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US Nuclear Regulatory Commission Practices in Risk-Informed Evaluation of Emergent Issues and Communicating Risk Insights Obtained from those Evaluations

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OUTLINE

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- Summary of Evaluation
- Recommendations

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- Communicating Risk Insights Using Be RiskSMART Framework

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Part 1

Risk-Informed Evaluation of Derecho Event at Duane Arnold Energy Center

- Overview of Event
- Summary of Evaluation
- Recommendations

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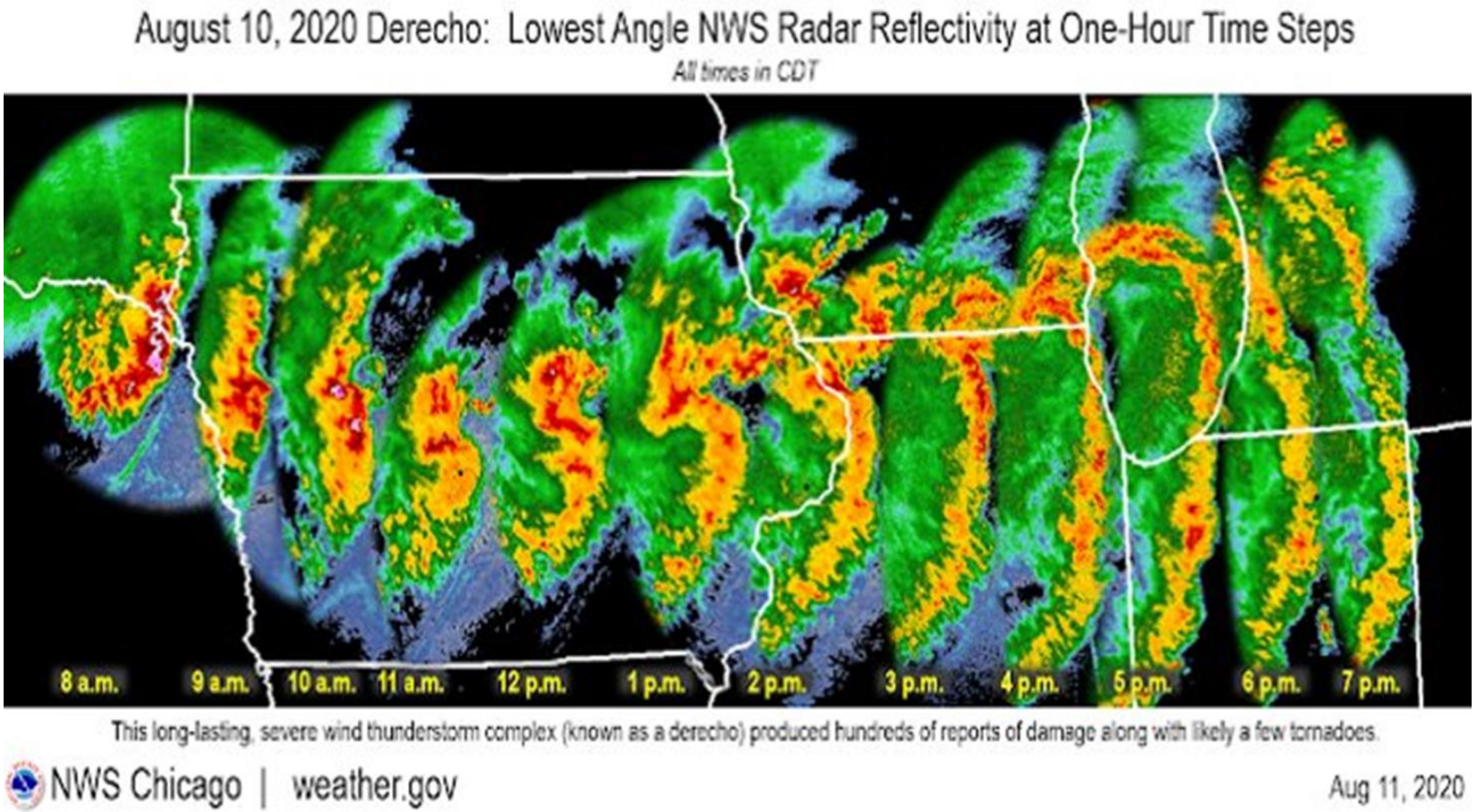
Duane Arnold Energy Center
(Boiling Water Reactor, 1912 MWth, Operating License: February 22, 1974, Undergoing DeCommissioning)

August 2020 Derecho



Damages Incurred to the Facility due to the Derecho

Impacts on Facility

Offsite power to the site was lost for about 23 hours.

