Insufficient Information ☐Good ☐Nominal ☒Poor	High stress due to time pressure, limited data, and complexity of the situation; see section 4.
Complexity	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Misleading information and illogical plant behavior; see section 4.
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Training inadequate for RCS depressurization events, operator inexperience with unplanned transients; see section 4.
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☒Poor	No procedure available directly addressed decreasing RCS pressure; see section 4.
Ergonomics& HMI	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Missing and misleading indications; see section 4.
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Time of day (3-4 am) contributed to poor cognitive functioning; see section 4.
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Poor supervision, failure to adequately use or access available information; see section 4.
Communication	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Poor communication; see section 4.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inadequate interaction between operators and supervision; see section 4.

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	Incorrect action to bump up power based on an incorrect premise.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☒	Misdiagnosis, misinterpretation, situation assessment error	Initial premise of RCS cooldown and failure for all to clearly know that RCS temperatures were not dropping, led to misdiagnosis of a power - steam mismatch with a corresponding cooldown and that more power was therefore needed.
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	

	Error Type	Comment
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: XHE2
Description: Operators do not pull out and implement the alarm response procedure (AR-502), as the intent of procedure is for dealing with suspected control circuit faults such as the spray valve indicating open. But the pressurizer spray valve RCV-14 was showing closed and the operators had no cause to suspect faulty circuitry including an incorrect valve position, so this action was not pursued. Had they looked at the procedure, they would have been instructed to manually close the pressurizer spray valve isolation valve and to notify maintenance to check for faulty circuitry, which would have identified the incorrect indication and would have terminated the event.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☒ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	

Plant Condition	Comment
☒ Instrumentation problems / inaccuracies	Continuous faulty/misleading position indication for the pressurizer spray valve, RCV-14 (valve incorrectly appeared closed though it was open), gave the crew no cause to suspect a control circuit problem with the valve (such as if it had been showing open) and thus the need to explicitly follow the alarm procedure (AR-502) was not clear.
☒ Control problems	There was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☐ Reactor scram / plant transient	
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

PSF	Positive Contributory Factor	Source / Inference	Comment
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☒ Training LTA (T 100)	☐ Source ☒ Inferred	Depending on the intended response to this alarm, if the licensee intended the alarm procedure to be followed even if there is no apparent circuit fault, then the training appears to have been misleading/unclear and was inadequate for addressing any RCS low pressure situation. Otherwise, the training may have been okay as is, though it could be argued that pulling out and quickly reviewing the procedure is still a more appropriate practice.
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ Procedures do not cover situation	☐ Source ☒ Inferred	Operators did not pull out the alarm procedure or use it since its intent was supposedly to address control circuit faults (operators had no indication that such a circuit fault (i.e., position indication) existed). So it is not clear whether the procedure was applicable or even if the operators actually should have used the procedure or if the procedure should be modified.
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☒ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☒ Inferred	Depending on the intended response to this alarm, if the licensee intended the procedure to be followed even if there is no apparent circuit fault, then the alarm design should have reflected that and/or its response procedure rewritten with follow-up training. If not, then the alarm and its procedural response are adequate as designed
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☒ Displays LTA (H3)	☒ Source ☐ Inferred	RCV-14 was incorrectly indicating closed.
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

PSF	Negative Contributory Factor	Source / Inference	Comment
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☒ Management expectations or directions less than adequate (O1 131)	☐ Source ☒ Inferred	Operators did not pull out the alarm procedure or use it since its intent was supposedly to address control circuit faults (operators had no indication that such a circuit fault (i.e., faulty position indication) existed). If it was management's intent that the alarm procedure be pulled out anyways and checked for possible implementation, this was apparently not clear to the operators through their training on alarms.
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☒ Failure to access available sources of information	☐ Source ☒ Inferred	Even though RCV-14 was showing closed, it would have been a good work practice to examine procedure AR-502 for applicability.
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☒ **Interpretation**	☐ **Planning**	☐ **Action**	☐ **Indeterminate**
Comment: This XHE involves failure to pull out and explicitly follow the alarm procedure (AR 502) for what was believed by the crew to be a legitimate (but perhaps incorrect) reason - supposedly it applied to suspected circuit faults and yet the crew had no strong indication that such a fault existed. Depending on management's intentions regarding the desired response to the alarm (e.g., perhaps the procedure should still be pulled out and at least checked for applicability and possible implementation), a possibly incorrect interpretation that the alarm was not relevant resulted in the subsequent decision to not pull out and implement the alarm procedure.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor, though pulling out a procedure in response to an alarm, in and of itself, is not complex.
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred inadequate training; see section 4.

PSF	PSF Level	Comment
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Procedure was not clearly applicable; see section 4.
Ergonomics& HMI	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Faulty indication; see section 4.
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred poor management expectations/directions, failure to access available sources of information; see section 4.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	It appears the crew made a conscious decision to not pull-out and follow the procedure believing it was not relevant since no circuit fault was suspected. Depending on the intended/trained and thus desired response, the crew may not have made an error at all, although one might still fault the crew for not checking the alarm response procedure at least for potential applicability and possible implementation.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	

	Error Type	Comment
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☒	Misunderstood instructions / information	The crew's understanding of the intent of the response procedure may have been misunderstood and that in fact, the procedure should have been pulled out and used.
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Not clear whether this was really an error on the part of the crew, depending on the intended/trained use of the alarm procedure.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: XHE5
Description: One of the operators bypasses engineered safeguards (ES) logics A and B supposedly announcing the bypass but without receiving either direct permission or apparently an acknowledgement (though there is some confusion that the Senior Reactor Operator was aware of the bypass). This was not in conformance with the procedures as bypassing the ES is allowed and intended when in normal cooling/shutdown procedures. However, this was a non-routine situation with loss of pressure control, and the operators were clearly not in shutdown procedures, as they were still trying to diagnose the cause of the depressurization and the condition of the plant was in doubt. This condition (bypassed ES) remained the status quo for the next 6+ minutes as discussed under CI1 and was not challenged by anyone until the Operations Superintendent did so (see CI1).

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☒ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	

Plant Condition	Comment
☒ Control problems	There was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☒ Reactor scram / plant transient	A reactor trip had just occurred and RCS pressure was continuing to drop with the "ES A and B NOT Bypassed" alarm sounding.
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☒ Other: Procedures were available.	☒ Source ☐ Inferred	Procedures (i.e., shutdown procedures) were available and instructed that the ES could be bypassed during shutting down/cooling down conditions (implication being that this should not be done for other conditions).
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☒ Limited time to focus on tasks	☐ Source ☒ Inferred	With the continuing attempt to to deal with the RCS depressurization and the desire to avoid what seemed to one or more crew members to be an unnecessary ES actuation involving HPI, emergency feed, and EDG starts in the next few minutes, there was limited time to focus on whether the ES really could/should be bypassed and, because it could give them a few more minutes to find the cause of the depressurization, the decision to do so was made.
	☐ Time pressure to complete task ☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred ☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Stress & Stressors	☒ High stress	☒ Source ☐ Inferred	The decision to bypass ES was made partially in effort to gain more time to determine the cause of the depressurization, which, combined with the illogical pressure behavior, indicates that stress was high.

