Development of the CIEHF White Paper on Human Factors in Barrier Management: Recommendations and Learnings

Dr Ronald W. McLeod, Ron McLeod Ltd. C.ErgHF, EurErg. Dr Ian Randle, Hu-Tech Human Factors, President CIEHF, C.ErgHF.

Abstract. CIEHF has recently published a White Paper on the subject of Human Factors in Barrier Management. This is the first White Paper produced by CIEHF and represents a significant step towards establishing a public position on what the Institute believes represents good practice in key areas of practice of the professional discipline of Human Factors and Ergonomics.

Development of the White paper was driven by concern among many CIEHF members working in high hazard industries at how human performance is being addressed in some current approaches to barrier management, in particular the Bowtie Analysis method.

This paper summarises the process adopted to develop the White paper, including the internal and external consultations undertaken. The contents of the White paper are summarised, including the relationship between elements of a barrier system, concerns with current practice, and recommendations covering Human Factors in the selection, verification, implementation and assurance of controls. A proposed layered approach is introduced where there is a need to examine in detail how barriers can be defeated by human error, and the safeguards that need to be in place to mitigate against it.

The paper also identifies seven lessons learned that may provide value to those embarking on similar tasks on behalf of the CIEHF in future.

1. Introduction: The case for a CIEHF White Paper

The concept of barrier management – implementing and assuring a range of controls to protect against the risk of major losses - is widely used across many industries. While it is currently applied with most rigour in industrial processes, and particularly the traditional "high hazard industries" (nuclear, oil & gas, rail, etc.), the concept applies to virtually every industry with the potential for significant losses. Industries such as healthcare, banking, the public services (police, fire, ambulance), and public utilities (water, electricity and gas distribution) all place heavy reliance on barriers to guard against losses.

Achieving and maintaining reliable human performance is a major concern in organisations that rely on barrier management. On the one hand the performance of people continues to be relied on for controls to function as expected. On the other hand, loss of human reliability – "human error" – is widely regarded as one of the principal threats that need to be guarded against through the use of barrier models.

Most organisations however struggle to know how to ensure that: a) the human performance they need and expect can reasonably be relied on to be delivered when and where it is needed, and; b) the controls that they have in place are as robust as they reasonably can be to the loss of the expected levels of human reliability.

Through their professional activities, CIEHF members are aware of the cross-sector importance of barrier management. In particular, the technique of Bowtie Analysis is becoming increasingly prominent in supporting the development and operational management of barrier models. There is as yet, however, little standardisation or recognised best practice about how to conduct and implement Bowtie Analysis either within or across sectors. The guidance that is available says little or nothing about what represents good practice in dealing with Human Factors aspects of barriers. Consequently, practices have developed and been shared across businesses and industries that may be inconsistent with good practice in Human Factors and Ergonomics.

A White paper is an authoritative report or guide that informs readers concisely about a complex issue and presents the issuing body's philosophy on the matter. It is meant to help readers understand an issue, solve a problem, or make a decision. The purpose of the CIEHF white paper is therefore to set out a CIEHF position on the treatment of Human Factors issues in barrier management in general, and in Bowtie Analysis in particular. Specific objectives are:

- i. To bring clarity to some areas where there is ambiguity or confusion in the way human performance is treated, and;
- ii. To set out some recommendations for good practice in developing and managing those elements of barrier systems that either rely on, or can be defeated or degraded by, human performance.

2. Development

Development of the white paper began with a half-day workshop held immediately prior to the 2016 CIEHF annual conference. The workshop aimed to discuss and review concerns about current practice and to try to determine what the CIEHF might consider as the basis of good practice.

Around 30 delegates, drawn from a wide range of industries including oil and gas, nuclear, maritime, rail, healthcare and defence attended the workshop. A series of short briefings were given by invited speakers known to have particular experience in the operational use of barrier management strategies. Delegates were then organised into teams and asked to work through four discussion questions, each with a dedicated facilitator and scribe (i.e. each group discussed all four questions). The discussion questions were;

- 1. What criteria should a proposed barrier in a layers of defences strategy that relied on human performance be expected to satisfy to be considered acceptable?
- 2. What action can organisations that propose to rely on human performance as a barrier take to demonstrate that those human barriers are as robust as they reasonably can be?
- 3. Is it realistic to identify a best-practice approach that can apply across all industries? What are the key differences and challenges that need to be customised to suit the needs of different industries or regulatory situations?
- 4. Can the role of people as a barrier preventing the release of a hazard (i.e. the left-hand side of a "bow-tie") and as a mitigating barrier (the right-hand side of a "bow-tie") be treated in the same way? Or do different factors need to be considered in each case?

At the end of the workshop, a working group was organised comprising delegates prepared to contribute to development of the white paper.

Over the subsequent six months, and drawing on the conclusions reached in the four discussion groups, three draft versions of the white paper were prepared and reviewed by the working group. Following the third round of reviews, the document was sent

to a further four experienced individuals who had not previously seen the content for their review. A copy was also sent, on request, to the UK's Health and Safety Laboratory. Comments and suggestions from these reviewers were incorporated at the discretion of the lead author, in consultation with working group members as appropriate.