The plant scrammed offline.

Operators shutdown the power safely.

Emergency diesels provided alternating current until offsite power was restored.

Non-safety cooling towers were destroyed.

Transmission towers knocked down and damage occurred to a standby transformer in the switchyard – complicated offsite power recovery.

One FLEX building was damaged, but equipment inside remained functional.

A small hole (~1 inch) was found in secondary containment – *Initially* thought that secondary containment was still operable, it was later learned by the NRC much later that secondary containment was INOP but functional

Emergency Service Water supply functionality was challenged by debris clogging the strainers; One train of ESW and it's EDG was declared inoperable but remained functional.

Change in core damage frequencies for eight representative plants with and without the benefit of post Fukushima modifications
(Source: Enclosure 1 to DAEC LIC 504 study, ML21078A178)

	ΔCDF (FLEX strategies credited)	ΔCDF (FLEX strategies not credited)	Reduction
Plant 1	3.4×10^{-5}	2.7×10^{-4}	7.9
Plant 2	1.1×10^{-6}	4.4×10^{-6}	4.1
Plant 3	5.2×10^{-7}	7.3×10^{-7}	1.4
Plant 4	1.8×10^{-6}	2.0×10^{-5}	11.4
Plant 5	8.4×10^{-6}	9.5×10^{-5}	11.4
Plant 6	2.4×10^{-6}	1.3×10^{-5}	5.4
Plant 7	1.0×10^{-6}	2.9×10^{-6}	2.9
Plant 8	1.2×10^{-5}	3.5×10^{-5}	2.8

Some Risk Insights (Source: NRC Information Notice 2021-03, ADAMS Accession No. ML21139A091)

Site and Design Characteristics	
Characteristic	**Impact of Characteristic on Risk**
Susceptibility of the water source for ESW todebris accumulation during a derecho	**Sites that have ultimate heat sink sources thatare not prone to accumulation of debris have reduced risk.**
Availability of additional diesels that do not rely on ESW, in addition to availability of diesels procured and installed as part of FLEX mitigation strategies	**Plants with additional AC power sources (often not dependent upon ESW for cooling) that havethe ability to provide motive power to essential loads are at reduced risk.**
Ability to promptly recognize the increaseddifferential pressure (ΔP) across strainers	**Plants that have alarms or annunciators to inform operators of increasing ΔP across the ESW strainer and intake structure screens areat reduced risk.**
Source of AC power to traveling screens	**Plants whose traveling screens are powered byemergency AC power are at reduced risk.**
Operating Characteristics	
Ability to promptly recognize increased ΔPacross strainers	**Early detection and procedures that instructoperators to monitor ΔP across the ESW strainer and intake structure screens upon receipt of warnings for severe weather, may decrease risk.**
Procedures and abnormal operating procedures related to severe weatherwarnings	**Severe weather preparedness procedures andabnormal operating procedures that:** **(1) recognize and take action to minimizethe potential for blockage of intake structures, traveling screens, and strainers decrease risk** **(2) direct risk management actions for ongoing site activities (e.g., suspension**

Risk-Informed Recommendations Using the Be riskSMART Framework

- #7: Issue an information notice informing licensees about the event and factors that influence the risk significance based on insight gained from the NRC's LIC-504 analysis.
- #8: Examine how industry response to Fukushima-related orders on extended loss of alternative current power and loss of ultimate heat sink (EA-12-049) impacted the risk significance of this issue and identify opportunities to further enhance reliability of diverse and flexible mitigation capability (FLEX) strategies.
- #11:Communicate risk insights gleaned from the DAEC LIC-504 with regional staff and NRR staff.
- #12:Share risk insights gained from the DAEC accident sequence precursor and the LIC-504 analysis with the regulated community.
- #13:During fiscal years 2021 and 2022, update two SPAR models that possess multiple design characteristics that yield relatively higher risk estimates.

- Questions

Part 2

Some Details on NRC's LIC-504 "Integrated Risk-Informed Decision Making for Emerging Issues" (ADAMS Accession No. ML19253D401, and the Be riskSMART Framework (NUREG\KM-0016, ADAMS Accession No. ML21071A238)

- Background
- Process summary and Evaluation criteria
- Communicating risk insights using Be RiskSMART framework

Background

US Government Accountability Office's Investigation of US NRC Regulatory Decisions in Response to Davis Besse Vessel Head Degradation Issue (GAO-04-415) (2004) prompted the development of the LIC-504 process.

