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In this edition:

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Editor's notes, news, and items of interest

The Office of the Chief of Defense Nuclear Safety (CDNS), NA-511, is seeking articles related to nuclear safety, operations, and safety/organizational culture, along with safety related questions and answers (Q&As) to share across the NNSA Enterprise, via the NNSA Technical Bulletin. Prior articles and Q&A can be found in the archived editions of the NNSA Technical Bulletin at the following NNSA Portal link – see the last item under the **Resources and Information** tab on the home page: https://nnsaportal.energy.gov/Pages/default.aspx

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Section I. Articles

Organizational Culture verses Organizational Climate: What's the Difference, and Why Does it Matter?

Stephen J. Wallace, NA-511

The concept of organizational culture has been around for several years and is often adapted to apply to one aspect of an organization, such as its 'safety culture'. However, an interrelated but distinct concept that is gaining currency, especially in social science and human behavioral areas, is organizational climate.

Lest you conclude that 'climate' is just a clever way to call culture something different, the distinction between organizational climate and culture has also been around for a long time and many storied institutions caution against using the terms interchangeably. The Oxford Review goes so far as to say it matters significantly if an organization mixes these concepts, calling it an 'expensive' mistake.[1]

So what is the difference in these concepts? What are the mistakes that can result from mixing them up, or at least failing to understand the distinctions? First, the concept of organizational climate has actually been around longer than organizational culture. In an article published in the journal Human Service Organizations: Management, Leadership & Governance, Glisson contends that the concept of organizational climate first appeared in the 1930s, and is associated with studies of how the social climate established by leaders affected the behavior of group members.[2] In contrast, the concept of an organizational cultures emerged in the 1970s.

Organizational culture is basically defined as the behavioral norms and expectations that characterize a work environment. These norms and expectations direct the way employees in a particular work environment approach their work, specify priorities, and shape the way work is done. Words that are commonly associated with culture include beliefs, values, routines, and traditions. These norms and expectations are also passed on to new employees through modeling and reinforcement. Organizational climate on the other hand, is created by employees' shared perceptions of their work environment. The Oxford Review notes that climate is a "sense, feeling, or atmosphere" that people have either on a day-to-day basis or generally. Glisson uses the example that when the people in a service organization agree that their work environment is highly stressful, the organizational climate is described as stressful. Another way to look at it is that the climate can be the shared way people feel at a particular moment, but the culture is more deep-seated and long standing and affects the way things get done.

So what's the danger of not understanding this distinction? The problem is that an organization may set out to change one aspect but actually be changing a different one. The Oxford Review contends that there are many examples where organizations attempt to change a culture, but

[1] https://www.oxford-review.com/blog-research-difference-culture-climate/
[2] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5008450/

instead stop once the climate has changed, assuming that the culture has changed also.[3] Take for example the problem of poor adherence to procedures; not doing things the way we document that we will do them.

There may be valid reasons why employees approach work tasks contrary to procedures. It may be that the procedures are dated and employees have found more efficient or even safer ways to accomplish work. A reasonable step would be to review current written procedures, vet current practices that are in conflict with procedures, and update the procedures to reflect current more efficient and safer practices or stop practices that are less efficient or less safe than written procedures. This approach is desirable. However, the organization must understand that by updating procedures (or practices as necessary) it is only tackling the problem of climate, not culture. Employees may have the current perception that the procedures are more closely aligned with how they actually do things (climate), but the underlying beliefs, values, and routines (culture) has not changed. What are the factors that resulted in poor adherence in the first place? What made the workforce believe that it was acceptable to take shortcuts and not feedback into the system to update procedures? Is there something fundamental about the difficulty in updating procedures that results in employees doing it their way and assuming (or hoping) that there is no consequence to violating procedures?

You can see that changing the climate may be a necessary first step in changing a culture, but the transformation cannot stop simply at a change in climate. Once the current perceptions wear off or grow stale - or are disrupted by some event - the organization will go back to the way it has always behaved unless the culture has truly changed as well.

In summary, the terms organizational culture and organizational climate are often used interchangeably, but though interrelated they are actually different concepts. Interventions to address one should not be mistaken for solutions to address the other.

[3] https://www.oxford-review.com/blog-research-difference-culture-climate/

Noteworthy Practices from the Recent Office of the Chief of Defense Nuclear Safety (CDNS) Biennial Reviews

Sharon Steele, NA-511

NNSA Supplemental Directive (SD) 226.1-1A, *Headquarters Biennial Review of Nuclear Safety Performance,* categorizes issues requiring performance improvement as findings or weaknesses. The SD also specifies identification of a *Noteworthy Practice*, defined as "a condition, practice, or situation that is highlighted for management attention for possible expanded implementation or communication to other NNSA offices." This article communicates the Noteworthy Practices from the past round of Biennial Reviews from 2017 through 2019.

Please note that each site is different, and the intent of this article is to highlight practices which may merit consideration by others, not to imply deficiencies at sites where a noteworthy practice was not identified for a particular functional area.

If you need more context for a particular Noteworthy Practice, please contact Sharon Steele at 202-586-9554 or sharon.steele@nnsa.doe.gov.