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☒ Simultaneous tasks with high attention demands	☐ Source ☒ Inferred	Dealing with both the continuing RCS depressurization and then having to quickly attend to the ES Not bypassed alarm, could have led to the quick but inappropriate decision to bypass the ES.
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☒ Training LTA (T 100)	☐ Source ☒ Inferred	In spite of the procedural guidance as to when ES bypass was permissible (during shutdown or after an automatic ES start), and according to the management finding that the action was inappropriate, leads to a likely conclusion that training in the correct response to this alarm was not sufficient/adequate.
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ Not familiar / well practiced with task	☒ Source ☐ Inferred	The operator involved in this XHE was relatively inexperienced in responses to unplanned transients.
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Procedures did exist as to when ES could be bypassed - so this is not considered a negative factor (see Section 3).
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☒ Circadian factors / individual differences (F 127)	☒ Source ☐ Inferred	Time of event (~3am) may have meant crew was not at their best in accordance with more normal, daylight, work rhythm. Crew had to use considerable knowledge skills, which are the most impaired in the early morning hours, to deal with the event.
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☒ Inadequate supervision / command and control (O1 130)	☐ Source ☒ Inferred	There is some confusion as to whether the SRO was aware of the bypass and yet did not question it. Further, the bypass occurred and yet was not immediately challenged (or perhaps noticed) by the shift supervision indicating a lack of appropriate command/control of actions occurring in the control room.
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☒ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☒ Progress not adequately monitored	☒ Source ☐ Inferred	Operators were not supervised as closely as they should have been, given their inexperience with unplanned transients.
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ Procedural adherence LTA (W2 185)	☒ Source ☐ Inferred	Plant shutdown procedures clearly dictate when bypassing ES is permissible; operator did not adhere to them and bypassed ES at an inappropriate time.
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☒ No communication / information not communicated (C 160)	☒ Source ☐ Inferred	The ES bypass was performed without receiving either direct permission or a clear acknowledgement (though there is some confusion as to whether shift supervision was aware of it). It is evident that clear and direct communication was not used about the intent and implementation of the ES bypass by one of the crew members.
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☒ **Interpretation**	☒ **Planning**	☐ **Action**	☐ **Indeterminate**
Comment: This XHE involves the inappropriate bypass of the engineered safeguards (ES) actuation logic in spite of procedural guidance as to when bypassing was permissible (especially in light of the ongoing RCS depressurization and that management concurrence was not clearly obtained). Incorrect interpretation of this as the appropriate action, and poor planning for not obtaining supervisor concurrence.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Limited time; see section 4.
Stress & Stressors	☐Insufficient Information ☐Good ☐Nominal ☒Poor	High stress; see section 4.
Complexity	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Multiple tasks; see section 4.
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred poor training on when to bypass ES, inexperience with unplanned transients; see section 4.
Procedures & Reference Documents	☐Insufficient Information ☐Good ☒Nominal ☐Poor	See section 3. Procedural guidance was at least available as to when it was appropriate to bypass ES.
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Impaired cognitive functioning due to time of day (3-4 am); see section 4.
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inadequate supervision and procedural adherence; see section 4.
Communication	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Poor communication; see section 4.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	ES was bypassed by a crew member without a clear and direct supervisor acknowledgement and in spite of procedural guidance as to when ES bypass was permissible (not appropriate for this condition). This action was not challenged by the shift supervision.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	

	Error Type	Comment
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☒	Misunderstood instructions / information	Recognition of the alarm and its implications was clear, but the crew member who bypassed the ES and the lack of an immediate challenge of the bypass by shift supervision shows a misunderstanding as to when the ES bypass was permissible.
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☒	Required procedures, drawings, or other references not used	Failure to refer to procedures that had guidance for when bypassing ES was permissible.
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: HS3
Description: The ES bypass is directed to be removed based on the ES bistables trip and the bypass is removed promptly, letting HPI, emergency feedwater, and EDGs start. Operators appropriately enter the ES actuation procedure (AP-380) though it is noted that the procedure was a bit confusing since it listed 1500 psig or manual actuation as entry conditions, but not an auto ES which because of bistable setpoints, actually occurs above 1500 psig.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☒ OPS Supervisors	☐ Administrative Support	☐ Training
☒ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☒ Control problems	There was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected.

Plant Condition	Comment
☒ Plant / equipment not in a normal state	Engineered safeguards logic had been manually bypassed earlier by an operator and so automatic ES could not initiate.
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☒ Reactor scram / plant transient	A reactor trip had occurred and the engineered safeguards (ES) actuation bistables had just tripped indicating that automatic ES wanted to initiate.
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

PSF	Positive Contributory Factor	Source / Inference	Comment
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☒ Supervision properly involved in task	☒ Source ☐ Inferred	Operations Superintendent recognized the inappropriate ES bypass and recommended the bypass be removed.
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☒ Quick identification of key information was important to success	☒ Source ☐ Inferred	Quick identification that the ES bistables had tripped and understanding the related implications, made for a quick decision to promptly remove the ES bypass. This ended the discussion by the crew as to whether the bypass should be removed.
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong positive factor for this particular HS.
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☒ Training LTA (T 100)	☐ Source ☒ Inferred	Apparently, based on the 6+ minute discussion about whether or not to remove the ES bypass, training as to when it was permissible to bypass ES was seemingly inadequate/poor. Nevertheless, when the ES bistables tripped, the safest action to remove the ES bypass was promptly carried out.
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☒ Procedure / reference document technical content less than adequate (LTA) (P 111)	☒ Source ☐ Inferred	Procedure entry conditions did not exactly fit the conditions (procedures were poorly written) but in spite of this, the crew appropriately entered the procedure (AP-380) even though an automatic ES had occurred above 1500 psig.
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☒ Procedure / reference document development and maintenance LTA (P 113)	☒ Source ☐ Inferred	Procedure entry conditions should have better reflected automatic ES conditions.
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☒ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☒ **Interpretation**	☐ **Planning**	☐ **Action**	☐ **Indeterminate**
Comment: This HS involves the correct interpretation and subsequent prompt removal of the engineered safeguards (ES) logic bypass once the ES bistables tripped condition was detected, indicating that automatic ES was intended.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred poor training on when bypassing ES was permissible; see section 4. In spite of this, the correct recovery action of removing the ES bypass was promptly implemented.
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Procedure technical content less than adequate; see section 4. In spite of the procedure entry conditions not fitting the actual situation, the crew appropriately did the safest thing and entered the ES actuation procedure (AP-380).
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Work Processes	☐Insufficient Information ☒Good ☐Nominal ☐Poor	Proper supervision and good conduct of work; see section 3.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

Section 6: Error Type ☒ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	

	Error Type	Comment
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	

	Error Type	Comment
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: XHE6
Description: While operators successfully entered the ES actuation procedure (AP-380), they exited it and carried out the manual HPI flow process without checking all the sections for potential applicability, which would have been appropriate, given that the plant was still not stabilized and the cause of the upset was not yet corrected. (Note: The Admin Control procedure had no caution against exiting such a procedure before checking the remaining sections of the procedure). Section 3.14 of the ES actuation procedure (AP-380) has actions to isolate possible sources of low RCS pressure including closing RCV-13, the isolation valve for pressurizer spray valve RCV-14. Step 3.14 is preceded by step 3.6 involving low pressure injection at 500 psig and since the pressure never was so low, the operators did not execute step 3.14 that would have terminated the event.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☐ OPS Supervisors	☐ Administrative Support	☐ Training
☒ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	

Plant Condition	Comment
☒ Control problems	There was the continuing difficulty to control the RCS depressurization because the cause was not yet diagnosed/corrected.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☒ Reactor scram / plant transient	A reactor trip had occurred and the crew was in the process of attempting to stabilize the plant and control the continuing RCS depressurization.
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

PSF	Positive Contributory Factor	Source / Inference	Comment
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☒ High stress	☐ Source ☒ Inferred	Operators were still having difficulty controlling RCS pressure, and had still not determined the cause of the problem. Inferred high stress.
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☒ Training LTA (T 100)	☐ Source ☒ Inferred	Depending on management's intentions and training as to the appropriate time to exit a procedure that has been entered, training may have been inadequate to ensure that procedures be at least checked for applicability before being exited (a good work practice).
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☒ Procedure / reference document technical content less than adequate (LTA) (P 111)	☒ Source ☐ Inferred	The relevant Admin Control Procedure had no cautions or other guidance against exiting such a procedure before checking its remaining sections for possible applicability for the situation.
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☒ Procedure / reference document development and maintenance LTA (P 113)	☒ Source ☐ Inferred	The relevant Admin Control Procedure and/or the other procedures should probably have had clear and direct guidance as to when procedures could be exited.
	☐ Procedures do not cover situation	☐ Source ☒ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☒ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☒ Circadian factors / individual differences (F 127)	☒ Source ☐ Inferred	Time of event (~3am) may have meant crew was not at their best in accordance with more normal, daylight, work rhythm. Crew had to use considerable knowledge skills, which are the most impaired in the early morning hours, to deal with the event.
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☒ Management expectations or directions less than adequate (O1 131)	☐ Source ☒ Inferred	It is possible that management's expectations as to when it is appropriate to exit a procedure were not clear.
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☒ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☒ Inferred	Establishing HPI to increase pressure and avoid insufficient subcooling was seen as the important task, and RCS pressure was still not under control, so it is likely that checking AP-380 for applicability before exiting the procedure was not considered in the face of these other priorities.
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: ____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☒ **Interpretation**	☐ **Planning**	☒ **Action**	☐ **Indeterminate**
Comment: This XHE involves the decision to exit the ES actuation procedure before checking the possible applicability of the remaining steps in the procedure especially in light of the plant not yet being stabilized and the cause of the RCS depressurization was not yet determined. This may have been an incorrect interpretation of guidance as to when it was acceptable to exit a procedure, leading to the subsequent act to exit the procedure, apparently prematurely.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Stress & Stressors	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred high stress; see section 4.
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred poor training on exiting emergency procedures; see section 4.
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☒Poor	No guidance in administrative procedures on when to exit an emergency procedure; see section 4.
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Impaired cognitive functioning due to time of day; see section 4.
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Inferred unclear management expectations about when to exit emergency procedures, poor coordination of multiple priorities, see section 4.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document.
This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	The crew apparently consciously exited the ES actuation procedure (AP-380) before checking whether other steps in the procedure might be relevant/useful for the situation. This was based on the fact that low pressure system actuation conditions were not relevant and thus the remaining steps in the procedure were presumed to be irrelevant. Guidance was apparently confusing, at best, as to when it was appropriate to exit such a procedure (e.g., the relevant Admin Control procedure had no such guidance) and so the crew may have been performing as trained based on their understanding of when one could exit a procedure.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	

