Success Factors for Human Factors Issues Management in the Nuclear Industry

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SUMMARY

This paper sets out to present several key Success Factors learned from the coordination and management of Human Factors Issues and Assumptions Register (HFIAR) administrative process' within the Nuclear Sector. The paper seeks to explore notable themes identified within HFIAR management and detail how the process can be suitably implemented to provide successful Human Factors (HF) Issues management to Nuclear Industry Clients.

KEYWORDS

Human Factors, Risk Management, Issues Management, Nuclear, Success Factors.

Introduction

This paper aims to identify and discuss key Success Factors that contribute to an effective and efficient Human Factors (HF) Issues and Assumptions Register Management Process within the Nuclear Sector. These Success Factors are included within the following stages (1) conceptual phase, (2) populating the HF Issues and Assumptions (HFIA) Register, (3) prioritisation and risk ranking of HFIA Register (HFIAR) items, and (4) closure of HFIAR items. The Success Factors have been drawn from a practical case study of the design and safety assurance of a nuclear facility, and collaborative gathering of lessons learned from HF Consultants drawing from their own experience of managing HFIARs within the Nuclear Sector.

Background

The purpose of a HFIAR management process is to define and utilise a method that captures, records and tracks the progression and closeout of HF considerations across the entire project lifecycle. HFIAR entries can be identified from a variety of sources throughout a project lifecycle and are not limited to HF. HFIAR items can also be identified across a range of HF Integration (HFI) areas (e.g., procedures, equipment design, organisational arrangements, Human-Machine Interface (HMI) and Safety Analysis). These items may require HF expertise to understand the nature of the consideration relative to the maturity of the design and project lifecycle, the associated risks, and dependencies and opportunities, and manage it towards closure. The process can also be used as a tool to provide oversight for key stakeholders and relevant parties on the project, providing a means in which HF risks can be communicated to stakeholders.

An HFIAR is typically captured within a spreadsheet with dedicated sheets to track the items, key definitions and metrics to give situational awareness to the project for the items that are identified. The process in its entirety should be underpinned by a methodology document that acts as a referenceable guide to the management of HFIAR entries, which can also be disseminated to stakeholders for whole-project understanding and buy-in. The document should also establish a

clear process for the close-out of entries to ensure entry closures are appropriate, consistent and supported by evidence.

The authors of this this paper have a shared belief that it is important to capture and analyse these focussed learnings from practical project applications, so that Success Factors are shared with the wider HF community for consideration and application to other projects. HFIAR management is an activity that is central to effective HFI and is paramount considering the developments and complexity of the Nuclear Sector. In addition, effective HFIAR management has equal importance within other high hazard sectors; a positive impact in this area can increase the overall success of HFI.

When the authors of this paper sought references relating to HFIA management, there were no specific references that were identified. This further confirms the value of this discussive paper as a resource for HF professionals that can be used to improve the quality of the HFIAR management process across HF in the Nuclear Sector. The Success Factors captured within this piece would also be appropriate to consider for HF in other sectors, as key starting points for the development of an early Issues Management procedure.

The following sections detail some key Success Factors from different stages of HFIAR management. These areas are: (1) conceptual phase, (2) populating the HFIAR, (3) prioritisation and risk ranking of HFIAR items, and (4) closure of HFIAR items.

Success Factors during the Conceptual Phase of a HFIAR (1)

The conceptual phase of the HFIAR management process is key to developing a strong foundation to the build and management of a HFIAR. Considering key Success Factors related to this phase will enable the development of the HFIAR concept and framework before progressing to its implementation. The outcome of the conceptual phase should result in a clear understanding of the purpose of the HFIAR, what information will be captured, how it will be appropriately managed to satisfy project and regulatory requirements, and how it will interface across the project.

Defining the scope of the HFIAR at the conceptual phase provides clarity on the objectives of the HFIAR, the management process for the HFIAR, and what information should be captured or excluded. Scoping activities can also identify what additional information should be captured for items which meet the pre-defined requirements for entry in the HFIAR, to facilitate the effective management of each item throughout its lifecycle (discussed in detail in the population phase). Having a clearly defined scope and boundaries from the start of the project will also aid in reducing risks that can occur on large scale nuclear projects, such as an unclear understanding of key stakeholders and misdirection of resource, both of which can lead to limited progression on items within the HFIAR. Scoping activities should be undertaken with a range of project stakeholders to ensure diverse input and discussion takes place. These activities should consider the use of the HFIAR throughout the project lifecycle, the information it must capture and how it will be used.