Noteworthy Practices by Functional Area, 2017 through 2019

Criticality Safety	**CS-1/NP**: This NNSA monthly call assures communication across the Criticality Safety Functional Area resulting in better consistency in oversight across NNSA. (HQ). **CS.1-1/NP**: SFO includes NA-51 nuclear criticality safety SMEs in reviews of ANSI/ANS-8 exemption requests.
Emergency Preparedness	**EP.1-1/NP**: Linking exercise objectives with corrective actions from prior findings [at Pantex/Y12] ensures the effectiveness of corrective actions has been verified. **ISMS.1-1/NP**: Rotations for new hires cultivate a well-informed workforce and contributes to a better understanding of the NFO mission. **EP.1-1/NP**: The joint LFO and LLNL DOE Order 151.D Implementation Report succinctly demonstrates their plan to transition from DOE O 151.C, *Comprehensive Emergency Management System* to DOE O 151.D.
Facility Representative	**FR.1-1/NP**: The LFO Manager conducts quarterly walk downs with all Facility Representatives in their assigned areas. This increases communication of nuclear safety information and contributes to a healthy safety culture.
Federal Training	**FTC.1-1/NP**: NA-LA's brown bag lunch sessions are effective in teaching changes to nuclear directives and other developmental topics.
Fire Protection	**FP.1-1/NP**: SFO uses the Building Fire Consequence Index (BFCI) tool to establish risk-based priorities for addressing fire protection issues.

	FP.1-1/NP: The NA-LA Fire Protection Program Manager has implemented an efficient and effective process for the management of Los Alamos National Laboratory fire protection related exemptions, equivalencies, and Conditions of Approval.
Integrated Safety Management	**ISMS.1-1/NP**: LFO's approach to accepting and addressing OFIs in addition to Findings and Weaknesses represents a tangible commitment to continuous improvement. **ISMS-1.1/NP**: The issue escalation process developed by NPO and described in NPO-1.5, *NPO Operating Philosophies and Management System Description* created a responsive communication mechanism for emergent issues that should be considered by other sites for implementation. **ISMS.1-1/NP**: NA-LA uses an Information Technology solution (the Dashboard), which is updated daily, to track delegated responsibilities for Managers that are on leave or otherwise not available.
Nuclear Explosive Safety	**NES.1-1/NP**: Although not required, the NPO has provided a Nuclear Explosive Safety Study Group member for major Nuclear Explosive Safety evaluations conducted over the last two years. This resulted in significant enhancements to Nuclear Explosive Safety. **NES-1/NP**: NA-121.1 and NA-511 have employees stationed at Pantex allowing field-level knowledge of their operations. NA-511 also has an employee stationed at Pantex to provide NA-50 with field-level knowledge.
Oversight	**OV.1-1/NP**: The NPO's quarterly reevaluation of the Site Integrated Assessment Plan (SIAP), risk register, and self-assessment of SIAP progress maintains focus on effective oversight. **OV.1-1/NP**: The NFO's Tri-annual Subject Matter Expert briefing is a very effective process for providing senior management and staff key information on contractor safety performance.
Packaging & Transportation	**P&T.1-1/NP**: The NA-LA work process between the Packaging and Transportation Subject Matter Expert and the Quality Assurance Staff is an excellent way of ensuring both quality requirements from DOE O 414.1D, *Quality Assurance* and 10 CFR 71, Packaging And Transportation of Radioactive Material Subpart H are reviewed by appropriately qualified staff.
Safety Basis	**NS.1-1/NP**: NA-LA Safety System Oversight Engineers have created an innovative review process to enhance the oversight of the Cognizant Systems Engineer program and credited safety systems.
Start up and Restart of Nuclear Facilities	**SNF-1.1/NP**: The NFO Integrated Oversight Team (IOT) Readiness verification methodology resulted in highly effective oversight of the U1a Complex HC-2 Restart. **SNF.1-1/NP**: NA-LA review of the implementation of the new Line Management Review process has resulted in improvements in nuclear safety performance and demonstrates the effectiveness of a well-organized disciplined approach to readiness review supporting the restart of mission critical operations.

NNSA's Safety, Analytics, Forecasting, Evaluation, and Reporting (SAFER) Project

Becky Sipes, Mike Hillman, and Aimee Gonzalez, NA-50

NNSA recently released three strategic planning documents: (1) *Governance & Management Framework;* (2) *Strategic Vision;* and (3) *Integrated Roadmap*. Together, these documents foster a broad understanding of how we work together to achieve success: *One Enterprise, Unified by Mission*. These documents explore the need for accurate and timely information sharing among all elements of the Enterprise. However, with eight sites, seven field offices, six program offices, five functional offices, and roughly 50,000 laboratory, plant, and site employees, integrating information is a formidable challenge.

At the same time, NNSA safety oversight is facing a critical period where workload is increasing while a significant portion of the safety professional workforce approaches retirement. With new life extension programs, major weapon system alterations, changes in pit production, and the expanding complexities of a 21st Century Nuclear Security Enterprise, the efficacy of safety oversight must increase as fast as, or faster than, the current increase in work activities. We need new approaches to work more effectively, but how?

NA-50 is sponsoring the Safety, Analytics, Forecasting, Evaluation, and Reporting (SAFER) project, to bridge the gap between safety professionals, the mission critical knowledge they possess, and how to share their knowledge with the greater enterprise for a more effective and connected workforce.

At the Subject Matter Expert (SME) level, we have various levels of access to different systems, documents, and tools. Whether a DOE database, a document management system, or a Management and Operating (M&O) Partner user-account, each come with different challenges of access and passwords to remember. Imagine integrating all the pieces of information you regularly use into a single place. Even more, imagine automating the functions you regularly perform with that information, and capturing it systematically for future generations of SMEs to use.

What is SAFER?