BACKGROUND

The U.S. General Accounting Office (GAO) (now the U.S. Government Accountability Office) report GAO-04-415 made several recommendations for addressing problems that contributed to the Davis-Besse vessel head degradation that could occur at nuclear power plants in the future. In the areas of risk evaluation, communication, and the decisionmaking process for determining if plant shutdown is warranted, the GAO made two recommendations:

- Develop specific guidance and a well-defined process for deciding when to shut down a nuclear power plant. The guidance should clearly set out the process to be used, the safety-related factors to be considered, the weight that should be assigned to each factor, and the standards for judging the quality of the evidence considered.
- Improve the NRC's use of PRA estimates in decisionmaking by ensuring that the risk estimates, uncertainties, and assumptions made in developing the estimates are fully defined, documented, and communicated to NRC decisionmakers and provide guidance to decisionmakers on how to consider the relative importance, validity, and reliability of quantitative risk estimates in conjunction with other qualitative safety-related factors.
    - Revision 0 of LIC-504 was prepared to address this recommendation. The LIC-504 process focuses on documenting those inputs so that the decisionmaker can clearly understand their contribution to the resulting decision. LIC-504 also focuses on so that the key assumptions are identified and suitably address uncertainties.

Commission Policy Drivers

- **In 1995, the NRC published in the Federal Register (60 FR 42622) its probabilistic risk assessment (PRA) policy (Ref. 2),** which states that an overall policy on the use of PRA methods in nuclear regulatory activities should be established so that the many potential applications of PRA can be implemented in a consistent and predictable manner. In that policy document, the Commission stated that it believes the use of PRA technology in NRC regulatory activities should be increased to the extent supported by the state of the art in PRA methods and data and in a manner that complements the NRC's deterministic approach.

- **In its staff requirements memorandum (SRM) to SECY-98-144, "Staff Requirements—SECY-98-144—White Paper on Risk-Informed and Performance-Based Regulation," dated March 1, 1999 (Ref. 3), the Commission stated the following**: A "risk informed" approach to regulatory decision-making represents a philosophy whereby risk insights are considered with other factors to establish requirements that better focus licensee and regulatory attention on design and operational issues commensurate with their importance to public health and safety. A "risk-informed approach" enhances the deterministic approach by: (a) allowing explicit consideration of a broader set of potential challenges to safety, (b) providing a logical means of prioritizing these challenges based on risk significance, operating experience, and/or engineering judgment, (c) facilitating consideration of a broader set of resources to defend against those challenges, (d) explicitly identifying and quantifying sources of uncertainty in the analysis (although such analyses do not necessarily reflect all important sources of uncertainty), and (e) leading to better decision-making by providing a means to test the sensitivity of the results to key assumptions.

LIC-504 is a Two-Step Process that Could Result in Four Different Outcomes

- determining whether to take immediate regulatory action, such as issuing an order to shut down the unit/s at the site where the concern was identified
- determining whether immediate regulatory action, such as issuing orders to shut down other sites, is necessary (i.e., generic concern)
- developing risk-informed options to resolve the issue at the unit or site of concern
- developing risk-informed options to resolve the issue at other potentially affected units

Process

The LIC-504 process was created to address recommendations in GAO report, GAO-04-415 (2004) entitled "Nuclear Regulation—NRC Needs to More Aggressively and Comprehensively Resolve Issues Related to the Davis-Besse Nuclear Power Plant's Shutdown."