At the conceptual stage of a HFIAR management process one of the priority Success Factors to understand includes the development of key definitions. Establishing what is required to be captured in the HFIAR management process gives a clear understanding of the scope and what aspects will require attention going forwards. Definitions across projects may vary in nature, however, it is key to define what constitutes an issue or assumption independently. Definitions should also be developed for any keywords for the risk ranking of items and status updates if these are used to prioritise items and capture progress updates. For example, definitions for the status of an item should be developed (e.g., open, in progress / managed, closed, and not applicable). Avoiding the inclusion of items that are not covered by definitions is key as this will impact on the

consistency of entries which becomes vital as a project grows in scope and complexity. Therefore, the definitions need to be defined, clear and specific, with concise wording which allows for items to be measured against them.

Ensuring an appropriate resource is assigned to the management of the HFIAR process is also a key Success Factor. The case study and group experience has demonstrated that proactive management of a HFIAR process on such a large scale takes a significant amount of time. It is important to ensure the size of the process is mirrored proportionally to the amount of resource that is allocated to item management. Resourcing of the HFIAR should ensure a suitable number of person(s) and time is agreed to actively manage the HFIAR, acknowledging that flexibility may be required to meet project demands and phases that generate a greater quantity of items. Management of a HFIAR should be given suitable HF oversight to ensure that items are appropriately captured, managed and closed, with the impact of each item understood from a HF context and only closed when appropriate. This will also support alignment with regulatory expectations and guidance [Ref 1- ONR TAG 058 – HFI].

During the conceptual phase, identifying key stakeholders and their purpose / interests is critical to effectively managing a HFIAR on large scale projects within the Nuclear Sector. There will likely be numerous stakeholders, with varying reasons and requirements for interfacing with the HFIAR. For example, this could include stakeholders who raise and identify new items, Subject Matter Experts (SMEs) who provide guidance and evidence for the closure of items, governing bodies and regulators who may want to understand and regulate the HFIAR management process, and technical or programme oversight who want to understand project risk and progress. Identifying stakeholders during the conceptual phase will facilitate proactive engagement with stakeholders, increasing collaboration and alignment across the project.

Suitable access to the HFIAR is a key enabler for success across the project. Industry experience from managing HFIARs on large scale nuclear projects has identified that granting stakeholder access to the HFIAR will support awareness of HF and also allow stakeholders to use items within the HFIAR to inform assessments and gather evidence to close items. Access could be provided via a shared project site, or emailed out regularly (e.g., bi-weekly). It is important that the ability to edit the HFIAR is restricted to those who are responsible for the management of it.

Another important Success Factor to consider during the conceptual phase is defining how the progress of the HFIAR will be reported. Reporting progress to stakeholders provides clarity of activities (completed and planned) and general progress, increases shared understanding of the current state of the HFIAR and strengthens alignment between teams across the project. The method for reporting progress should consider the stakeholders (and their interests) and the frequency of providing updates. Options could include a meeting (e.g., monthly) to provide updates on progress and allow discussion amongst stakeholders, as well as a dashboard which categorises and displays progress using graphs / tables or written updates. Overall, planning how progress will be reported and careful consideration of the format to report in, what information to report and who to report to, will support a collaborative approach to the HFIAR management process and allow for progress to be tracked in a consistent manner.

A final important Success Factor from the conceptual phase, particularly on large scale or complex projects, is to produce a supporting document in the form of a guide or working instruction. This will capture information for all of the Success Factors presented and will support and facilitate understanding of the HFIAR management process across the project and key stakeholders. This should capture and define key information which may include written definitions, management processes, key stakeholders, how progress is reported (e.g., meetings), how to raise an item to the

HFIAR process and relevant information. Producing such a document provides assurance of a clearly defined HFIAR management process and elucidates the process and purpose of the RAIDO log to any stakeholders, ensuring a consistent understanding for each stakeholder.

Success Factors during Population of a HFIAR (2)

The completion of the above aspects around the conceptual stage of a HFIAR (i.e., the identification of clear definitions, terminology and supporting guidelines) lays the foundation for the long-term operation and use of the HFIAR management process. Following this, clear expectations need to be established from first use for how entries are populated within the register. This subsequently sets the premise for the consistent reporting of entries that, in turn, supports the efficiency and effectiveness of their management which is particularly pertinent for large-scale and complex engineering projects.