Bicycles help people move faster and farther with less effort. Similarly, the SAFER project is working to bring modern tools to our safety professionals that add value, not hassle. Specifically, SAFER is working to:

- Provide a common operating platform for sharing information, and facilitating knowledge management across our workforce.
- Modernize safety functions in a paper-to-digital conversion.
- Explore new capabilities in analysis and data visualizations for planning and decision support.
- Right-size safety with new insights for requirements, information sources and synthesis.

See the Attachment to this article for additional information on SAFER.

The Right Information, to the Right Person, at the Right Time

What's Next?

We've partnered with the National Technical Information Services (NTIS) and Palantir Technologies to bring industry leading capabilities in the fields of data science and business intelligence to our workforce. During the next few months, we are busy building out the concepts and ideas laid out. The scope of our first effort is focused on the maintenance safety management program, implemented across three sites:

1. Sandia National Laboratories (SNL)
2. Los Alamos National Laboratory (LANL)
3. Lawrence Livermore National Laboratory (LLNL)

As the project matures, we will capture maintenance across all NNSA sites, and eventually expand to all safety management programs. We're moving forward, as *One Enterprise, Unified by Mission*. If you are interested in learning more, sharing your ideas, or simply joining the momentum, please reach out to the SAFER team.

Attachment

Background Information – SAFER

The Problem:

NNSA is facing a critical era where mission complexity is increasing rapidly, but human resources are constrained. The efficacy of safety oversight must increase as fast, or faster, than the increase in mission targets. We are looking for a new approach: coupling our workforce with modern tools for gained effectiveness and efficiencies. NNSA needs tools that help describe our systems and enable better knowledge management. We need to:

1. More efficiently and effectively collect, process, analyze, and disseminate data.
2. Improve the ability to measure, track, communicate, and manage safety risks.
3. Capture the knowledge of our workforce ensuring its availability across the enterprise and for the future.

Ultimately, we need to ensure that NNSA works from a single source of truth as an integrated organization that captures knowledge as work is performed, and encourages effective collaboration.

The Project:

The Office of Safety, Infrastructure, and Operations, NA-50, is sponsoring the Safety, Analytics, Forecasting, Evaluation, and Reporting (SAFER) project to integrate data for safety management programs across the nuclear security enterprise and work toward real-time information sharing and collaboration. The long-term outcomes of this effort will enable decision makers to leverage resources and cross-enterprise knowledge to support healthy, safety management groups.

Data Integration across Sites:

SAFER will provide an interactive platform that integrates datasets to create real-time summaries of NNSA safety program health and impact. It will provide common access to current information, for all safety programs across all NNSA sites.

Improved Mission Integration:

SAFER will improve our ability to inform NNSA Program and Functional offices of the impacts associated with safety, and reduce our likelihood of critical failure driven by inadequate communication.

Data-Informed Safety Management:

SAFER will enable forward looking safety management where trending and analysis support data informed decision-making, including improving the ability to prioritize safety resources and manage safety requirements by measuring their impacts.

The SAFER Pilot:

The SAFER pilot allows us to iterate on an innovative solution for data management, analysis, and collaboration to increase the effectiveness of data capture and transfer, and to perform safety oversight more efficiently.

Through the development of a prototype for a data analytics solution, we are working towards providing the following deliverables to safety professionals across the enterprise:

1. A common operating platform for securely sharing information and facilitating knowledge management across the workforce.
2. A paper-to-digital transformation of safety management.
3. New capabilities in analysis and data visualization for planning and decision support.
4. New insights for information sources and synthesis.

Specifically, we are looking for capabilities that optimize our ability to:

1. Explore, discover, query, analyze, and export enterprise data from across sites, programs, M&O contractors, and other collaborators.
2. Gain holistic insight into NNSA's world through configurable, consolidated views of field offices, sites, safety management programs, facilities, staff, and more.
3. Interrogate, transform, and analyze information using point-and-click and/or code-based applications.

The Software:

NNSA is leveraging the Palantir Platform ("Palantir") to transform its operations and achieve critical missions through effective infrastructure and enterprise services. Together, we are developing and testing a prototype in spring 2020 that can be scaled and operationalized to achieve enterprise goals, both now and in the future. Palantir enables NNSA to centralize and streamline operations, resulting in an integrated and collaborative environment where information can be accessed, analyzed, and shared with ease, regardless of its source of format. We will use this powerful data asset to share and analyze information across sites and safety management programs.

NNSA + Palantir SAFER Vision

Future State:

With a comprehensive, objective, decision-making tool and consolidated data asset, users across NNSA will be able to leverage safety professional knowledge and critical information to achieve the long-term goals of SAFER.

User interface mocks have been developed that are an initial vision of what the SAFER project could look like in production, based on user interviews across the enterprise. This is a starting point for what NNSA could achieve in partnership with Palantir, and serves as an example of the many things that could be configured to support users across the enterprise. Palantir equips NNSA with a flexible and extensible solution that will evolve over time to meet future needs and respond to changes in directives, policies, and regulations.

User Interface Examples:

Executive Dashboard - Answers questions like:

- What is the highest risk site or safety management program?
- How can I trust that this information is accurate and timely?
- How do I learn more about what's driving the highest areas of risk?
- Where should we deploy more resources?

Field Office 360 – Answers questions like:

- Where am I on mission targets?
- How are these metrics trending over time?
- What actions are necessary for the long term health of my site?
- How should I prioritize my safety management programs or focus my resources for future oversight?

Safety Management Programs 360 – Answers questions like:

- What is contributing to the overall health of my safety management program?
- Is this consistent with my understanding and operational awareness?
- Where should I plan for an assessment?
- What areas need my immediate attention?