	Error Type	Comment
☐	Use of wrong procedure	
☒	Misunderstood instructions / information	The crew's understanding of when it was acceptable to exit such a procedure may have been inappropriate. Guidance was apparently confusing, at best.
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Not clear whether this was really an error on the part of the crew, depending on the intended/trained guidance on when it was appropriate to exit a procedure.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: XHE7
Description: While carrying out the process of temporarily stabilizing the plant, the operators stopped all HPI flow when RCS pressure was ~1675 psig and the pressurizer level indication was at the top of the scale. This was done to avoid eventual pressurizer relief valve operation. There is some concern expressed by the trip report team that this was bad judgment since this left considerable pressure margin before the relief valve setpoints would be reached but left much less margin (and hence was not a conservative act) for losing subcooling at ~1500 psig. It is noted that the ES actuation procedure did not address the priorities in such a situation.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☒ OPS Supervisors	☐ Administrative Support	☐ Training
☒ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	

Plant Condition	Comment
☒ Control problems	There was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☒ Reactor scram / plant transient	A reactor trip had occurred and the crew was in the process of attempting to stabilize the plant and control the continuing RCS depressurization. Pressurizer level indication was at the top of the scale and RCS pressure was ~1675 psig.
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☒ Situation outside the scope of training	☐ Source ☒ Inferred	Apparently, the situation of attempting to to find a safe plant stable condition between wanting to avoid a pressuizer relief valve opening and maintaining RCS subcooling had not been trained on (note: the ES actuation procedure did not address priorities for such a situation, so, presumably, it was not covered in training either).
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☒ Procedure / reference document technical content less than adequate (LTA) (P 111)	☒ Source ☐ Inferred	The ES actuation procedure (AP-380) did not address priorities with regard to avoiding pressurizer relief valve opening and simultaneously ensuring adequate RCS subcooling.
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☒ Procedure / reference document development and maintenance LTA (P 113)	☒ Source ☐ Inferred	The ES actuation procedure had not been designed to address the appropriate priorities for the situation encountered.

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Procedures do not cover situation	☐ Source ☒ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☒ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☒ Circadian factors / individual differences (F 127)	☒ Source ☐ Inferred	Time of event (~3am) may have meant crew was not at their best in accordance with more normal, daylight, work rhythm. Crew had to use considerable knowledge skills, which are the most impaired in the early morning hours, to deal with the event.
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☒ Management expectations or directions less than adequate (O1 131)	☐ Source ☒ Inferred	Apparently management did not make clear its priorities for the situation encountered through the apparent lack of training and the fact that the procedures did not address how to appropriately balance plant conditions so as to avoid pressurizer relief valve opening and to ensure adequate RCS subcooling.

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☒ Non-conservative action (W2 193)	☒ Source ☐ Inferred	Based on the source, shutting down HPI completely was not necessarily the safest, most conservative action, especially considering the cause for the RCS depressurization had still not been corrected and it remained difficult to maintain RCS pressure, potentially jeopardizing the ability to maintain adequate RCS subcooling.
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ **Detection**	☒ **Interpretation**	☒ **Planning**	☐ **Action**	☐ **Indeterminate**
Comment: This XHE involves the decision to, and subsequent stopping of, all HPI flow when it was detected that pressurizer level was at the top of the scale and this was interpreted as nearing a possible pressurizer relief valve opening condition. This action to stop HPI with less of a margin for RCS subcooling and when RCS depressurization was still occurring was likely not the safest thing to do given these conditions. Procedural/training guidance as to the priorities in such a situation was at best, confusing or non-existent.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Complexity	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Experience & Training	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Situation outside the scope of training; see section 4.
Procedures & Reference Documents	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Procedures did not cover the situation; see section 4.
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Impaired cognitive functioning due to time of day; see section 4.
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Unclear management expectations, non-conservative decision making; see section 4.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☒	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	The crew consciously stopped all HPI flow to avoid a potential pressurizer relief valve opening condition in spite of having little margin for RCS subcooling and under continuing RCS depressurization conditions. Procedural and training guidance as to the proper priorities in such a situation were at best, confusing or non-existent. It is not clear that the action taken (stop all HPI) was the safest thing to do for this situation.
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☒	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	If an error, it is because the action was probably not the safest thing to do given the continuing difficulties with stabilizing RCS pressure and thus the possibility of losing RCS subcooling (which was decreasing).
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	

	Error Type	Comment
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

Not clear whether this was really an error on the part of the crew, depending on the intended/trained guidance as to proper priorities for such a situation.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: HS5
Description: Operations Superintendent suggests closing pressurizer spray line isolation valve RCV-13 without any specific indication other than the fact that RCS pressure was starting to drop again after HPI termination. The valve is closed and this action terminated the RCS depressurization caused by the stuck-open (unknowingly) RCV-14 pressurizer spray valve.

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☒ OPS Supervisors	☐ Administrative Support	☐ Training
☒ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	
☒ Control problems	There was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	

Plant Condition	Comment
☐ Loss of electrical power	
☒ Reactor scram / plant transient	A reactor trip had occurred and plant conditions were not yet entirely stabilized (RCS pressure began to drop again upon HPI termination).
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

PSF	Positive Contributory Factor	Source / Inference	Comment
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☒ Supervision alerted operators to key issue that they had missed	☒ Source ☐ Inferred	The more experienced acting supervisor suggested that closing RCV-13 (the pressurizer spray line isolation valve) be tried to see if it would be helpful. Prior to this point, this action was not apparently seriously considered and certainly not tried by the crew. Upon performing the suggested action, the event was correctly (and finally) terminated.
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Stress & Stressors	☐ High stress	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☒ Ambiguous or misleading information present	☒ Source ☐ Inferred	In spite of the "closed" indication for the pressurizer spray valve, RCV-14 (which was actually open and causing the RCS depressurization), the acting supervisor suggested RCV-13 (the spray line isolation valve) be closed to see if it would be helpful (perhaps based on his experience and knowledge of some procedure steps to check spray line isolation under certain circumstances).
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☐ Simultaneous tasks with high attention demands	☐ Source ☐ Inferred	
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☐ Procedure / reference document technical content less than adequate (LTA) (P 111)	☐ Source ☐ Inferred	
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.

PSF	Negative Contributory Factor	Source / Inference	Comment
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☐ Circadian factors / individual differences (F 127)	☐ Source ☐ Inferred	
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☐ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management	☐ Source ☐ Inferred	
	☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	
	☐ Failure to access available sources of information	☐ Source ☐ Inferred	
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☐ Team interactions less than adequate (W2 191)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular HS.