After identifying a potential HFIAR item that may be suitable for inputting into the log/database, it should be ensured that the item first and foremost aligns with the definitions set out at the conceptual stage that would signal its appropriateness to be captured for further management / progression. Following this, several key categories of information should be captured, these include:

- Item identification (ID): A unique ID should be added to each item to ensure it can be easily identified and tracked.
- Item Source: This should make clear reference to the document, discussion, or meeting output in which the item was identified.
- Item Categorisation: This details whether the item is considered a HF issue or assumption. .
- Item Description: The item description should be specific and clear as a standalone statement. It should allow the reader to understand exactly what the HFIAR item is and any relevant technical details.
- Item Consequence(s): This aspect should capture the consequence of the HFIAR item not being addressed. For example, within the nuclear industry, if a significant HF issue is not addressed, it may undermine the nuclear safety case, the achievability of actions related to Human Based Safety Claims and / or result in a nuclear safety significant consequence. This aspect is critical for informing the risk ranking and prioritisation aspect of the HFIAR.
- Item Risk(s): This details the level of risk which the item holds if not addressed. This can be used to inform priority of actions when managing the HFIAR. See Section 3 for more detail.
- Item Priority: Assigning a priority (e.g., low, med, high) supports the management of the HFIAR by identifying items that may need more urgent focus. This could be informed by items being high risk, or items that must / can only be addressed by a certain project milestone / phase. This is discussed further in Section 3.
- Item Recommendation(s) and / or Action(s): HF recommendation(s) and / or action(s) that are expected to support the close-out of the item should be identified, communicated and agreed by the relevant stakeholder(s).These should use the SMART (Specific, Measurable, Achievable, Relevant and Time-bound) method to clearly detail *what* is expected, from *who*, and *when*. The completion of the recommendation(s) and / or action(s) should ultimately indicate that the item has been addressed and can be closed.
- Item Closure Date / Milestone: The closure date should be identified by the stakeholder(s) to signal when the item actions are expected to be addressed and / or any project milestones that the item would be required to be closed-out by. For example, with design-related items, the close-out date may be related to a specific design stage, which once

surpassed, leaves limited or no opportunity for the design recommendation to be implemented. This may lead to the requirement to identify alternative (and often less desirable) closure-routes to be put in place (e.g., procedural control to mitigate against a design-related issue).

- Item Owner: This details the stakeholder(s) who has agreed to take responsibility for the risk and progression of the item towards is closure.

As part of this Success Factor, providing stakeholders with templates, item examples and / or an instruction guide can help to ensure that they understand what is requested of them so they can provide the information and level of detail that is required. This can be populated as intended by the stakeholder in their own time or a more guided approach can be taken by means of a meeting facilitated by the individual(s) responsible for managing the HFIAR management process.

If the above points are not suitably detailed within the HFIAR entry, requesting follow-ups or additional stakeholder support can be difficult due to potentially ambiguous and unclear entries, or those that lack sufficient information to support their progression. This can ultimately lead to confusion among stakeholders on what the exact requirement is and what is expected of them. As a result, there may be a lack of clarity on how to progress or close the entry. This can result in items remaining in the process for long periods of time and surpass the closure date / milestone for their intended and timely resolution.

Another aspect of this Success Factor is to ensure the HFIAR items are updated in line with the 'time-bound' aspects of the actions or target closure dates. These updates can be prompted to stakeholders and / or action owners via email so updates are captured in plain text and can be referenceable, or those responsible for managing the HFIAR process can facilitate dedicated stakeholder meetings to review the item and update the entry this way. Utilising the latter approach gives more space for discussion and allows for effective multi-disciplinary collaboration, if this is required.

The following points are important to review as part of any HFIAR item update:

- Action & status updates: When the identified timeframe is reached for when the item actions should be addressed, and the update should be input into a 'status update' column and should follow a prescribed format. For example, the update should be timestamped, with a clear record of *who* has provided the update and their role. This is important for organisations that have individuals move roles or departments on a regular basis or rota. The update should be clear and concise, and link to referenceable evidence where possible. Should the status update evidence the closure of the item action(s), this should clearly link to the precise action(s), as appropriate. The status update should take place alongside a review of the item actions. Should the actions be deemed to be closed, it should be captured with a clear closure date and link to evidence outlined in the status update column.
- Status indicator: This can represent whether the item is open, managed or closed, following definitions set out in the conceptual stage of the HFIAR development. This should be reviewed by the item owner and stakeholders in line with the completion of the identified actions to ascertain whether the item may be closed, and if so, updated accordingly.
- Close-out (see Success Factor: Closure of HFIAR Items).