SECTION II. Questions and Answers

Question:

What is the definition and interpretation of "strategies" as used in DOE Order 420.1C, *Facility Safety*, Change 3, Attachment 2, Chapter II, Fire Protection, Paragraph 3.e.(2), Pre-Incident Plans?

Answer:

Strategies are the overall approach to the initial firefighting response for a fire incident at a given location, considering critical factors.

Pre-Incident Plans (PIPs) have strategies that are designed to apply to the initial firefighting response which then can be tailored by the Incident Commander to reflect the actual situation encountered by fire fighters arriving at the incident scene. PIPs are not intended to cover the entire spectrum of possible fire scenarios over the course of the fire response.

DOE Order 420.1C, *Facility Safety*, Change 3, Attachment 2, Chapter II, Fire Protection, Paragraph 3.e.(2), states the following :

> *Pre-Incident Plans. Pre-incident strategies, plans, and standard operating procedures must be established to enhance the effectiveness of manual fire suppression activities, including areas within – or adjacent to -- moderator-controlled areas. The criticality safety staff must review PIPs and procedures related to moderator-controlled areas.*

DOE Order 420.1C does not provide further clarification as to what is meant by strategies. DOE-STD-1066-2016, *Fire Protection*, Paragraph 6.3, Pre-Incident Planning, does not define strategies either, but does reference NFPA 1620, *Standard for Pre-Incident Planning.*

NFPA 1620, 2018 edition, points out that the details of any particular incident cannot be anticipated. NFPA 1620, Annex, Section A4.9 provides further clarification:

> *The pre-incident plan should be a foundation for the decision-making process during an emergency situation and provide important data that will assist the incident commander in developing appropriate strategies and tactics for managing the incident. The pre-incident plan should help responding personnel identify critical factors that will affect the ultimate outcome of the incident, including personnel safety. The incident commander should use the information contained in a pre-incident plan to anticipate likely scenarios and to develop tactical options.*

Per NFPA 1620, PIPs are used during the response phase by the Incident Commander. NFPA 1620 also notes that, to support development of effective strategies that will affect the ultimate outcome of the incident, PIPs should identify critical factors that will improve the awareness of responding personnel. Critical factors are unique, facility-specific information, contained in PIPs, used by responding personnel at the onset of a response.

Critical factors are identified in PIPs, and assist the Incident Commander in developing effective responses to better protect the safety of responders, occupants, nearby personnel, the public, the environment, and property. These critical factors may include unique onsite and nearby hazards, response approaches, contamination concerns, coordination needs, and challenges to potential response actions. Critical factor examples include standoff locations, unique hazards (e.g. explosives, chemicals, rad material etc.), response challenges, and coordination uncertainties.

Information used to develop firefighting strategies is obtained through various ways, including, but not limited to, training, exercises, facility walkthroughs and communication with representatives from the facility.

Implementation of this definition and interpretation of "strategy" could be accomplished using a distinct section in the PIPs (or other related documents), titled "Critical Factors". This section could include unique facility information for consideration by the Incident Commander in developing appropriate responses and tactics for managing the incident. The content under the "Critical Factors" section should be brief, clear, concise, and able to be easily reviewed in the initial stages of a fire department response to an incident.

*Reference*s:

1. DOE Order 420.1C, *Facility Safety*, Change 3.
2. DOE-STD-1066-2016, *Fire Protection.*
3. NFPA 1620, *Standard for Pre-Incident Planning*, 2018 Edition.

Question:

NNSA approved SD 226.1-1A, *Headquarters Biennial Review of Nuclear Safety Performance*, on December 16, 2011. Since then, NNSA Governance and Management principles dictate performance-based, systems-level oversight. Is there a plan to revise NNSA SD 226.1-1A?

Answer:

Yes, the NNSA Office of Safety (NA-51) submitted a revised and updated SD 226.1-1A to the NNSA Office of Management and Budget (NA-MB) for their review, and the NNSA review and comment period ended on March 5, 2020. The revised SD should be issued this year, and will be discussed in a future NNSA Technical Bulletin.

Question:

If a nuclear facility's maximum analyzed material at risk (MAR) limit is exceeded, does that constitute a potential inadequacy of the safety analysis (PISA)?

Answer:

Yes, this scenario would constitute a PISA.

The following is an excerpt taken from DOE-STD-1186-2016, *Specific Administrative Controls*, Section 4.3 (emphasis added):

> **4.3 DEVELOPING A MAR TECHNICAL SAFETY REQUIREMENTS (TSR) CONTROL**
>
> In many nuclear facilities, the MAR is a major analytic assumption underlying the hazard and accident analyses. In such cases, a MAR inventory greater than assumed in the DSA would place [the] facility in an unanalyzed condition. As such, MAR assumptions would need to be protected in a highly reliable and enforceable manner. However, it is not normally possible to control MAR with an active or passive SSC; hence, administrative controls are used. A Directive Action Specific Administrative Controls (SAC), if necessary, is the preferred approach unless a Limiting Condition for Operation (LOC) SAC can be technically justified and defended.
>
> An LCO SAC may be warranted if facility operations can be effectively conducted while limiting the actual MAR in the facility to a specified fraction (e.g., 90 percent) of the MAR value assumed in the safety basis. **Controlling to a lower MAR limit in the LCO helps to protect the MAR value assumed in the safety basis,** and provides operational attention and flexibility. However, in the event that the MAR is discovered to exceed the MAR value assumed in the safety basis, the use of an LCO format SAC would **not** exempt a facility

from declaring a **PISA**. In any event, facilities are expected to effectively manage MAR in a way that protects LCO SAC limits, rather than relying on unplanned LCO entry and Action Statement completion to manage MAR. Because the MAR is such an important analytical assumption, if it is credible that the MAR limit can still be exceeded, an additional TSR provision should be considered as part of the LCO SAC to protect the absolute MAR limit.