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☐ Detection	☒ Interpretation	☐ Planning	☒ Action	☐ Indeterminate
Comment: This HS involves the correct action of closing the pressurizer spray line isolation valve, RCV-13, though the action was based more on attempting to be helpful rather than a conscious determination that the pressurizer spray line was open. Proper interpretation of what might be the cause of the continuing RCS depressurization and the suggestion and prompt implementation of closing RCV-13 were the actions that finally terminated the cause of the event.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Stress & Stressors	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Complexity	☐Insufficient Information ☐Good ☐Nominal ☒Poor	See section 4 for contributing reason(s) for PSF level. In spite of this, it was thought that closing RCV-13 might be helpful and actually terminated the cause of the event.
Experience & Training	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Procedures & Reference Documents	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Fitness for Duty / Fatigue	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Work Processes	☐Insufficient Information ☒Good ☐Nominal ☐Poor	See section 3 for contributing reason(s) for PSF level.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

Section 6: Error Type ☒ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	
☐	**Error of Omission:** Failure to perform an action is an error of omission.	
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	
☐	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	

	Error Type	Comment
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

The Operations Superintendent could not remember a specific reason for his suggestion to close the spray block valve RCV-13. It is possible that he was recalling the rule in section 3.14 of abnormal procedure AP-380 that states that closing RCV-13 is one proper response to a low RCS pressure condition. It is clear, though, that this action was not taken due to any understanding of the cause of the depressurization.

Human Event Repository & Analysis (HERA) Worksheet, Part B

Source Document: Onsite Trip Report EGG-HFRU-10085 Subevent Code: XHE8
Description: The action level determination and notification of state/NRC occurred much later than the time specified in plant emergency operating prcedures (approximately 1.5 hour late). These notifications are intended to allow for others to take appropriate action while in-plant actions are in progress (not after the event is done and stable conditions are reached). The action level determination and notification of NRC were made without checking procedures for the appropriate timeliness of these actions in accordance with the emergency plan for the site which required such actions be taken upon initiation of emergency safeguards (ES).

Section 1: Personnel Involved in Subevent

Indicate which personnel were involved in the subevent. Check all that apply.

☐ Operations (OPS)	☐ Plant Support Personnel	☐ Security
☒ OPS Supervisors	☐ Administrative Support	☐ Training
☐ Control Room (CR) Operators	☐ Chemistry	☐ Shipping / Transportation
☐ Outside of CR Operators	☐ Emergency Planning / Response	☐ Specialized Task Force
☐ Technical Support Center (TSC)	☐ Engineering	☐ Work Control
☐ Maintenance and Testing	☐ Fitness for Duty	☐ Licensing / Regulatory Affairs
☐ Maintenance Supervision / Planning	☐ Fuel Handling	☐ Non-Plant Personnel
☐ Mechanical	☐ Health Physics	☐ Contractor Personnel
☐ Electrical	☐ Procedure Writers	☐ Manufacturer
☐ I&C	☐ QA / Oversight	☐ NRC / Regulator
☐ Management	☐ Site-Wide	☐ Vendor
☐ Other: ____		

Section 2: Contributory Plant Conditions

Indicate plant conditions that contribute to this subevent, and / or influence the decisions and / or actions of personnel. Leave a detailed comment, with reference to the source document.

Plant Condition	Comment
☐ Equipment installed does not meet all codes / requirements	
☐ Manufacturer fabrication / construction inadequate	
☐ Specifications provided by manufacturer inadequate	
☐ Documents, drawings, information, etc., provided by the manufacturer incorrect or inadequate	
☐ Substitute parts / material used do not meet specifications	
☐ Material used inadequate	
☐ QA requirements not used or met during procurement process	
☐ Post-procurement requirements not used / performed	
☐ Lack of proper tools / materials	
☐ Installation workmanship inadequate	
☐ Equipment failure	
☐ System / train / equipment unavailable	
☐ Instrumentation problems / inaccuracies	

Plant Condition	Comment
☒ Control problems	During the time when the declaration and notification of state/NRC should have been made, there was the continuing difficulty to control the RCS depressurization since its cause was not yet diagnosed/corrected. By the time the declaration and notification were made, the event had ben terminated and the plant had been returned to a stable condition.
☐ Plant / equipment not in a normal state	
☐ Plant transitioning between power modes	
☐ Loss of electrical power	
☒ Reactor scram / plant transient	When the declaration and state/NRC notifications should have been made, a reactor trip had occurred and the crew was in the process of attempting to stabilize the plant and control the continuing RCS depressurization. By the time the declaration and notification were made, the event had ben terminated and the plant had been returned to a stable condition.
☐ Other: _____	
☐ None / Not Applicable / Indeterminate	

Section 3: Positive Contributory Factors / PSF Details

Indicate any positive factors beyond what is nominally expected that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues on the next page.

PSF	Positive Contributory Factor	Source / Inference	Comment
Available Time	☐ More than sufficient time given the context	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Stress & Stressors	☐ Enhanced alertness / no negative effects	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Complexity	☐ Failures have single vs. multiple effects	☐ Source ☐ Inferred	
	☐ Causal connections apparent	☐ Source ☐ Inferred	
	☐ Dependencies well defined	☐ Source ☐ Inferred	
	☐ Few or no concurrent tasks	☐ Source ☐ Inferred	
	☐ Action straightforward with little to memorize and with no burden	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Experience & Training	☐ Frequently performed / well-practiced task	☐ Source ☐ Inferred	
	☐ Well qualified / trained for task	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Procedures & Reference Documents	☐ Guidance particularly relevant and correctly directed the correct action or response	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
	☒ Other: Procedure available	☒ Source ☐ Inferred	The emergency plan for the site dictated that such declarations/notifications should have been made upon initiation of emergency safeguards (ES).
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Unique features of HMI were particularly useful to this situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Fitness for Duty / Fatigue	☐ Optimal health / fitness was key to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Planning / Scheduling	☐ Correct work package development important to the success	☐ Source ☐ Inferred	
	☐ Work planning / staff scheduling important to the success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Supervision / Management	☐ Clear performance standards	☐ Source ☐ Inferred	
	☐ Supervision properly involved in task	☐ Source ☐ Inferred	
	☐ Supervision alerted operators to key issue that they had missed	☐ Source ☐ Inferred	
	☐ Pre-task briefing focused on failure scenario that actually occurred / discussed response plans that were directly applicable	☐ Source ☐ Inferred	
	☐ Pre-task briefing alerted operators to potential problems in a way that made them alert to the situation that developed	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Conduct of Work	☐ Quick identification of key information was important to success	☐ Source ☐ Inferred	
	☐ Error found by 2nd checker, 2nd crew, or 2nd unit	☐ Source ☐ Inferred	
	☐ Important information easily differentiated	☐ Source ☐ Inferred	
	☐ Determining appropriate procedure to use in unique situation was important to success	☐ Source ☐ Inferred	
	☐ Complex system interactions identified and resolved	☐ Source ☐ Inferred	
	☐ Remembered omitted step	☐ Source ☐ Inferred	
	☐ Difficult or potentially confusing situation well understood	☐ Source ☐ Inferred	
	☐ Safety implications identified and understood in a way that was important to success	☐ Source ☐ Inferred	
	☐ Acceptance criteria understood and properly applied to resolve difficult situation	☐ Source ☐ Inferred	
	☐ Proper post-modification testing identified and ensured resolution of significant problem	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

PSF	Positive Contributory Factor	Source / Inference	Comment
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Good trending of problems was important in correct diagnosis / response plan revision	☐ Source ☐ Inferred	
	☐ Adaptation of industry notices / practices was key to correct diagnosis / response plan verification	☐ Source ☐ Inferred	
	☐ Good corrective action plan avoided serious problems	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Communication	☐ Communications practice was key to avoiding severe difficulties	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Environment	☐ Environment particularly important to success	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.
Team Dynamics / Characteristics	☐ Extraordinary teamwork and / or sharing of work assignments was important to success	☐ Source ☐ Inferred	
	☐ Exceptional coordination / communications clarified problems during event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a positive factor.

Section 4: Negative Contributory Factors / PSF Details

Indicate any negative factors that contributed to the subevent. Check all that apply; if no details apply for a PSF category, check None. Indicate whether the detail is selected based on evidence directly from the source or if it is coder inference. Leave a detailed comment, with reference to the source document. This information is used to calculate the Performance Shaping Factor (PSF) level in Section 5. This table continues over the next three pages.

PSF	Negative Contributory Factor	Source / Inference	Comment
Available Time	☐ Limited time to focus on tasks	☐ Source ☐ Inferred	
	☐ Time pressure to complete task	☐ Source ☐ Inferred	
	☐ Inappropriate balance between available and required time	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Stress & Stressors	☒ High stress	☒ Source ☐ Inferred	At the time when the action level determination and notifications should have been made, the crew were in a state of high stress: they were still struggling with controlling RCS pressure, determining the cause of illogical and implausible RCS behavior, and avoiding insufficient undercooling and possible pressurizer relief valve operation.