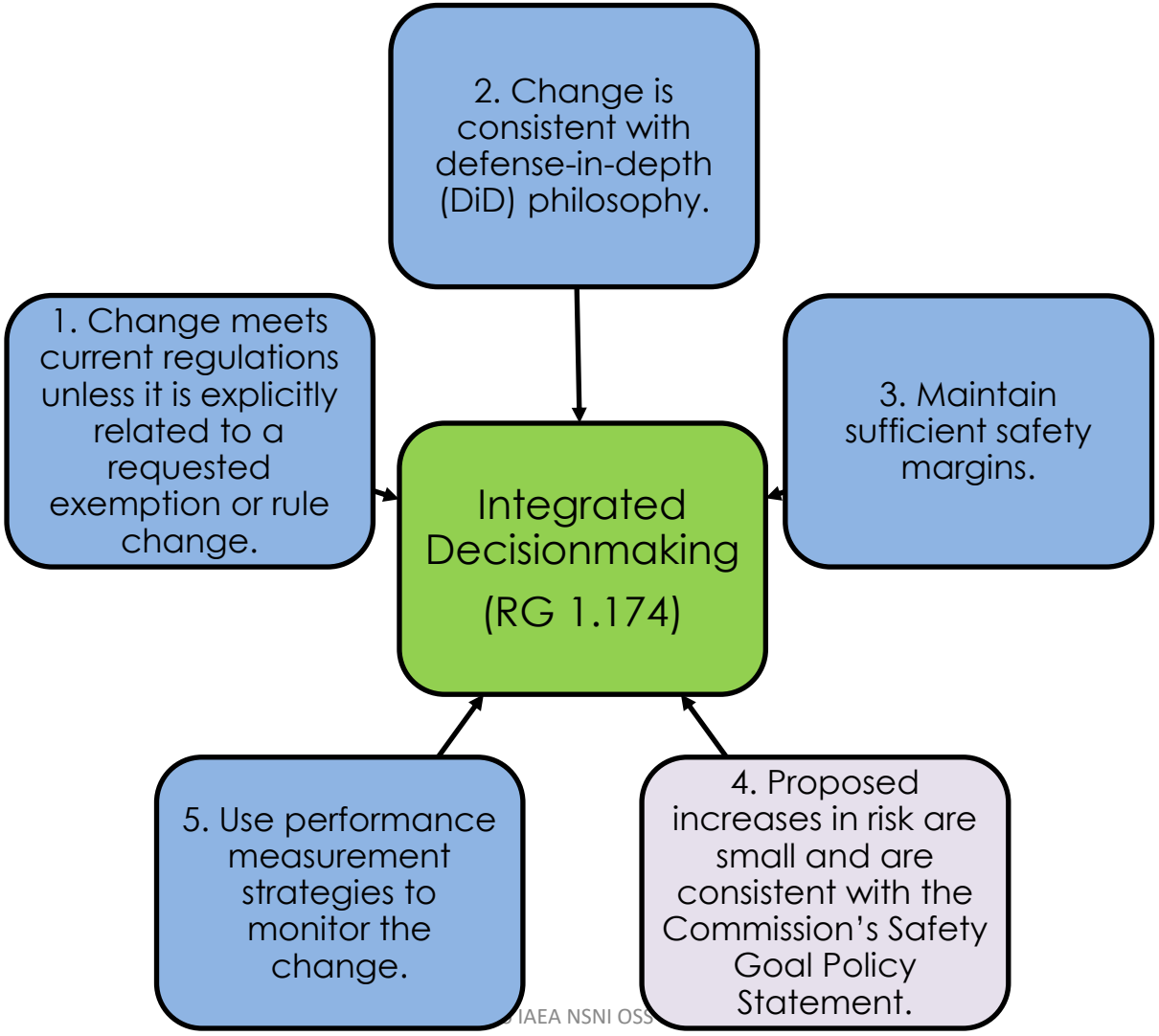
The major revision (Rev. 5, 2018) includes several significant changes prompted by previous uses (e.g., considering Enterprise Risk, considering exposure to worker, guidance on how to consider risk significance to recommend generic communications).

LIC-504 evaluations result in two distinct products:

- Determine whether prompt regulatory actions are necessary.
- Use best available information to develop risk-informed recommendations for management consideration; Use conservative assumptions in the absence of information..
- Use best available information and rely on performance monitoring (NUREG\CR-1855) to address uncertainties

The manner in which LIC-504 teams develop recommendations has evolved to accommodate some key elements of the Be RiskSMART (NUREG/KM-0016) framework.

EVALUATION CRITERIA



Evaluation Criteria (Continued)

Enterprise Risk Management

Averting radiation exposure to plant workers

Risk tradeoffs

Use of Generic Communications to Support LIC-504 Findings

Information Notice:

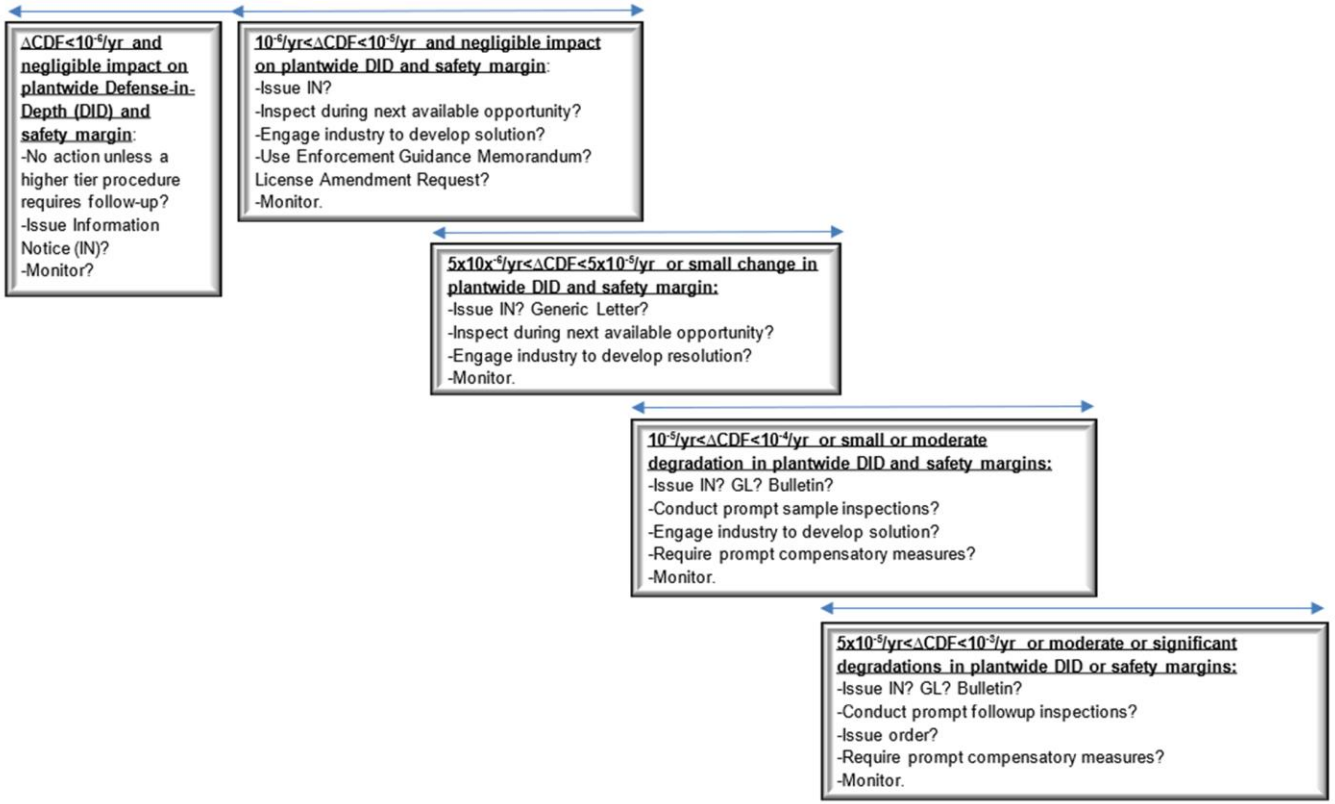
- Expects that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar issues.
- INs may not impose new requirements.

Generic Letters

- Request licensees to provide information so the NRC can decide what actions it must take
- Issued infrequently; Since 2016, NRC has not issued Generic Letters

Bulletins

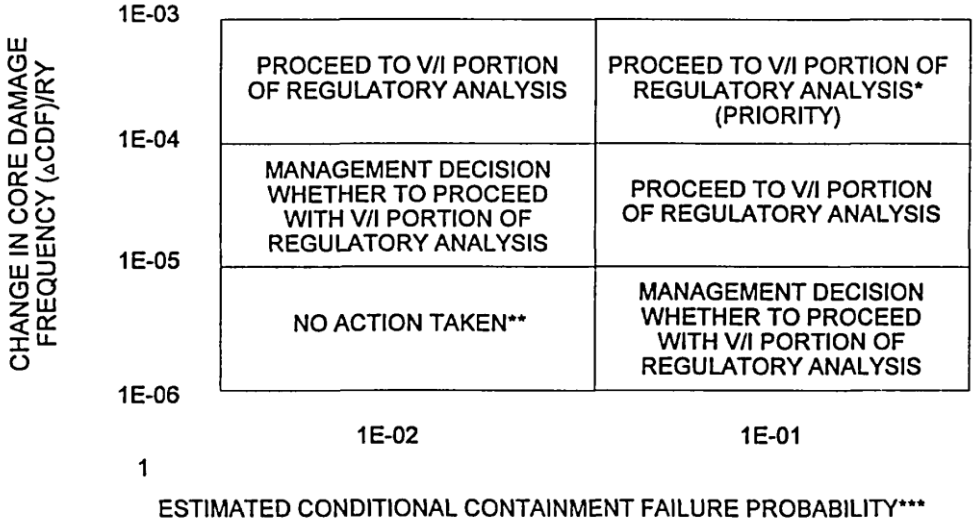
- May require licensees to implement prompt actions (e.g., verify compliance with regulations)
- May require licensees to provide information to NRC within a short period
- Issued infrequently; Since 2012 NRC has not issued any bulletins)



LIC-504 Guidance on Recommendations for Generic Communications

NRC Regulatory Guidance to Evaluate Need for a Regulatory Analysis (Source: NUREG\BR-0058)

Estimated Reduction In CDF	Staff Action
> 10^{-4}/reactor year	Proceed with the regulatory analysis on a high-priority basis.
10^{-4}–10^{-5}/reactor year	The decision whether to proceed with the regulatory analysis is to be made by the responsible division director (see Figure 3.2).
< 10^{-5}/reactor year	Terminate further analysis unless the office director decides otherwise based upon strong engineering or qualitative justification (see Figure 3.2).