Regardless of whether a Directive Action SAC or LCO SAC is used to control MAR, exceeding the **MAR value assumed in the safety basis** puts the facility in an unanalyzed condition, and a PISA would need to be declared. And, violation of a Directive Action SAC would result in a TSR violation. However, a MAR LCO SAC can allow a facility an action completion time which, **if met**, could avert a TSR violation.

Research Corner

Nuclear Safety Research and Development (NSR&D) Program

This NATB's Research Corner opens with a summary of NNSA's NSR&D program, listing NA-50 funded research since FY 2018.

NNSA funded several NSR&D activities that were completed with FY 2019 funding. The NSR&D report that follows was selected for inclusion in this edition of the NATB. Additional NSR&D reports or report summaries will be included in future editions of the NATB.

NNSA's Nuclear Safety Research and Development Program

Sharon Steele, NA-511

The Office of the Chief of Defense Nuclear Safety (NA-511) in the Office of Safety, Infrastructure, and Operations (NA-50) manages NNSA's NSR&D program with a focus on infrastructure safety needs. Such research can provide a technical foundation for safety analyses and hazard controls, or help improve authorization basis decision making. In the past four years, the NA-50 NSR&D program has obtained an average of $4M in annual funding. In NNSA Technical Bulletin 2017-2, published June 2017, CDNS identified proposals that were funded in fiscal year (FY) 2017. This article lists research NA-50 funded since FY 2018, (see Tables 1-3 below).

NSR&D Selection Criteria and Process

The CDNS staff shares proposals with the NSR&D Working Group made up of contractor representatives from each NNSA nuclear site. Each representative rates the proposals based on a set of criteria. CDNS staff provides further input based on priority of observed needs within NNSA and makes recommendations to the Central Technical Authority (CTA) whose concurrence is needed to execute the program funds. The CTA has the discretion and authority to fund additional or different proposals

The Working group evaluates and ranks the proposals considering the following criteria:
Nuclear Safety Benefit or Risk Reduction – The research improves nuclear safety through reducing risks by better understanding existing or developing new approaches and technologies.
Timely and Relevant – Research addresses a current or pressing NNSA need.
Infrastructure Research and Development – The effort must truly be R&D and have an infrastructure focus, as opposed to direct stockpile work or other defense programs focus.
Discrete Deliverables – It must specify reasonable deliverables and funding requirements for each year of the proposal.
Multi-Site Benefit and Collaborative – The results of the proposal affect nuclear safety activities across multiple sites or program offices within NNSA/DOE and researchers from multiple sites participate in the effort.

Table 1: ***New NSR&D Research Funded in FY 2018***

ID#	Lead	Research Title and Technical Objective
18-3	ORNL	**Verification of Subcritical Limits in ANSI/ANS-8.1-2014 for Nuclear Facility Safety Use**: Provide verification that the subcritical limits (SCLs) in the ANSI/ANS-8.1-2014 standard, *Nuclear Criticality Safety in Operations with Fissionable Materials Outside Reactors*, provide sufficient margins of safety for safety basis and nuclear criticality safety purposes.
18-5	CNS-Y12	**Determination of ARF/RF for Use in Safety Basis Documents**: Determine ARF/RF values for thermal oxidation of uranium and metal alloy chips utilizing a previously designed apparatus. More effort is required for characterizing materials anticipated for use in enduring Y-12 missions (e.g. metallurgical phases, compositions and types of alloys).
18-10	INL	**NNSA Mission Support Research and Development with Direct Application to PF-4**: Support the Non-Linear Seismic Dynamic Analysis at PF-4 (the first of a kind application of nonlinear soil-structure interaction (NLSSI) analysis to an operational nuclear facility.)
18-14	LLNL	**Prototype Ceramic HEPA Filter Testing and Filter Media Development**: Develop fire tolerant ceramic HEPA filter technology to benefit DOE nuclear facilities by providing a robust, passive mitigation against radiological releases that does not depend on active safety systems in conditions associated with a fire.
18.19	ORNL CNS-Y12	**Gamma Imaging for In-Situ Holdup**: Acquire gamma-ray images of real holdup deposits using an existing coded-aperture gamma-ray imager, and assess their usefulness as an alternative or adjunct to gross count rate scanning for quantitative analysis.
18-20	ORNL, SNL	**Drone Assisted Dispersion and Dose Consequence Modeling using MACCS2 in the DOE Complex**: Use drone assisted measurement technology and small portable sensors to quantify and scale the assessment of essential parameters for dispersion analysis. The modified site-specific dispersion and plume rise models can be incorporated into a version of MACCS2.
18-23	SRNL	**Spark Plasma Sintering (SPS) for transformation and disposition of special nuclear materials (SNM)**: Develop SPS to homogeneously dilute, bind, and densify waste PuO^2 and other waste materials in an inert, solid matrix to create a durable, monolithic waste form that could meet attractiveness level E standards and qualify as special form radioactive material.