Ensuring all these suggestions are followed will ensure each item in the HFIAR is clearly detailed, auditable and provides sufficient information should it be requested by stakeholders or regulators at a later date. This becomes more important the larger or more complex a project becomes as some HFIAR can hold hundreds of HF entries, and as differing individuals are responsible for the management of the log.

Success Factors during the Prioritisation and Ranking of HFIAR Items (3)

A HFIAR may contain a large number of entries, and therefore, to inform decision making, task prioritisation and resource allocation during the progression and closure of entries, a risk targeted approach to the management process is necessary. This will often take the form of a simple risk ranking of items of which the different levels of risk will need to be clearly defined at the beginning of the project during the conceptual stage. These risk ranking definitions will need to be continually referred to throughout population to ensure a consistent assignment of risk is applied. A common approach to risk assignment within risk registers is the application of the risk matrices, which quantifies the level of risk based on assigned categories of 'probability', 'likelihood' or frequency, and 'severity', impact' or consequence'. For example, the 5 x 5 risk matrix presented in Table 1, where *Risk = likelihood x severity*. The use of a risk matrix can be refined by assigning numerical values to each category to further inform risk prioritisation (e.g., risk). However, caution is advised when using risk matrices, as the subjective assignment of categories can fall victim to biases (e.g., confirmation bias), and result in differences in qualitatively assigned risk rankings (e.g., higher qualitative ratings to quantitatively smaller risks). To help mitigate this issue, it is recommended that clear and concise definitions for the individual ratings within each category are defined at the conceptual stage and referred to when populating an entry to inform assignment of risk. Additionally, this should be underpinned by detailed 'consequence' descriptions as part of the HFIAR population.

In addition to a simple risk matrix (or alternatively), other metrics can be utilised to inform prioritisation, such 'complexity / relative effort to resolve', 'required closure date 'and 'Project Impact[1]. However, caution is advised when adding additional matrices, as this can increase the burden of populating an entry and adds an element of complexity for stakeholders when communicating entries.

Table 1 - Standard 5 x5 Risk Matrix

RISK SCORE	Severity				
Likelihood	Very Low (1)	Low (2)	Medium (3)	High (4)	Very High (5)
Very High (5)	LOW	MEDIUM	HIGH	HIGH	HIGH
High (4)	LOW	MEDIUM	HIGH	HIGH	HIGH
Medium (3)	LOW	LOW	MEDIUM	HIGH	HIGH
Low (2)	LOW	LOW	MEDIUM	HIGH	HIGH
Very Low (1)	LOW	LOW	LOW	MEDIUM	HIGH

When defining an appropriate risk ranking method, additional consideration should be given in large complex engineering projects, where there may be a hierarchical structure of HFI activities (e.g., Client level, responsible designer level, and supply chain contract levels), and therefore multiple HFIARs. It is important to ensure there is a consistent approach of quantifying and assigning risk across the different HFIAR items at the different levels to support the escalation of

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[1] i.e. what is the impact of not resolving the entry on the project programme delivery.

entries 'up the chain', if required and the subsequent decision making, task prioritisation and resource allocation of that entry relative to the other entries in the new log or register during the closure stage.

Success Factors during the Closure of HFIAR Items (4)

Closing items appropriately is a crucial part of any HFIAR management process in that the consistent closure of items reduces the overall risk of the project, as risk is inherently carried within any HFIAR management process.

The closure of items on the HFIAR is fundamentally linked to identifying the correct stakeholders. This Success Factor will allow the HFIAR manager to discuss items with the correct stakeholders per topic and agree appropriate actions going forwards. A key method to implement to capture the correct stakeholders is to create a stakeholder management matrix. This document should be developed from the earliest possible stage, and to be updated at regular intervals to ensure the information within is updated with the status of the project. Key information to be identified within the stakeholder management matrix may be name, role, email address and HFIAR items that the stakeholders have ownership of. If the HFIAR manager role is then handed on to another member of the HF team, the handover process includes the stakeholder management matrix to allow the new manager to understand an accurate representation of the stakeholders on the project.

