



Implementing Internal Independent Nuclear Safety Oversight (INSO) in the Nordic Nuclear Industry

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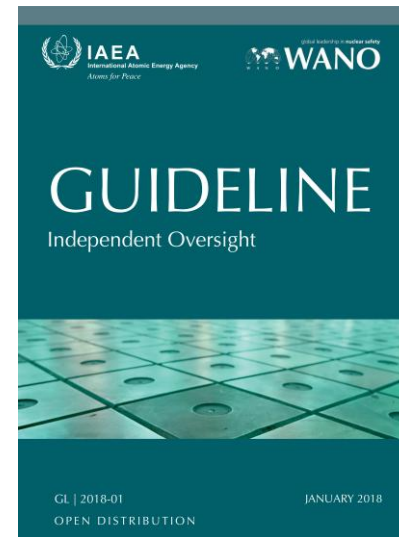
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17/10/2025 VTT – beyond the obvious

Internal Independent Nuclear Safety Oversight

- The nuclear industry (WANO, IAEA, national regulators) has recently advanced its safety assurance practices by widely promoting Internal Independent Nuclear Safety Oversight (**INSO**)
- INSO is an **internal organizational function**, implemented as part of the nuclear licensee organization
- **Purpose of INSO:** to **verify that the utility has the full capability** to perform in a manner which achieves fundamental nuclear safety functions; provide **additional perspectives** to performance monitoring, and to **avoid common mode risks**
- INSO is distinct from other similar functions:
 - **Nuclear safety focus:** cf. QA which has a more generic quality management function
 - **Independence:** cf. nuclear safety department, which is more involved in operations



Introduction of INSO in statutory and regulatory requirements in Nordic countries

- In Sweden, requirements for INSO have already been included in regulations (SSMFS 2021:6 2. 3 §)
- In Finland, specific requirements for INSO are included in the new Nuclear Energy Act (see draft on right), planned to be issued in 2027

Finnish Nuclear Energy Act (draft) 124 § Riippumaton ydinlaitoksen turvallisuusvalvonta

Luvanhaltijan on järjestettävä riippumaton ydinlaitoksen turvallisuusvalvonta, jonka tehtävänä on arvioida sisäisen valvonnan riittävyttä ja tehokkuutta sekä organisaation kykyä huolehtia muiden tässä laissa säädettyjen vaatimusten noudattamisesta.

Riippumattoman turvallisuusvalvonnan tuloksista ja toimenpidesuosituksista on säännöllisesti raportoitava organisaation ylimmälle johdolle, jonka on päätettävä, mihin toimiin tulosten ja suositusten perusteella ryhdytään.

Säteilyturvakeskus voi antaa tarkempia teknisluonteisia määräyksiä riippumattomasta turvallisuusvalvonnasta.

Nordic research project on INSO (NKS-R INSOLE)

- Two-year cooperation between VTT (coordinator), Risk Pilot, and Lilikoi

Overall goal

- Contribute to the development of INSO function at Nordic NPPs by means of applied scientific research

Methods

- Case studies in three Nordic power companies
- Accident case analyses
- Interviews with international experts



Organizing INSO

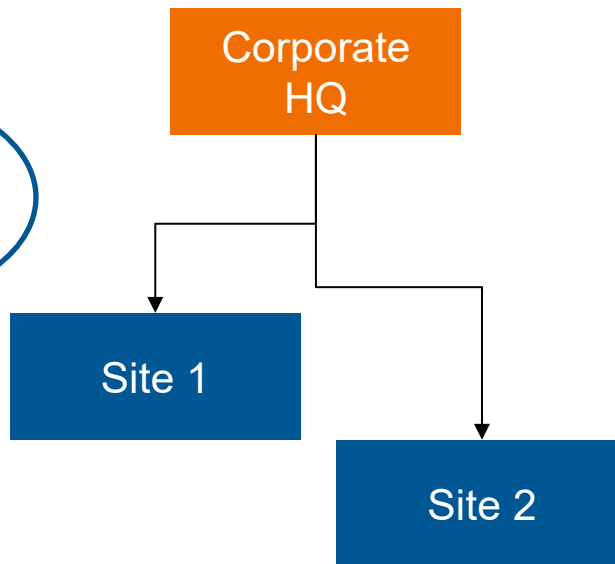
Corporate INSO

Big picture,
fleet-wide
overview

Local INSO (site 1)

Local INSO (site 2)

Single site
perspective,
in the field
at site



Implementing INSO

Added value of INSO for nuclear safety

- **Independent challenge** of the line activities and decisions: extra set of eyes, offering different perspective to the line
- **Advising and supporting** the line organization and senior management: support in licensing or escalating issues, interpreting regulations, facilitating top management
- Providing an **independent overview** of nuclear safety: independent evaluation of level of safety and wider overview compared to the line

Examples of **challenges** related to INSO

- Finding the right balance between independence and involvement, and lacking guidance and tools to do it
- Establishing ways of influencing the line that maintain sufficient independence
- Underutilization of INSO recommendations by top management
- Lack of agreement between INSO and the line organization regarding INSO's role, tasks, and results
- Unavailability of resources for conducting INSO activities