Table 2: ***New NSR&D Proposals Funded in FY 2019***

ID#	Lead	Research Title and Technical Objective
19.07	LANL	**Testing of Nitrogen Atmospheres as a Fire Suppression System for Gloveboxes**: Develop a responsive system that would maintain an inert atmosphere, notify emergency responders in the event of a fire and maintain the inert atmosphere sufficient to meet national codes and standard related durations.
19.09	LANL	**Fiber Optic Sensors for ESD Experiment Data**: Generate experimental data which can be used to validate models to create a physic-based toolset used to analyze electrostatic discharge (ESD) events at weapons facilities. This data base may provide a foundation to objectively critique the overly conservative positions in safety analyses.
19.12	LLNL	**Evaluating Environmental Performance of Internal Sealants for Ceramic Nuclear HEPA Filters**: Extend the work of developing a ceramic HEPA filter prototype, in particular the development and performance characterization of internal filter sealants (i.e. material between ceramic tubes and filter housing).
19.17	CNS-PX	**Portable Faraday Shield Room for Pantex Operations**: Develop, fabricate, and test portable Faraday screen room that can be erected around workstands in the Material Access Area. If successful, this screen room can allow continued testing of weapons during lightning warnings while maintaining the required safety envelope.
19.29	SRS	**Determination of Particulate Respirable Fractions (RF) in Support of Tritium Hazard Category 2 Threshold Values**: Obtain representative RF data for several Special Tritium Compounds to support science-based threshold values and controls for HazCat 2 tritium handling facilities.
19.20	SNL	**7A Drum with UT 9424S Filter Thermal Testing to Determine ARF**: Demonstrate that 7A drums that have an Ultra Tech (UT) 9424S filter on the lid, and are loaded with combustible materials, release less material than currently assumed by DOE STD 5506-2007 when exposed to fire thermal conditions.

Table 3: ***New NSR&D Research Funded in FY 2020***

ID#	Lead	Research Title and Technical Objective
20.2	LLNL	**Evaluating Gasket Materials for External Sealing of Ceramic Nuclear High Efficiency Particulate Air (HEPA) Filters** - Build upon ongoing LLNL efforts toward ceramic HEPA filter and sealant technologies. Develop fire and moisture tolerant filtration systems to benefit DOE nuclear facilities by providing robust, passive mitigation against radiological releases that do not depend on active safety systems.
20.5	SRNL	**Computational Capabilities for Tritium Safety Analysis** - Develop high-fidelity modeling and simulation tools to address key safety scenarios in support of DOE tritium processing activities. This effort leverages the existing SIERRA/Fluid Mechanics toolset. It will also focus on enabling the re-issuance of safety guidelines by providing relevant data to help categorize and describe safety requirements for DOE tritium operations.
20.6	SRNL	**Measuring the Environmental Fate of Tritium Oxide in Complex Environments** - Provide measurement data to quantify the movement of tritium oxide in the environment following an airborne release to include airborne transport, transfer between the air and vegetation, and transfer between the air and soil. This data will be used to improve tritium oxide deposition modeling in dose consequence assessment codes (e.g. MACCS2, GENII) for use in safety basis documents and to mitigate the effects of overly conservative methodologies.
20.10	ORNL	**Development of Gamma-Ray Imaging for In-Situ Holdup** - Improve the quantitative assessments of real holdup deposits obtained from gamma-ray images of the deposits collected using an extant, coded-aperture, gamma-ray imager. Automate attenuation corrections, to develop techniques to handle the complex source geometries frequently encountered in real hold-up measurements and generate guidelines and procedures for NCS and MC&A professionals.
20.13	CNS-PX	**Dielectric Electrostatic Discharge (ESD) Test System** - Design and build a system to quantify the risks of ESD from dielectric materials to potentially electrostatic-sensitive components during nuclear weapon assembly and disassembly.
20.15	SNL	**Next-Generation Fragmentation Hazard Screening via X-ray Diagnostics** - Develop x-ray diagnostics to quantify weapons component fragmentation hazards, addressing safety and higher-order consequences during assembly and disassembly. Advance the science to enable direct kinetic energy mapping and quantify secondary high-explosive ignition dynamics.
20.17	SNL	**Weapon Response Infrastructure R&D for ESD Protocol Calculator** - Increase understanding of the phenomena included in Electrostatic Discharge (ESD) protocol implementations to generate new weapon responses for the B83, W76-1, and the

ID#	Lead	Research Title and Technical Objective
		W80. SNL's Fortran-based ESD protocol calculator used for weapon response must be properly researched and documented to ensure it implements the weapon system-specific ESD protocol correctly. SNL will develop the guide for using the ESD threshold calculator and deploy the code to a high performance computer.
20.19	LANL	**Testing of Nitrogen based Magnesium Oxide Class A, B and D Fire Suppression System for Gloveboxes** - Demonstrate a Nitrogen fire suppression system will sufficiently deliver Magnesium Oxide sand to control a Class A, B and Class D fire in a glovebox. Test various types and quantities of Class A, B combustible materials. N&MgO has shown to be effective on metal fires and is easily cleaned up after a fire event.
20.20	SRNL	**Novel Safety/Risk Optimization R&D for Pu/U SNM Related Assay, Monitoring & Dosimetry** - Research, develop and demonstrate a novel sensor that is highly efficient, light-weight, cost -wise, easy to use, H* spectroscopy capable, 100% blind to gamma-beta radiation fields, and qualified for use in various environments. This enables a single instrument for general use across the DOE nuclear infrastructure, including hot-cell and high activity special nuclear material operations.