To close HFIAR items, the actions developed are required to be appropriate. Successful actions are to be agreed with the stakeholder (s) responsible for the area where the open item sits within the project, for example, HF leads or engineers from other disciplines across the project. This should be identified via the stakeholder management matrix discussed in the previous paragraph. Actions should be specific, with a specific outcome or assessment result required to close the item (s). The closure required should outline a timescale, this is often dictated by planned assessments or assessments in progress, but this can be driven by the project if item closure is required before a project milestone, for example, outstanding items on pieces of equipment before installation or any design related items before a design freeze. If the timescale is not known, the stakeholder should be able to provide a timescale for the HFIAR manager to get in contact and check on the progress of the item.

When the HFIAR manager believes that the actions required to close an item have been met, the HFIAR manager should work to develop a closure statement. The effective use of closure statements is a Success Factor that will ensure that the appropriate audit trail is kept, and the evidence for closure is captured. This demonstrates how the risk contained within the HFIAR register is mitigated. The closure statement detail should include how the agreed actions have been met to close out the register, this can be done in bullet point form or prose; the key point is for the reasons for closure of item to be outlined to any potential reader for across the project. Following the drafting of the closure statement, this should be presented to the stakeholder with ownership of the item to review, the review will ensure that the HFIAR manager has captured the key closure points and allows the stakeholder to agree and sign off that the relevant actions have been carried out taking the item (s) through to closure. The HFIAR manager should note down as part of the closure statements that the words have been agreed with the owner to ensure traceability and credibility of the closure statement.

High significance items, defined during the conceptual (1) phase of the HFIAR management process, should be given due care and attention as part of the closure process. Often items that may have an impact on nuclear safety should be signed off by a designated and senior technical member of the HF team. This Success Factor is designed to ensure that items that require a high level of

attention are reviewed and approved by a secondary source, given the potential for higher risk to potential areas such as safety, cost or the design stability.

Conclusions

Across the experience of the four authors of this paper, the following section pulls together meaningful conclusions based on their cumulative industry experience and Success Factors identified within this paper.

When reading through the Success Factors in the isolated nature of this paper, it is key for the reader to understand the principal of proportionality. When undertaking or taking over a HF project, it is key to understand the size and relative effort that is required from the HFIAR management Process. Small projects, with a large number of hours taken up on HFIAR management is not going to be a beneficial use of time and other HF analysis will be sacrificed, meaning time management becomes unbalanced. This is not to say, that if the project size increases time on HFIAR management should not also increase. The relative time should reflect the scale and outcomes expected from the project.

In Nuclear Sector HF projects, change is a common occurrence. Due to reasons such as scope changes or design changes, there is potential for the HFIAR management process to become outdated during a project. It is key for the HFIAR management process to communicate with key stakeholders in the project to ensure that the process is still working towards the desired objective and in the way required. Communication ensures a two-way discussion between the HFIAR management process and the project to ensure that any required changes can be implemented to ensure that the HFIAR items can be tracked and closed as appropriate.

The two above conclusion points lead to the echoing of an earlier Success Factor highlighting the need for an effective supporting methodology (as discussed in the conceptual phase section (1)) document. The presence of this document allows the facilitation and effective changes of the project process, by allowing regular updates to the methodology. The creation and maintenance of this document allows for an up-to-date understanding of the proportionality of the HFIAR management process and encourages communication and updates with stakeholders if changes to the methodology are required.

Following this paper, further research may be considered around the development of robust ranking methodologies and definitions. This would require consideration in the development of consistent definitions as it is important that rankings clearly define the risk, and this is required to be repeatable across the project and maybe shared wider. This would allow an improved determination of item closure priority. Linked to this would be the consideration of ranking of items and the ability to improve the ranking process, developing an effective standardised process with acceptable internal validity and reliability. This, in turn, may help to establish a ranking process that can be used across projects with consistent comparisons and applications, ensuring the risk is minimised by attending to the priority items at the first convenience.

A key area of further research should consider lessons learned from HF across wider industries, and what their strategies are to ensure HF issues management is appropriately considered and operated. This may include, but is not limited to, Rail, Healthcare, Defence and Aviation industries. This paper captures what has been learned across varying experiences in HFIAR management within the Nuclear Sector, but it is key that these lessons should not be learned in silos. The authors of this paper believe that it would be of great benefit to the HF community to come together and gather the lessons learned cross-industries and understand the strategies used to benefit the wider HF discipline.

References

NS-TAST-GD-058, ONR Technical Assessment Guide – Human Factors Integration (HFI), Issue No. 5, March 2023, Office for Nuclear Regulation.