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Complexity	☐ High number of alarms	☐ Source ☐ Inferred	
	☐ Ambiguous or misleading information present	☐ Source ☐ Inferred	
	☐ Information fails to point directly to the problem	☐ Source ☐ Inferred	
	☐ Difficulties in obtaining feedback	☐ Source ☐ Inferred	
	☐ General ambiguity of the event	☐ Source ☐ Inferred	
	☐ Extensive knowledge regarding the physical layout of the plant is required	☐ Source ☐ Inferred	
	☐ Coordination required between multiple people in multiple locations	☐ Source ☐ Inferred	
	☐ Scenario demands that the operator combine information from different parts of the process and information systems	☐ Source ☐ Inferred	
	☐ Worker distracted / interrupted (W2 198)	☐ Source ☐ Inferred	
	☐ Demands to track and memorize information	☐ Source ☐ Inferred	
	☐ Problems in differentiating important from less important information	☐ Source ☐ Inferred	
	☒ Simultaneous tasks with high attention demands	☒ Source ☐ Inferred	At the time when the action level determination and notifications should have been made, the crew were still struggling with controlling RCS pressure, determining the cause of illogical and implausible RCS behavior, and avoiding insufficient undercooling and possible pressurizer relief valve operation.
	☐ Components failing have multiple versus single effects	☐ Source ☐ Inferred	
	☐ Weak causal connections exist	☐ Source ☐ Inferred	
	☐ Loss of plant functionality complicates recovery path	☐ Source ☐ Inferred	
	☐ System dependencies are not well defined	☐ Source ☐ Inferred	
	☐ Presence of multiple faults	☐ Source ☐ Inferred	
	☐ Simultaneous maintenance tasks required or planned	☐ Source ☐ Inferred	
	☐ Causes equipment to perform differently during the event	☐ Source ☐ Inferred	
	☐ Subevent contributes to confusion in understanding the event	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Experience & Training	☐ Fitness for Duty (FFD) training missing / less than adequate (LTA) (F 124)	☐ Source ☐ Inferred	
	☐ Training LTA (T 100)	☐ Source ☐ Inferred	
	☐ Training process problem (T 101)	☐ Source ☐ Inferred	
	☐ Individual knowledge problem (T 102)	☐ Source ☐ Inferred	
	☐ Simulator training LTA (T4 103)	☐ Source ☐ Inferred	
	☐ Work practice or craft skill LTA (W2 188)	☐ Source ☐ Inferred	
	☐ Not familiar with job performance standards	☐ Source ☐ Inferred	
	☐ Not familiar / well practiced with task	☐ Source ☐ Inferred	
	☐ Not familiar with tools	☐ Source ☐ Inferred	
	☐ Not qualified for assigned task	☐ Source ☐ Inferred	
	☐ Training incorrect	☐ Source ☐ Inferred	
	☐ Situation outside the scope of training	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Procedures & Reference Documents	☐ No procedure / reference documents (P 110)	☐ Source ☐ Inferred	
	☒ Procedure / reference document technical content less than adequate (LTA) (P 111)	☒ Source ☐ Inferred	While the plant emergency plan dictated when declarations/notifications should have been made (see section 3 above), the procedure the crew was utilizing, AP-380, did not include a reference to check the emergency response plan, as is customary at many plants.
	☐ Procedure / reference document contains human factors deficiencies (P 112)	☐ Source ☐ Inferred	
	☐ Procedure / reference document development and maintenance LTA (P 113)	☐ Source ☐ Inferred	
	☐ Procedures do not cover situation	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Ergonomics & HMI	☐ Alarms / annunciators less than adequate (LTA) (H1)	☐ Source ☐ Inferred	
	☐ Controls / input devices LTA (H2)	☐ Source ☐ Inferred	
	☐ Displays LTA (H3)	☐ Source ☐ Inferred	
	☐ Panel or workstation layout LTA (H4)	☐ Source ☐ Inferred	
	☐ Equipment LTA (H5)	☐ Source ☐ Inferred	
	☐ Tools and materials LTA (H6)	☐ Source ☐ Inferred	
	☐ Labels LTA (H7)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Fitness for Duty / Fatigue	☐ Working continuously for considerable number of hours	☐ Source ☐ Inferred	
	☐ Working without rest day for considerable time	☐ Source ☐ Inferred	
	☐ Unfamiliar work cycle	☐ Source ☐ Inferred	
	☐ Frequent changes of shift	☐ Source ☐ Inferred	
	☐ Problem related to night work	☐ Source ☐ Inferred	
	☒ Circadian factors / individual differences (F 127)	☒ Source ☐ Inferred	Time of event (~3am) may have meant crew was not at their best in accordance with more normal, daylight, work rhythm. Crew had to use considerable knowledge skills, which are the most impaired in the early morning hours, to deal with the event.
	☐ Impairment (F 129)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Work Processes	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Planning / Scheduling	☐ Work planning does not control excessive continuous working hours (F 125)	☐ Source ☐ Inferred	
	☐ Inadequate staffing / task allocation (W1 181)	☐ Source ☐ Inferred	
	☐ Scheduling and planning less than adequate (LTA) (W1 180)	☐ Source ☐ Inferred	
	☐ Work package quality LTA (W1 182)	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Supervision / Management	☐ Administrative assurance of personnel ability and qualification to perform work less than adequate (LTA) (F 120-122)	☐ Source ☐ Inferred	
	☐ Inadequate supervision / command and control (O1 130)	☐ Source ☐ Inferred	
	☐ Management expectations or directions less than adequate (O1 131)	☐ Source ☒ Inferred	
	☐ Duties and tasks not clearly explained / work orders not clearly given	☐ Source ☐ Inferred	
	☐ Progress not adequately monitored	☐ Source ☐ Inferred	
	☐ Inadequate control of contractors	☐ Source ☐ Inferred	
	☐ Frequent task re-assignment	☐ Source ☐ Inferred	
	☐ Pre-job activities (e.g., pre-job briefing) LTA (W1 183)	☐ Source ☐ Inferred	
	☐ Safety aspects of task not emphasized	☐ Source ☐ Inferred	
	☐ Informally sanctioned by management ☐ Formally sanctioned workarounds cause problem	☐ Source ☐ Inferred ☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Conduct of Work	☐ Self-check less than adequate (LTA) (W2 197)	☐ Source ☐ Inferred	
	☐ Improper tools or materials selected / provided / used	☐ Source ☐ Inferred	
	☐ Necessary tools / materials not provided or used	☐ Source ☐ Inferred	
	☐ Information present but not adequately used	☐ Source ☐ Inferred	
	☐ Failure to adequately coordinate multiple tasks / task partitioning / interruptions	☐ Source ☐ Inferred	
	☐ Fitness for Duty self-declaration LTA (F 123)	☐ Source ☐ Inferred	
	☐ Fitness for Duty non-compliance (F 128)	☐ Source ☐ Inferred	
	☐ Control room sign off on maintenance not performed	☐ Source ☐ Inferred	
	☐ Tag outs LTA (W1 184)	☐ Source ☐ Inferred	
	☐ Second independent checker not used or available	☐ Source ☐ Inferred	
	☐ Work untimely (e.g., too long, late) (W2 192)	☐ Source ☐ Inferred	
	☐ Housekeeping LTA (W2 194)	☐ Source ☐ Inferred	
	☐ Logkeeping or log review LTA (W2 195)	☐ Source ☐ Inferred	
	☐ Independent verification / plant tours LTA (W2 196)	☐ Source ☐ Inferred	
	☐ Procedural adherence LTA (W2 185)	☐ Source ☐ Inferred	
	☐ Failure to take action / meet requirements (W2 186)	☐ Source ☐ Inferred	
	☐ Action implementation LTA (W2 187)	☐ Source ☐ Inferred	
	☐ Recognition of adverse condition / questioning LTA (W2 189)	☐ Source ☐ Inferred	
	☐ Failure to stop work / non conservative decision making (W2 190)	☐ Source ☐ Inferred	
	☐ Non-conservative action (W2 193)	☐ Source ☐ Inferred	
	☐ Failure to apply knowledge	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ Failure to access available sources of information	☒ Source ☐ Inferred	The shift supervisor relied on his memory of determination/notification requirements rather than check any procedure.
	☐ Post-modification testing inadequate	☐ Source ☐ Inferred	
	☐ Post-maintenance testing inadequate	☐ Source ☐ Inferred	
	☐ Retest requirements not specified	☐ Source ☐ Inferred	
	☐ Retest delayed	☐ Source ☐ Inferred	
	☐ Test acceptance criteria inadequate	☐ Source ☐ Inferred	
	☐ Test results review inadequate	☐ Source ☐ Inferred	
	☐ Surveillance schedule not followed	☐ Source ☐ Inferred	
	☐ Situational surveillance not performed	☐ Source ☐ Inferred	
	☐ Required surveillance / test not scheduled	☐ Source ☐ Inferred	
	☐ Incorrect parts / consumables installed / used	☐ Source ☐ Inferred	
	☐ Failure to exclude foreign material	☐ Source ☐ Inferred	
	☐ Incorrect restoration of plant following maintenance / isolation / testing	☐ Source ☐ Inferred	
	☐ Independent decision to perform work around or circumvention	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	
Problem Identification & Resolution (PIR) / Corrective Action Plan (CAP)	☐ Problem not completely or accurately identified (R1 140)	☐ Source ☐ Inferred	
	☐ Problem not properly classified or prioritized (R1 141)	☐ Source ☐ Inferred	
	☐ Operating experience review less than adequate (LTA) (R1 142)	☐ Source ☐ Inferred	
	☐ Failures to respond to industry notices or follow industry practices	☐ Source ☐ Inferred	
	☐ Tracking / trending LTA (R1 143)	☐ Source ☐ Inferred	
	☐ Root cause development LTA (R2 145)	☐ Source ☐ Inferred	
	☐ Evaluation LTA (R2 146)	☐ Source ☐ Inferred	
	☐ Corrective action LTA (R3 147)	☐ Source ☐ Inferred	
	☐ Action not yet started or untimely (R3 148)	☐ Source ☐ Inferred	
	☐ No action planned (R3 149)	☐ Source ☐ Inferred	
	☐ CAP Programmatic deficiency (R4 150)	☐ Source ☐ Inferred	
	☐ Willingness to raise concerns LTA (R5 151)	☐ Source ☐ Inferred	
	☐ Preventing and detecting retaliation LTA (R5 152)	☐ Source ☐ Inferred	
	☐ Failure to resolve known problems in a prompt fashion	☐ Source ☐ Inferred	
	☐ Failure to maintain equipment in accordance with licensing basis	☐ Source ☐ Inferred	
	☐ Audit / self-assessment / effectiveness review LTA (R1 144)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Communication	☐ No communication / information not communicated (C 160)	☐ Source ☐ Inferred	
	☐ Misunderstood or misinterpreted information (C 51)	☐ Source ☐ Inferred	
	☐ Communication not timely (C 52)	☐ Source ☐ Inferred	
	☐ Communication content less than adequate (LTA) (C 53)	☐ Source ☐ Inferred	
	☐ Communication equipment LTA (C 162)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	