Testing of Nitrogen Atmospheres as a Fire Suppression System for Gloveboxes

LA-UR-19-31812

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Abstract

Nitrogen based, glovebox fire suppression system discharge tests were conducted at the New Mexico Institute of Mining and Technology (NMTEC) Energetic Materials Research and Testing Center (EMRTC) in Socorro, New Mexico. The tests focused on maintaining or restoring a glovebox inert atmosphere. Secondary tests involved extinguishing fires involving flammable liquids and ordinary combustible materials that represent conditions that may be found in Los Alamos National Laboratory (LANL) operated gloveboxes. The tests were conducted over a 3-day period in July 2019. A Hybrid Victaulic Vortex fire suppression system, developed by Fire and Pump Service Group, LLC (FPSG) was used to maintain the inert atmosphere during pre-described adverse events, as well as extinguish fires within the test glovebox. The fire tests were performed by a combination of a LANL Certified Fire Protection Specialist, the FPSG Vice President Operations, and a NMTEC professor, with numerous students and Grad students supporting. The tests were witnessed by an Underwriters Laboratory (UL) employee.

Technical Objective

Develop a nitrogen based fire suppression system that could be U.L. listed or FM approved, and demonstrate that a nitrogen atmosphere in a glovebox provides an inert atmosphere sufficient to prevent or control fires in a glovebox. The Hybrid Vortex system tested could be U.L. listed if a NFPA standard that addressed a nitrogen fire suppression system for gloveboxes was developed; the Hybrid Vortex system could be FM approved by following FM approval guidelines to obtain approval for the combination of the FM approved Hybrid Vortex system and the U.L. listed O_2 monitor.

Discussion

National Fire Protection Association (NFPA) Standard 801 *Standard for Fire Protection for Facilities Handling Radioactive Materials*, 2008 Edition and the American Glovebox Society (AGS) standard AGS-G010-2011 *Standard of Practice for Glovebox Fire Protection*, 2011 Edition, prohibit a glovebox's inert atmosphere being credited as an automatic fire suppression system (AFSS). Numerous gloveboxes where combustible metals are processed – or where explosive concentrations of gases or vapors are present – utilize inert atmospheres to prevent ignition. However, due to the previously mentioned restrictions, the installation of an additional AFSS may be required. The restrictions in those standards are applicable to National Nuclear Security Administration (NNSA) sites by NNSA contract with the operating contractors. Therefore, those restrictions have the potential to increase glovebox operational and maintenance costs.

The NFPA and AGS basis for prohibiting accreditation of a glovebox inert atmosphere as an AFSS includes the lack of a reliable means to ensure the inert atmosphere is maintained during glovebox maintenance activities or upset conditions. These bases are identified in both the NFPA 801 Annex (A.7.1.4.4.7), and in AGS-G010-2011, section 9.2. Additional information about the prohibition was gained from personnel discussions and e-mail exchanges between the Author of this paper and members of the NFPA 801 and AGS G010 standards development committees.

A LANL Fire Protection Specialist and FPSG personnel adapted the FPSG Hybrid Vortex Fire Suppression system to respond to an elevated oxygen concentration alarm from an oxygen monitor to initiate nitrogen discharge into the protected glovebox at a rate that would restore and maintain the oxygen level below the concentration required to support combustion, while maintaining a negative or almost negative atmosphere within the glovebox.

Preliminary tests were conducted in a wooden glovebox, which is located at the FPSG lab in Compton, California. Subsequent testing was conducted at the EMRTC, Torres Complex's "2-Ton" Bunker, located in Socorro, New Mexico. The elevation of the EMRTC Torres Complex is 4600 feet. A photo of the 2-ton bunker, NMTech students and the nitrogen supply tube trailer are shown in Figure 1. The glovebox used for testing was located in the room on the right side of the bunker face shown in the photo, while the room to the left was occupied by the data acquisition equipment and personnel during testing. All tests conducted at EMRTC were witnessed by a UL LLC Representative.

Figure 1. The "2-Ton" Bunker near Torres Laboratory

The nitrogen fire suppression system tested was an FPSG Hybrid-Pac ® which utilizes a modified version of Victaulic Vortex Hybrid System, Model 1500, incorporates a Honeywell Notifier control panel. The FPSG Hybrid-Pac ® was used with the water component turned off, and no water was provided in the Hybrid-Pac's water tank.

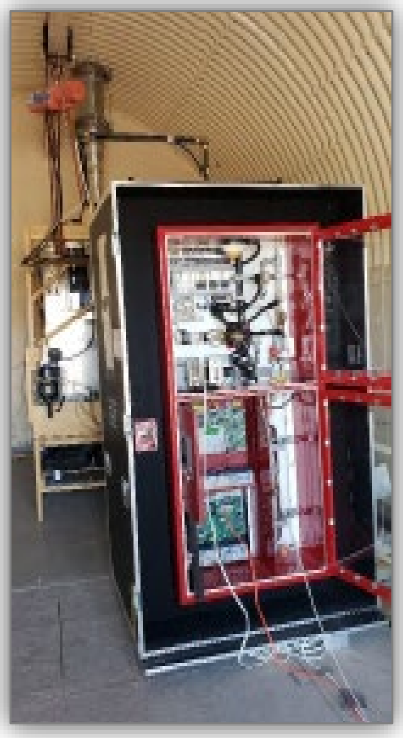

Figure 2. The FPSG Hybrid-Pac ® with the test glovebox in the background.