Internal independence as a multidimensional continuum

- **Internal independence** is a dynamic continuum that involves intelligently managing the tension between excessive independence (isolation) and excessive dependence
- Dimensions of independence:
 - **Functional:** INSO not being involved with the task you are overseeing
 - **Cultural:** INSO identity and consequent interest alignment with line organization
 - **Financial:** line organization defines INSO resources

Level of independence	Description	Typical activities
Independent – passive	INSO works independently, but has limited effect on safety	Observes, reads safety analyses
Independent – contributing	INSO works independently, but contributes to safety	Follows up, makes recommendations, does independent reviews
Involved	INSO sacrifices independence by getting involved in line activities but not getting dependent on the line	Gives concrete suggestions, escalates, approves documents
Dependent	INSO works as a line function and INSO activities are controlled by the line organization	Fixes issues, develops documents, makes operational decisions

Identified best practices

- **Best practices and at-risk approaches for INSO implementation, summarized in INSOLE Independent Nuclear Safety Oversight framework (see right)**

System perspective

Organization clearly understands INSO's position within the **organizational defence-in-depth** structure



INSO has clear strategy concerning the **type and expected level of independence** and the reasoning behind it

The **responsibilities** of the INSO function and the line organization are clearly separated

INSO personnel is sufficiently **independent** from the line organization

Clear division of labour and coordination between **other oversight or safety functions**



Context



INSO strategy and arrangements are aligned with the **organizational context** and its structural complexity, and culture

INSO focus areas and activities are aligned with the **situational factors** at the organization and at the plant(s)

INSO focus areas and activities reflect an understanding of the **risks of the nuclear technology** applied by the overseen nuclear facility

INSO considers **external influences** on the management, line operations and the INSO

Management and organizing

Senior management is committed to INSO implementation and actively seeks out its perspectives

INSO function has access to the **information sources** needed



Formal and effective **escalation channels** are available and utilized

Healthy and appropriate interaction with the **line organization**

INSO function understands the **nature, reliability, and limitations of the information** it utilizes

INSO strives to collect **first-hand information**



The **power and authority** of the INSO function are clear and at appropriate level



The **role** of INSO function is clear and communicated throughout the organization



Clear integration with the **management system**

Necessary **resource base** is available

Competent INSO personnel

Systematic implementation of activities

Outcome

Clear, verifiable, justifiable, and actionable **communication**

INSO produces **added value** to the organization

INSO applies a **sociotechnical approach** to nuclear safety

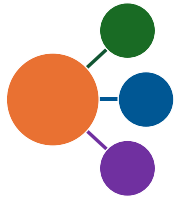


The effectiveness of the INSO function is **continuously monitored and improved**

INSO function facilitates organizational development through **benchmarking and international cooperation**

Management and organizing

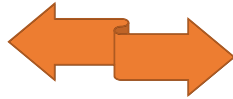
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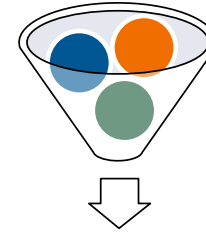


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Practical tools for INSO assessment and development

- **INSO function maturity model:** identify and define development needs of the INSO function

SYSTEM PERSPECTIVE / Organizational defence-in-depth and independence				
Evaluation criterion	Level 0: no implementation	Level 1: basic	Level 2: advanced	Level 3: best practice
Organization clearly understands INSO's position within the organizational defence-in-depth structure	The organization sees INSO as a line function.	The organization sees INSO solely as a barrier to prevent the propagation of errors from the line organization.	The organization sees INSO as an assurance function overseeing that the line takes care of its own responsibilities, including line's own oversight. In addition, the value added by INSO's findings to line development is understood.	The organization sees INSO as an assurance function overseeing that the line takes care of its own responsibilities, including line's own oversight. In addition, the value added by INSO's findings to line development is understood.
INSO has clear strategy concerning the type and expected level of independence and the reasoning behind it	INSO strategy does not reflect an understanding of what independence means.	INSO has implicit understanding of its desired level of independence, but it is characterized by functional terms (participation in tasks), and black-and-white thinking (fully independent, fully dependent).	INSO has an understanding of its desired level of independence and the various sacrifices to independence that INSO needs to make in order to contribute to nuclear safety.	INSO function acknowledges the several types of dependencies it is affected by, and dynamically balances their level between independence and involvement.
The responsibilities of the INSO function and the line organization are clearly separated	INSO function regularly performs tasks that are or should be the responsibility of the line organization.	The processes owned by the INSO are formally separated from line processes. INSO experts are regularly needed to perform tasks for the line organization.	The processes owned by the INSO function are separated from line processes. Individual INSO experts may occasionally perform tasks for the line organization, and vice versa, but there is clear awareness of how this affects their independence.	The processes owned by the INSO function are clearly separated from line processes, including the resources and competence required for their implementation.
INSO personnel is sufficiently independent from the line organization	All or almost all INSO personnel have formal, continuing associations (tasks, responsibilities, etc.) with the line organization.	INSO personnel have informal associations with the line organization, and their implications on independence are not fully acknowledged or understood by the INSO function.	The INSO function has identified the formal and informal associations, helping INSO personnel be aware of when and how their independence may be compromised.	The INSO function continuously follows-up and actively manages the formal and the possible informal associations with the line organization.
Clear division of labour and coordination between other oversight or safety functions (e.g., internal audit, QA, safety department, safety committees and councils)	The INSO function and the other oversight and safety functions do not coordinate, share information, or do not know about each other's activities.	Coordination between the oversight and safety functions is irregular. Information is occasionally exchanged through reports or other non-interactive means.	Representatives from the different oversight and safety functions are periodically invited to each other's meetings to present and discuss their observations. Their roles are understood by all parties, including their place in the organizational defence-in-depth.	Oversight and safety functions systematically meet to coordinate and reflect upon their findings. INSO oversees how the other oversight and safety functions perform their oversight.