PSF	Negative Contributory Factor	Source / Inference	Comment
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a strong negative factor for this particular XHE.
Environment	☐ Temperature / humidity less than adequate (LTA) (H10 71)	☐ Source ☐ Inferred	
	☐ Lighting LTA (H10 72)	☐ Source ☐ Inferred	
	☐ Noise (H10 73)	☐ Source ☐ Inferred	
	☐ Radiation (H10 74)	☐ Source ☐ Inferred	
	☐ Work area layout or accessibility LTA (H10 75)	☐ Source ☐ Inferred	
	☐ Postings / signs LTA (H10 76)	☐ Source ☐ Inferred	
	☐ Task design / work environment LTA (F 126)	☐ Source ☐ Inferred	
	☐ Other: _____	☐ Source ☐ Inferred	
	☒ None / Not Applicable / Indeterminate	☒ Source ☐ Inferred	Nothing in the source document alludes to this PSF as being a negative factor.
Team Dynamics / Characteristics	☐ Supervisor too involved in tasks, inadequate oversight	☐ Source ☐ Inferred	
	☐ Crew interaction style not appropriate to the situation	☐ Source ☐ Inferred	
	☒ Team interactions less than adequate (W2 191)	☒ Source ☐ Inferred	According to the source document, a more effective division of responsibilities among the various crew members could have prevented the delay in the declaration/notifications since many of the crew members were capable of assisting with such a task.
	☐ Other: _____	☐ Source ☐ Inferred	
	☐ None / Not Applicable / Indeterminate	☐ Source ☐ Inferred	

Section 5: Performance Shaping Factors

Part A: *Indicate whether the error or success occurred in detection, interpretation, planning, action, a combination (check all that apply), or could not be determined from the source information.*

☒ **Detection**	☐ **Interpretation**	☐ **Planning**	☐ **Action**	☐ **Indeterminate**
Comment: This XHE involves the failure to make the required site declaration and notifications in a timely manner; in this case, when engineered safeguards (ES) were initiated. Procedures associated with the emergency plan for the site were not pulled out and used to make the declaration/notifications when required. This appears to involve a failure to detect or otherwise properly interpret the plant had reached a condition when it was necessary to perform this task, thus leading to failure to carry out the task until the event was essentially over.				

Part B: *Assign PSF weightings for the subevent. This section summarizes and assigns a PSF level (Insufficient Information, Good, Nominal, Poor) to the detailed performance shaping factor information indicated in Sections 3 and 4. Leave a detailed comment, with reference to the appropriate details sections.*

PSF	PSF Level	Comment
Available Time	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Stress & Stressors	☐Insufficient Information ☐Good ☐Nominal ☒Poor	High stress; see section 4.
Complexity	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Multiple tasks with high attention demands; see section 4.
Experience & Training	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.

PSF	PSF Level	Comment
Procedures & Reference Documents	☐Insufficient Information ☐Good ☒Nominal ☐Poor	Plant Emergency Response Procedures specified when declarations/notifications should be made (see section 3), but the procedure that the crew was utilizing did not include a reference to check the Emergency plan (see section 4).
Ergonomics& HMI	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Fitness for Duty / Fatigue	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Impaired cognitive functioning due to time of day; see section 4.
Work Processes	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Failure to refer to procedures; see section 4.
Communication	☒Insufficient Information ☐Good ☐Nominal ☐Poor	Not clear if this was a factor.
Environment	☐Insufficient Information ☐Good ☒Nominal ☐Poor	In-control room actions so environment was likely "nominal."
Team Dynamics / Characteristics	☐Insufficient Information ☐Good ☐Nominal ☒Poor	Poor division of responsibilities between supervisors; see section 4.

Section 6: Error Type ☐ Check to Exclude

Code for XHE only. Indicate the appropriate error type for any human errors (XHEs). Check one box in Part A and all that apply in Part B. Leave a detailed comment, with reference to the source document. This list continues on the next page.

Part A: Commission / Omission

	Error Type	Comment
☐	**Error of Commission:** An incorrect, unintentional, or unplanned action is an error of commission.	
☒	**Error of Omission:** Failure to perform an action is an error of omission.	The crew failed to make the necessary declaration/notifications when they should have been made. Instead, this task was performed after considerable delay (about 1-1/2 hour delay).
☐	**Indeterminate**	

Part B: Slip / Lapse / Mistake / Circumvention / Sabotage

	Error Type	Comment
☐	**Slip or lapse:** A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. If it is not possible to assign one of the subcategories below to indicate the type of slip or miss, then this code is assigned.	
☐	Response implementation error	
☐	Unconscious wrong action or failure to act, wrong reflex, wrong instinctive action	
☐	Wrong action or lack of action due to omission of intentional check, insufficient degree of attention, unawareness	
☐	Strong habit intrusion, unwanted reversion to earlier plan	
☐	Continuation of habitual sequence of actions	