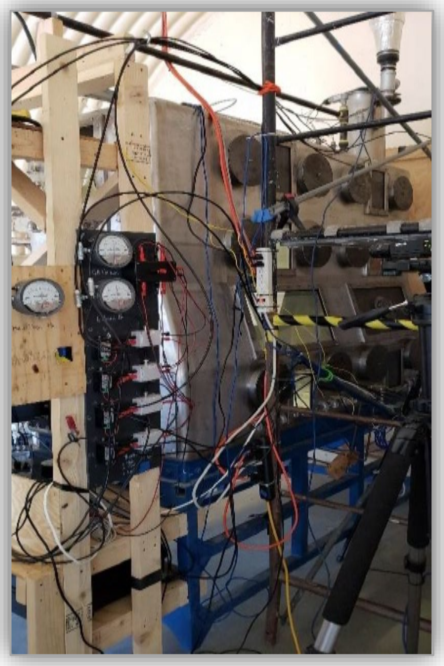

Figure 3. Data Collection Instrumentation, the Glovebox HEPA Exhaust arrangement, and capped gloveports are shown.

Instrumentation

The following instruments and devices were used in the conduct of the tests:

1. Heat Detector – Fenwal, "Detect-A-Fire", Model 27021-0, 140ºF placed in the thermal detector wells located in the glovebox ceiling in close proximity to the fire suppression system discharge emitter/nozzle and used to activate the FSS system.
2. Oxygen Detector – AMI, Model 201RS, s/n 071025-2, the oxygen detector probe was located approximately 6 in. off the floor, 2 in. from the back wall, adjacent to the sealed pass thru located on the side wall.
3. Pressure Transducers – Dwyer, Model 648B-16, s/n 4713025, 4713110, 4713111, and 4713112, were located in the glovebox within the exhaust filter and in line with the inlet nitrogen stream to measure the glovebox pressure relative to ambient pressure and the pressure drop across the exhaust filter before, during, and after testing including fire testing.
4. Thermocouples – 1/16 in. diameter, Type K Inconel sheathed thermocouples located approximately 0.5, 2.5, and 4.5 ft. from the floor of the glovebox.
5. Flow Meter – TSI Corporation, Model 5575, s/n T57251511004. Placed by the inlet to measure the inlet air-flow rate to the glovebox.
6. Static Pressure Gauge – Dwyer, Magnehlic, Model W12Z FH and W12Z AT, -2 to 2 in. water, maximum pressure 15 psig.
7. Video – used to capture images during testing while personnel are located in the room adjacent to the glovebox cell. The video cameras were located to provide an inclusive view of the glovebox exterior and interior.
8. Electronic data acquisition system – National Instruments, Model CDAQ-9174. Set-up to obtain the data generated and monitor the video feed. (Please note that the electronic data acquisition system often failed; therefore manual data recording was utilized and is considered as the official records of the tests).

Data and Results - Simulation of loss of the Inert Atmosphere Due to an Adverse Event (Loss of a Glove):

The nitrogen AFSS was able to respond to the simulated adverse condition and provide enough nitrogen to re-inert the glovebox and drive the oxygen level below 5% for 60 seconds. After the 60 second hold, oxygen levels ranged from 2.0 to 3.5%. The table 4 test results below were obtained through analysis and comparison of the NMTEC recorded data sheets (Digitized) and the table provided in the U.L. Verification Services Technical report, written by Michelle Sluga, U.L. Staff Engineer, dated August 7, 2019, File NC28671, Project 4789005583.

Table 4: Data observed and recorded during the simulated Loss of Glove tests. (Ref 1)

Test	Time (Min:Sec) Duration When O_2 Monitor High O_2 Level Alarm Occurred after Simulated Loss of Glove	AFSS Nitrogen Flow Time (Min:Sec) Duration to Re-establish the Inert Atmosphere (Reduce O_2 Below Alarm Point)	O_2 % Range from Initial Through Alarm to Reestablishment of the Inert Atmosphere and Final	GB Pressure (in Aq)		AFSS N_2 flow (cfm)
				Pre-Discharge	During	
1	0:15.8	0:41.9	4.1, 7.0, 8.10, 2.1	-0.52	.01 to 0.3	40
2	00:27	00.41	2.2, 6.5, 9.0, 2.0	-0.52	0.0 to 0.2	36
3	00:34.3	00.40.1	1.4, 5.6, 2.0	-0.52	0.28	36
4	00.25	00.44.2	1.8, 8.5, 5.0, 2.7	-0.52	0.1 to 0.3	30
5	0.22.3	00.44.2	1.8, 8.5, 5.0, 2.7	-0.51	0.0 to 0.10	25
6	00.32.2	00:49.1	2.1, 9.7, 5.0, 3.5	-0.52	-0.10	20

The test results noted in table 4 as observed and recorded at EMRTC (Ref 2) suggests that the FPSG Hybrid-Pac ® system can restore the inert atmosphere before the oxygen levels rise sufficient to support combustion of ordinary combustibles. However, it should be noted that the tests were conducted at a facility 4600 ft. above sea level; therefore, additional engineering and testing for application at facilities at different elevations may be warranted.

Based upon the positive results from a limited number of tests, the Victaulic Vortex Hybrid R is able to respond to upset conditions and fire events within a glovebox. Therefore, with additional site specific engineering the system may provide justification to allow the glovebox's inert atmosphere to be credited by the local authority having jurisdiction as an automatic fire protection system.

References

1. Verification Services Technical Report U.L. LLC on Fire Suppression Systems for use in Glovebox Applications New Mexico Tech Test Plan TP-19-22 LANL Testing of the Fire and Pump Service Group Nitrogen Fire Suppression System for Gloveboxes for Fire & Pump Service Group Rancho Dominguez, CA 90220 USA, written by Michelle Sluga, reviewed by Kevin Holly, Jr., dated August 7th, 2019, File NC28671, Project 3789005583.

2. NM Tech Data Sheets (Digitized), various, dated 7/10/2019. Not official publications.