Be RiskSMART Framework (NUREG\KM-0016, ADAMS Accession No. ML21071A235)

"To become a modern, risk-informed regulator, the NRC focused on four transformational areas: (1)managing the workforce, (2) applying risk in decision-making, (3) generating innovative ideas to improve the way that NRC works, and (4) adopting new technologies and approaches to data analytics. The Be riskSMART framework supports the second transformation area by providing a systematic approach to making risk-informed decisions across disciplines. Be riskSMART combines traditional concepts, such as the risk triplet, risk management, the risk heat map and risk appetite, into a plain language framework that gives the staff confidence to apply and communicate risk-insights for all kinds of NRC decisions whether they are in the technical, corporate, or legal arena.."

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Use Be RiskSMART framework (NUREG/KM-0016, ADAMS Accession No. ML21071A238)

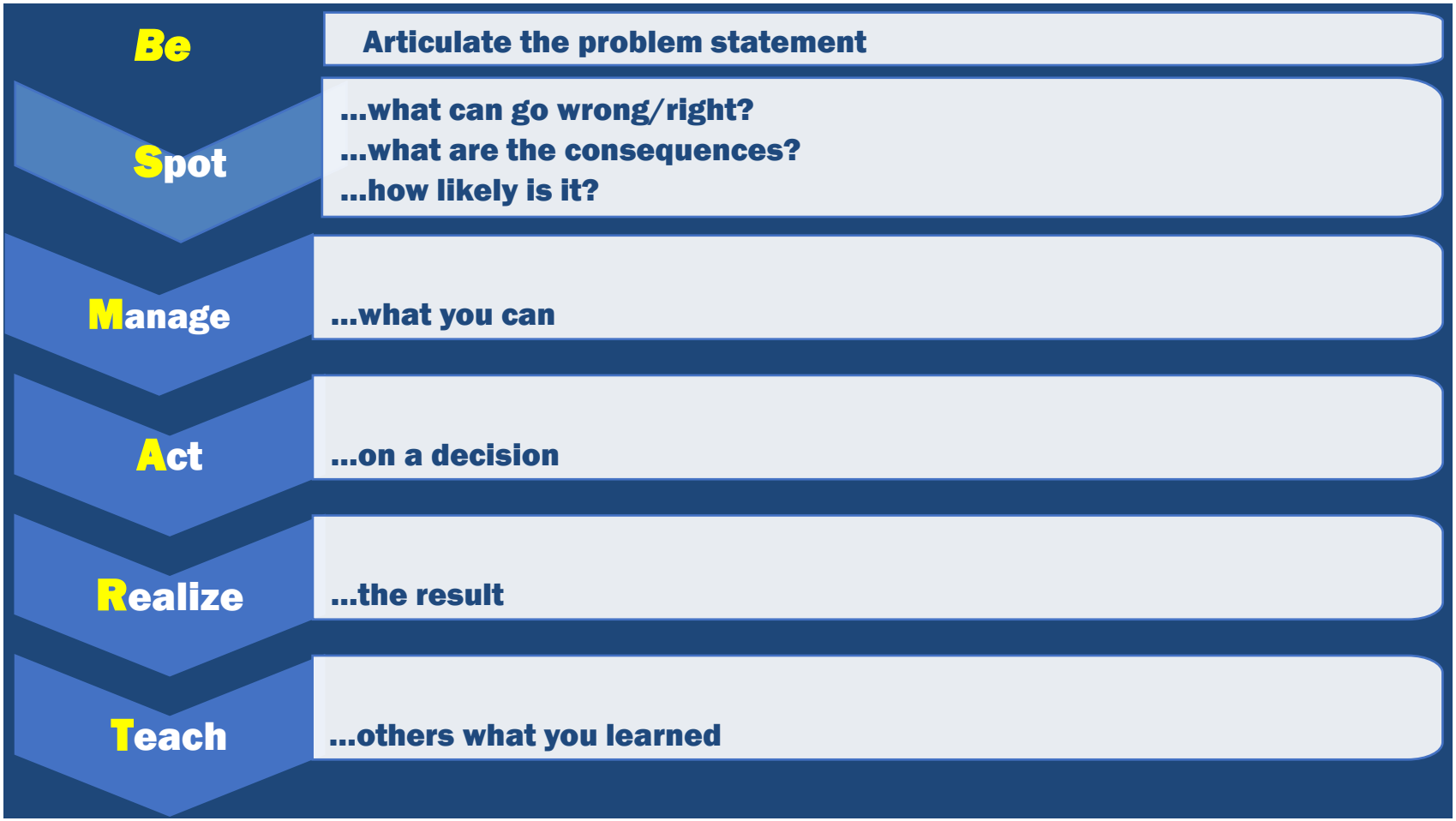
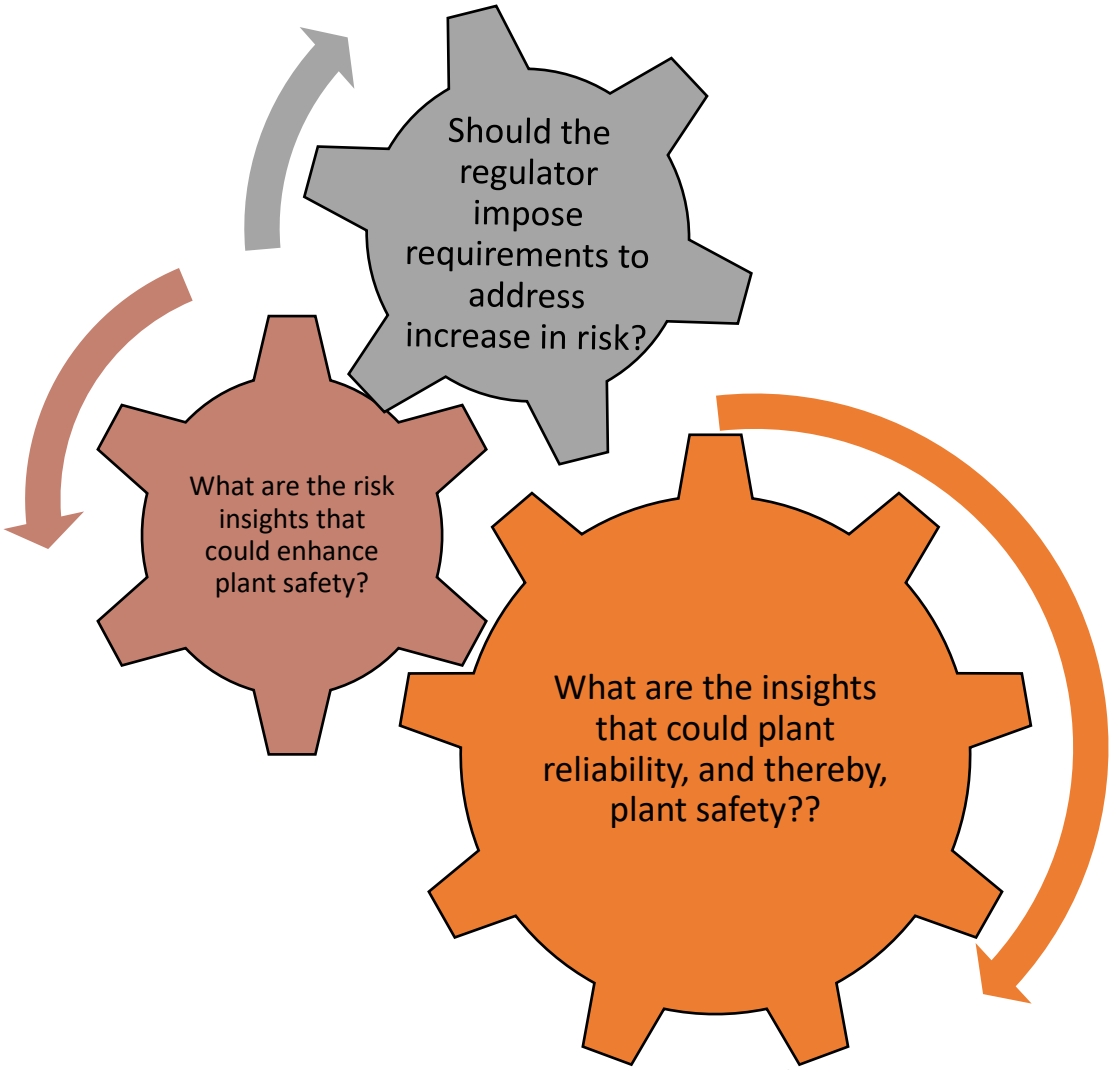
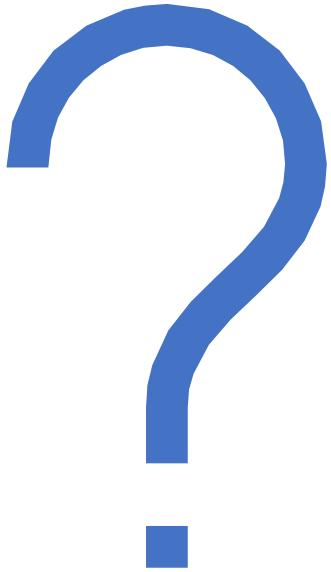