	Error Type	Comment
☒	Failure to act because focal attention is elsewhere, failure to attend to need for change in action sequence	While it is not entirely clear as to the underlying reason why the declaration and notifications were made so late, the fact that the source document found fault with an ineffective division of responsibilities among the crew suggests that operators attentions were focused elsewhere to the point that this administrative requirement was not fulfilled in a timely manner (it is surmized that the crew was probably dealing with the continuing RCS depressurization and the difficulties to stabilize the plant).
☐	Omission of intentional check after task interruption	
☐	Interference error between two simultaneous tasks	
☐	Confusion error (wrong component, wrong unit), spatial disorientation (wrong direction), check on wrong object	
☐	Omission of steps or unnecessary repeating of steps in (unconscious) action sequence	
☐	Task sequence reversal error	
☐	If appropriate, check the most applicable characterization of the slip: ☐ too early ☐ too late ☐ too fast ☐ too slow ☐ too hard ☐ too soft ☐ too long ☐ too short ☐ undercorrect ☐ overcorrect ☐ misread	
☐	**Mistake:** A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc. Use this category if you cannot distinguish among the mistake examples listed below.	
☐	Misdiagnosis, misinterpretation, situation assessment error	
☐	Wrong mental model, wrong hypothesis	
☐	Failure to detect situation, information overload (indications not noticed, acted upon)	
☐	Use of wrong procedure	
☐	Misunderstood instructions / information	
☐	Lack of specific knowledge	
☐	Tunnel vision (focus on limited number of indications, lack of big picture)	
☐	Over-reliance on favorite indications	
☐	Not believing indications / information (lack of confidence)	
☐	Mindset / preconceived idea / confirmation bias / overconfidence (failure to change opinion, discarding contradictory evidence)	
☐	Over-reliance on expert knowledge	
☐	**Circumvention:** In spite of a good understanding of the system (process, procedure, specific context) an intentional breaking of known rules, prescriptions, etc., occurred without malevolent intention. Use this field if it is clear that a circumvention applies but unclear which of the options below apply.	
☐	Administrative control circumvented or intentionally not performed	
☐	Required procedures, drawings, or other references not used	
☐	Intentional shortcuts in prescribed task sequence	
☐	Unauthorized material substitution	
☐	Situations that require compromises between system safety and other objectives (production, personal or personnel safety, etc.)	
☐	Intentional disregard of safety prescriptions / concerns	
☐	**Sabotage:** An intentional breaking of known rules, prescriptions, etc., occurred with malevolent intention.	
☐	**Indeterminate**	

Section 7: Subevent Comments

Provide any additional remarks necessary to complete or supplement the worksheet analysis for this subevent.

APPENDIX E

GLOSSARY

GLOSSARY

Note: Where applicable, definitions correspond to those found in ASME RA-S-2002, *Standard for Probabilistic Risk Assessment for Nuclear Power Plant Applications.*

Action – As commonly used in HRA, that portion of human performance involving a response or activity (typically observable and often practiced or routine) that is carried out by the plant staff. In HERA, this aspect of human performance is indicated separately from the diagnosis portion of human performance (see *Detection*, *Interpretation*, and *Planning*). Human errors (XHEs) or successes (HSs) can stem from failure or success in response implementation.

Active – A subevent (XHE, HS, CI, XEQ, EQA, or PS) that has an immediate impact on a scenario or activity being performed or modeled. An active error can become a latent error if it is not detected and creates a situation that could affect a scenario at a later time (e.g., failure to correctly restore a piece of equipment after maintenance that affects an operator's ability to respond to an accident scenario). In HERA, an active subevent is any subevent that occurs during the event sequence being analyzed, regardless of whether it is pre- or post-initiator (see *Latent*, *Pre-Initiator*, and *Post-Initiator*).

Available Time – Performance shaping factor used in HERA. Refers to the time available to complete a task, often in the context of the time to complete a corrective action in a nuclear power plant.

Circumvention –The class of errors that occur when, in spite of a good understanding of the system (process, procedure, specific context), a person deliberately breaks known rules, prescriptions, etc., without malevolent intention, usually with the intention of maintaining safe and/or efficient operations.

Common Cause Failure (CCF) – A failure of two or more components or human actions during a single short period of time as a result of a single shared cause.

Communication – Performance shaping factor used in HERA. Refers to the quality of verbal and written interaction between personnel working together at the nuclear power plant.

Complexity – Performance shaping factor used in HERA. Refers to how difficult the task is to perform in the given context. Complexity considers how ambiguous the situation/task is, the number of inputs and possible causes, the mental effort required, the clarity of cause-and-effect relationships, and the physical effort required. The more difficult a task is, the greater the chance for human error.

Contextual Information (CI) – Human subevent categorization used in HERA. Represents situational and background information about the human action or inaction. CI is a human action or inaction that:

- Is associated with design errors or improper guidance; *OR*
- Takes place outside the NSSS and BOP systems; *OR*
- Is an engineering function including onsite engineering.

Also, contextual information may include any information that affects the quality of the human action or interaction with the plant or its systems and components.

Conduct of Work – Subcategory of the Work Processes PSF. All contributing factors to a subevent that involve performance of work activities, at both the individual and group level. Conduct of work includes such factors as procedural adherence, whether work is done in a timely manner, appropriate or inappropriate use of knowledge and available information, test acceptance criteria, etc.

Contributory Plant Conditions – Any plant conditions that contribute to a human error (XHE) or human success (HS), and / or influence the decisions and / or actions of personnel, including system or equipment malfunctions or failures, power outages, equipment actuations, instrumentation problems, refueling outages, and transients.

Dependency – Refers to the relationship between human subevents, where subevents are determined by, influenced by, or correlated with prior human subevents. As applied to human actions, this is the situation in which the probability of failure of an action is influenced by whether a failure occurred for previous action. HERA recognizes that it is possible for dependency to exist between two successes or between a success and a failure; however, current methods of calculating the effect of dependency on human error probability (HEP) cannot account for any dependency other than between human errors. As a result, dependency in HERA is considered between human errors (XHEs) only.

Detection – The human information processing step associated with seeking and monitoring, in which the human realizes or becomes aware that task relevant information is present. Detection is influenced by two fundamental factors: the characteristics of the environment and a person's knowledge and expectations (see *Interpretation*, *Planning*, and *Action*). Human errors (XHEs) or successes (HSs) can stem from failure or success in detection.

Environment – Performance shaping factor used in HERA. Refers to external factors such as ambient noise, temperature, lighting, etc., which can greatly influence the ability of personnel to carry out their prescribed tasks.

Equipment Actuation (EQA) – Plant subevent categorization used in HERA. Represents successful equipment actuation that is automatic, activating as designed, and not by human action that potentially has a positive effect on the event outcome.

Equipment Failure (XEQ) – Plant subevent categorization used in HERA. Represents an equipment (EQ) failure or malfunction that potentially contributes to the fault (X).

Ergonomics and Human-Machine Interface (HMI) – Performance shaping factor used in HERA. Refers to the equipment, displays and controls, layout, quality and quantity of information available from instrumentation, and the interaction of the operator/crew with the equipment to carry out tasks. The adequacy or inadequacy of computer software is also included in this PSF. Examples of poor ergonomics may be found in panel design layout, annunciator designs, and labeling.

Error Category – Generalized categories of errors that are modeled in probabilistic risk assessments (PRAs) and some categories for events that may be studied for possible future use in risk assessments. For example, HERA analyzes human errors that precede an initiating event, while current PRAs do not include human errors in setting initiating event frequencies,

but use actual industry plant trip experience data instead. Each XHE analyzed is checked against the list of categories and placed in the one that best fits the situation.
Error of Commission – A human failure event resulting from an overt action, that, when taken, leads to a change in plant or system configuration with the consequence of a degraded plant or system state. Examples include terminating running safety-injection pumps, closing valves, and blocking automatic initiation signals.

Error of Omission – A human failure event resulting from a failure to take a required action, that leads to an unchanged or inappropriately changed plant or system configuration with the consequence of a degraded plant or system state. Examples include failures to initiate standby liquid control system, start auxiliary feedwater equipment, and failure to isolate a faulted steam generator.

Error type – A way of classifying human failure events related to the level of intent of the failure (error). In HERA, errors are categorized as either omission or commission, and as a slip or lapse, mistake, circumvention, or sabotage.

Event – Refers to an occurrence of one or more related operations and actions (called subevents in HERA; see *Subevents*) that, as applied here, are of interest from a human performance perspective. Often, this leads to a 'reportable occurrence' at a nuclear power plant. In HERA, an event includes the entire chronology of significant human actions and plant operational responses (i.e., subevents) contained in the information source.