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Practical tools for INSO assessment and development

- **INSO function maturity model:** identify and define development needs of the INSO function
- **Model of functional involvement:** position the INSO activities in the continuum of independence-dependence and to reflect on the advantages and disadvantages of various types of involvement

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MONITORING PERFORMANCE				
	Independent - passive	Independent - contributing	Involved	Dependent
Activity	Observing issues in the field or in meetings and documenting them.	Asking relevant questions in meetings and safety walks, having dialogue with personnel.	Making safety observations during the safety walks into the line organization's observation system.	Monitoring performance in areas where line has identified a need or gap.
	Reading safety analyses, technical documentation and investigations.	Providing comments on safety analyses, technical documentation and investigations.	Approving or rejecting safety analyses, technical documentation or investigations.	Correcting documents or conducting analyses for line organization.
	Participating in selected investigations, audits or assessments as observers.	Participating in selected investigations, audits or assessments and contributing with questions.	Participating in selected investigations, audits or assessments as a member of the team.	Taking responsibility for investigations, audits and assessments.
Pros and cons	INSO remains an independent observer. Usefulness depends on the way of summarizing and reporting the findings.	INSO remains independent but contributes by prompts, comments and questions that, in addition to providing more information to INSO, can facilitate reflection in the line organization. Comments and questions can steer line decisions (especially if considered "hints" about later INSO review), which sacrifices independence.	INSO sacrifices independence by taking part in a process owned by the line organization (review & approval, experience feedback). INSO can make a positive effect on those processes, but care must be taken by INSO when/if later assessing those processes (not by the same persons who participated in them).	INSO works as part of a line function while doing this. Can contribute to nuclear safety in case of acute resource or competence gaps in the line organization. In the long run it makes INSO a de facto line function and removes one layer of organizational defence-in-depth.

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17/10/2025 VTT – beyond the obvious				

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- **Role independence reflection tool:** reveal dependency-related biases and their consequent phenomena in the role of an INSO expert

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CULTURAL AND SOCIAL DEPENDENCIES

Reflection question	Considerations
Do you spend time informally with the people you oversee?	Spending too much time with those you oversee can lead to cultural and social dependency – sharing the same assumptions and blind spots and becoming too close to provide constructive criticism. On the other hand, informal interactions can help getting to know line organization staff and gain their acceptance of INSO, as well as obtain first-hand understanding of the situation and climate in the line organization.
Do you oversee groups where you previously worked?	Overseeing groups where you previously worked may hinder independent oversight due to loyalty to former colleagues, potential difficulty in challenging them, and discipline blindness (having shared blind spots with the overseen). On the other hand, overseeing familiar groups may help focus and contextualize oversight, and better make sense of the oversight findings due to having an experience-based understanding of the local conditions, ways of working, and culture.
Do you usually spend time with people who think the same way as you?	Spending time and/or working with people who think the same way as you can make it easier to understand each other, and it can be easier and quicker to work and to make decisions. On the other hand, not having sufficient diversity of thinking in a work group can contribute to groupthink, complacency, and a lack of challenge and questioning attitude – all of which can adversely influence INSO effectiveness as an independent, "second opinion".

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INSO in changing nuclear environment

- With SMR technologies, new organizational forms, young companies and new-builds, come new boundaries and opportunities that can affect how internal oversight is organized
- They may require **reconceptualization** of internal oversight to effectively apply it to “unconventional” organizational settings

Some open questions

- What is the extent to which INSO can be **outsourced**, and what are the implications of outsourcing on its effectiveness? Outsourcing may increase independence, but it can also lead to a loss of contextual understanding and ability to influence
- How to organize INSO in companies with highly **decentralized** organizational forms (e.g., multiple minimally staffed SMR plants)?

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- Viitanen, K., Reiman, T., Karadeniz, S., Airola, M., Jakobsson, F., Sylvander, C., Lind, S., 2024. Internal nuclear safety oversight as part of organizational defence-in-depth. Lessons learned for the Nordic nuclear industry. Intermediate report from the NKS-R INSOLE activity (No. NKS-482). Nordic nuclear safety research, Roskilde, Denmark. URL https://www.nks.org/en/nks_reports/view_document.htm?id=111010214698535
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bey⁰nd

the obvious

VTT – beyond the obvious

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Thank you!

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