Illustration of planned use of “Teaching” and “Managing” Elements to generate recommendations during a LIC-504





- Questions

Part 3
Challenges to Develop and Implement LIC-504 Type Processes to Evaluate Emergent Issues

Technical Challenges
Non-technical Challenges

Technical Challenges

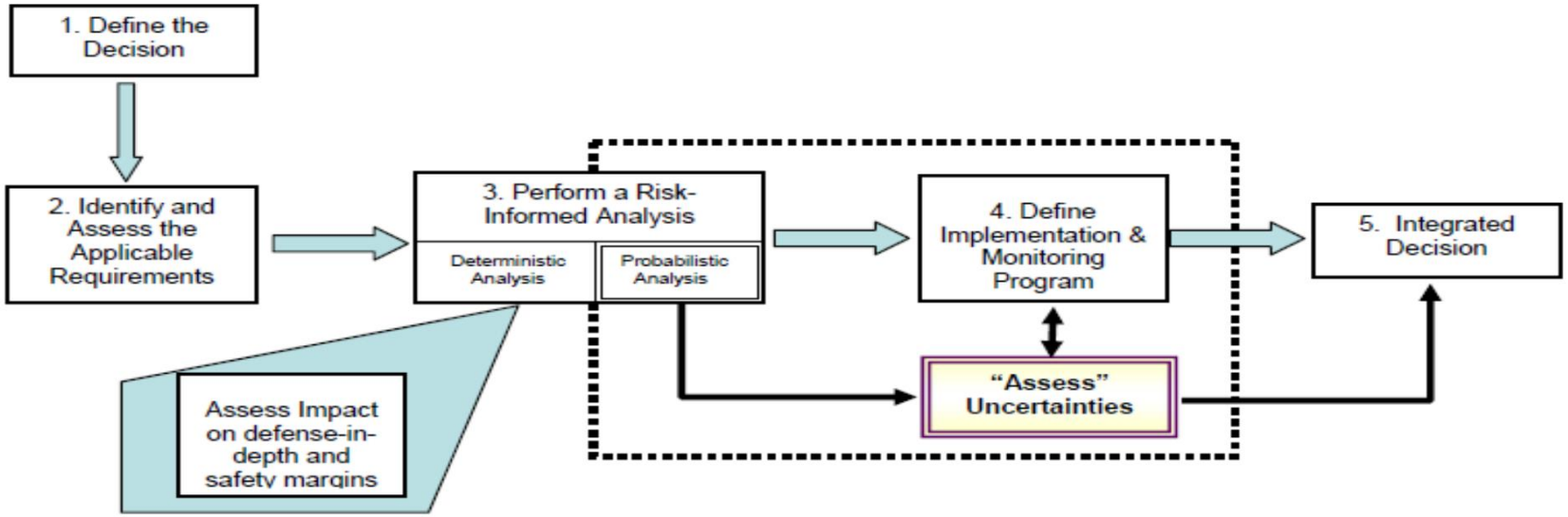
Availability of technical expertise to the regulator to perform qualitative or quantitative risk assessments.

Technical expertise who has the ability to qualitatively or quantitatively assess "What can go wrong?," "How likely is it?," and "What are the consequences?" is essential.

Possession of PRA/PSA models is NOT essential.

Ability to generate risk-informed decisions under when significant uncertainties are present.

Parameters needed to support qualitative or quantitative risk assessments for emergent issues are likely to have significant uncertainties.



Risk-Informed Decision Making: Treatment of Uncertainties

Non-Technical Challenges

- A regulatory culture that understands unique capabilities of risk assessments to generate risk insights that enable the regulator and the regulated community to focus limited resources on issues that are most important to public heath and safety.
    - US NRC's learning process started in mid-1970s and continues
        - Examples: WASH-1400 (1975), Three Mile Island accident (1978), Severe Accident Policy (1985), Safety Goal Policy (1988), PRA Policy (1995), SRM-SECY-98-0144 (1998), GAO Report on Davis Besse (2004.), Revision 0 of LIC-504 (2004), Revision 5 of LIC-504 (2019),….
- A regulated community that understands unique capabilities of risk assessments to obtain risk insights that enable them to focus limited resources on issues that are most important to public heath and safety.
    - Examples: US NRC Generic Letter 88-20 Supplements 1-5 (1988- 2005)

Questions