Event timeline – A listing (Index of Subevents) and graphical representation of the significant human actions and plant operational responses (i.e., subevents) associated with an event. In HERA, this chronological information is especially useful for identifying fault or error precursors and for determining dependencies among human actions.

Experience & Training – Performance shaping factor used in HERA. Included in this consideration are years of experience of the individual, specificity of training, and amount of time since training.

Fitness for Duty/Fatigue – Performance shaping factor used in HERA. Refers to whether or not the individual performing the task is physically and mentally fit to perform the task at that time.

Human reliability analysis (HRA) – A structured approach used to identify potential human failure events and to systematically estimate the probability of those events using data, models, or expert judgment. HERA provides information that may be used to support HRA using a variety of methods.

Human Error (XHE) – Human subevent categorization used in HERA. Represents a human error (HE) that potentially contributes to the fault (X). An XHE is a human action or inaction that:

- Occurs within the boundary of the nuclear steam supply system (NSSS) and balance of plant (BOP) systems; *AND*
- Is unsafe; *OR*
- Potentially negatively affects plant, system, equipment availability, operability, and consequences; *OR*
- Represents a circumvention with negative impact.

Human Error Probability (HEP) – A measure of the likelihood that plant personnel will fail to initiate the correct, required, or specified action or response in a given situation or by commission performs the wrong action. The HEP is the probability of the human failure event. Typically in HRA, performance shaping factors are used to modify the base human error rate to determine the HEP.

Human Failure Event (HFE) – A basic event that represents a failure or unavailability of a component, system, or function that is caused by human inaction or inappropriate action. This is a general term used in Human Reliability Analysis (HRA) and is not to be confused with the HERA subevent category of Human Error (XHE).

Human Success (HS) – Human subevent categorization used in HERA. Represents a successful human action or inaction that potentially has a positive effect on the event outcome. HS is a human action or inaction that:

- Occurs within the boundary of the NSSS and BOP systems; *AND*
- Potentially positively affects plant, system, equipment availability, operability, and consequences; *OR*
- Represents a circumvention with positive impact.

Initiating Event – Any event either internal or external to the plant that perturbs the steady state operation of the plant, if operating, thereby initiating an abnormal event such as transient or loss of coolant accident (LOCA) within the plant. Initiating events trigger sequences of events that challenge plant control and safety systems whose failure could potentially lead to core damage or radioactive release to the environment. In HERA, an initiating event is labeled as *Initiator (INIT)* in the Index of Subevents.

Interpretation – The active process by which individuals create an understanding of what is happening in a given situation, in real time, based on the current inputs from the monitoring and detection activities, and based on an individual's knowledge and experience. Human errors (XHEs) or successes (HSs) can stem from failure or success in interpretation.

Latent – A subevent (XHE, HS, CI, EQA, or XEQ) that does not have an immediate effect on system performance, but whose consequences can become important at a later time, particularly when something else goes wrong. In HERA, a latent subevent is any subevent that occurs prior to the event sequence being analyzed, regardless of whether it is pre- or post-initiator (see *Active*, *Pre-Initiator*, and *Post-Initiator*).

Mistake – The class of errors that occur when a person is following a plan diligently, but the plan is inappropriate for the actual situation. A mistake is an intended action resulting in an undesired outcome in a problem solving activity: a person made a wrong action because he did not understand the system, the procedure, the specific context, the prescribed task, etc.

Performance Shaping Factor (PSF) – A factor that influences human performance and the resulting human error probabilities as considered in a HRA. In HERA, there are eleven PSFs (rated as Insufficient Information, Good, Nominal, or Poor): Available Time, Stress & Stressors, Complexity, Experience & Training, Procedures and Reference Documents, Ergonomics & Human-Machine Interface (HMI), Fitness for Duty, Work Processes, Communication, Environment, and Team Dynamics / Characteristics.

Performance Shaping Factor Detail / Contributory Factor – Detailed listings of both positive and negative contributing factors to human errors (XHEs) and successes (HSs), organized by the corresponding performance shaping factor (PSF). The PSF table (Section 5 of Worksheet B) serves as a summary of the information in the contributory factors / PSF details sections (Sections 3 and 4 of Worksheet B). The purpose of the PSF table (Section 5) is to rank the influence of a particular PSF on a human subevent based on the details identified in Sections 3 and 4. That ranking can then be used to apply a modification value to the calculation of the HEP.

Planning and Scheduling – Subcategory of the Work Processes PSF, which precedes Action during an event. All contributing factors to a subevent that involve planning work activities and scheduling. Work planning includes work package development, and scheduling includes assigning enough appropriate personnel to each shift or ensuring that an operator does not work too much overtime.

Plant State (PS) – Plant subevent categorization used in HERA. Represents information about the plant state that helps to explain the equipment failure, actuation, or other noteworthy factors pertaining to plant health or transients.

Post-Initiator – Any subevent (XHE, HS, CI, XEQ, or EQA) that occurs during response to an initiating event.

Pre-Initiator – Subevents (human errors, successes, contextual information, and equipment actuations or failures) that occurred prior to the initiation of an accident (e.g., during maintenance or the use of calibration procedures).

Probabilistic risk assessment (PRA) – A qualitative and quantitative assessment of risk associated with plant operation and maintenance that is measured in terms of frequency of occurrence of risk metrics such as core damage or radioactive material release and its effects on the health of the public (also referred to as a probabilistic safety assessment (PSA).

Procedures and Reference Documents – Performance shaping factor used in HERA. Refers to the existence and correct use of formal operating procedures or best practices for the tasks under consideration.

Problem Identification and Resolution (PIR) / Corrective Action Plan (CAP) – Subcategory of the Work Processes PSF. All contributing factors to a subevent that involve identifying and resolving problems at a plant. This includes factors such as classification of issues, root cause development, planning and implementation of corrective actions, review of operating experience, trending of problems, individuals' questioning attitudes and willingness to raise concerns, and preventing and detecting retaliation.

Recovery—A human action performed to regain equipment or system operability from a specific failure or human error to mitigate or reduce the consequences of the failure.

Sabotage—The class of errors that encompass an intentional breaking of known rules, prescriptions, etc., with malevolent intention.

Slip / Lapse – The category of errors that occur when a person intends to take the correct action, but either takes a wrong action (a slip) or fails to take the action they intended (a lapse). A slip or lapse is an unconscious unintended action or failure to act, resulting from an attention

failure or a memory failure in a routine activity. In spite of a good understanding of the system (process, procedure, and specific context) and the intention to perform the task correctly, an unconscious unintended action or a failure to act occurs or a wrong reflex or inappropriate instinctive action takes place. Simple examples would include turning the wrong switch when the correct one is located next to it or inadvertently leaving out a step in a procedure when they fully intended to complete the step.

Stress and Stressors—Performance shaping factor used in HERA. Stress as used in HERA refers to the level of undesirable conditions and circumstances that impede the operator from easily completing a task. Stress can include mental stress, excessive workload, or physical stress such as that imposed by difficult environmental factors. Environmental factors often referred to as stressors, such as excessive heat, noise, poor ventilation, or radiation, can induce stress in a person and affect the operator's mental or physical performance.

Subevents – Individual operations and actions that contribute to an overall event. Each subevent has a separate analysis section in HERA.

Subevent codes – Symbols used to categorize the negative or positive effects of subevents. HERA employs the following codes: human failure (i.e., error) (XHE), successful human action (HS), equipment failure (XEQ), successful equipment actuation/operation (EQA), human contextual information (CI), and plant state contextual information (PS).

Supervision and Management – Subcategory of the Work Processes PSF. All contributing factors to a subevent that involve supervision of work and organizational/management issues. This includes such factors as command and control, whether work orders/instructions are given clearly, emphasis of safety, and organizational acceptance of workarounds.

Team Dynamics / Characteristics – Performance shaping factor used in HERA. Refers to style and level of supervision, crew interactions (beyond simple communication), morale, and teamwork.

Work Processes – Performance shaping factor used in HERA**.** In HERA, Work Processes consists of four subcategories of Planning and Scheduling, Supervision and Management, Conduct of Work, and Problem Identification and Resolution (PIR) / Corrective Action Plan (CAP).

Work Type – The type of activity being performed by workers at the time a human error (XHE) or success (HS) occurs. In HERA, Work Type is also indicated with contextual information (CI), when applicable. HERA utilizes the Human Factors Information System (HFIS) work type categories and definitions.