Following completion of the fourth and final draft, the document was sent to a professional publisher who carried out an editorial review and formatted the document ready for external release. The document was released for public use on the CIEHF web-site in December 2016.

3. Content and highlights

The white paper is organised into 6 sections. Section 1 provides an introduction and explains the case for developing a CIEHF white paper on Human Factors in Barrier Management.

Section 2 sets out the scope of the document and introduces basic concepts in barrier management and bowtie analysis. It aims to clarify and explain the relationship between the various components of a barrier model (using the diagram shown as figure one) and introduces a key distinction between two types of controls: barriers and safeguards. The term "barriers" refers to controls that are assessed as being sufficiently robust and reliable that they are relied on as primary control measures against incidents. The term "safeguards" means controls that support and underpin the availability and performance of barriers but that cannot meet the standards of robustness or reliability to be relied on as a primary measure.

Section 2 also sets out six criteria that any control considered to be a barrier should meet: having clear ownership and traceability to the HSE Management System, and being specific, independent, effective and capable of being assured.

Section 3 discusses four topics that provide essential context to any attempt to incorporate human and organisational factors in a barrier system: complex sociotechnical systems and the systemic nature of incidents; the role of people in safety management (i.e. the need to recognise the significant contribution that people make to controlling risk, and not simply treating people as a threat); the different perspectives on barriers that exist at different levels in an organisation, and; the difference between formal and informal uses of barrier models.



Figure 1: Summary of the relationships between components of a Barrier system.

Section 4 discusses a number of limitations in barrier models and sets out a number of concerns CIEHF members have expressed about how Human Factors are often treated in approaches to barrier management. These are summarised in table 1. The section also discusses differences between the left and right hand sides of a bowtie analysis in terms of the difference between controlling events (on the left hand side of the bowtie), and the need to be resilient and flexible in responding to events that have happened (on the right hand side).

Section 5, for many people, will be the heart of the white paper. It sets out 33 recommendations intended to improve the development, implementation and management of those aspects of barrier management systems that rely on human performance or are intended to protect against loss of human reliability. The recommendations are organised into five topics:

- 1. General policy around the treatment of and attitude to barriers (7 recommendations);
- 2. The categorisation of different types of barriers and barrier elements and their characteristics (3 recommendations);
- 3. The lifecycle of the development and use of human barriers, including selection, verification, implementation and assurance (7 recommendations);
- 4. Criteria to ensure human barrier elements, as well as the human performance that is relied on for technical barrier elements to function, are sufficiently robust that they can be relied on (7 recommendations);
- 5. The contents of a Human Performance standard for human barrier elements (5 recommendations).

Table 1: Summary of concerns identified as being especially important in addressing Human and Organisational Factors in Bowtie Analysis:

Human error is commonly modelled as a threat, and barriers are put in place that try to block the error from leading to a top event. Effort is therefore concentrated on trying to minimise the risk of human error rather than recognising the real barriers and ensuring they are robust against any degradation factors – of which human error is usually only one.

Although Bowties frequently identify a reliance on human performance to achieve barrier functions, they rarely specify the level of human performance that needs to be achieved for the barrier to function.

Top Events are frequently located too far to the right: that is, the events that barrier systems seek to avoid by means of prevention barriers are too close in time to the consequences (fatalities, losses, etc.) that those events can lead to.

Too many "barriers" are identified, most of which are not able to meet the criteria for robust barriers. While they have a role as "safeguards", they should not be confused with the principal barriers that need to be capable of being relied on.

Barrier models rarely recognise the influence that a wide range of organisational factors – such as leadership, culture, incentive schemes, commercial arrangements, or contactor management – can have on the performance of people at the front-line.

Organisations frequently hold unrealistic expectations about what people will be able to do, and how they will actually perform, in the circumstances that exist when barriers need to function.

The intentions and expectations of human performance that are implicit in the decision to rely on people as part of a barrier system are rarely made explicit. They are therefore not communicated to those that need to implement, perform, support or maintain barriers.

Barrier models are often prepared, implemented and distributed to the workforce in a manner that does not properly support their operational use.

Section 5 also introduces the concept of using a layered approach where organisations want to give special attention to the risks associated with human error. Figure 2 illustrates the concept of layered bowties. The figure shows a main bowtie ("Level 0") where human error has been identified as a degradation factor for Barrier 2. Two progressively more detailed levels are shown (Levels -1 and -2) developing progressively more detailed understanding of the risk from human error and the safeguards that are relied on to mitigate that risk.

In addition, section 5 makes recommendations, and contains two examples showing how a Human Performance Standard for human barrier elements can be specified in terms of six characteristics:

- a. What makes the human performance specific to the threat and situation?
- b. Who is expected to be involved in delivering the required performance?
- c. What competence do the individuals involved need to have?
- d. What is the expected timing of the performance of the barrier?
- e. What are the criteria for successful performance of the barrier?
- f. Key expectations about how operations around the barrier will be conducted that are especially critical to performance of the barrier function.



Figure 2: Illustration of the concept of layered Bowties

The final recommendation in section 5 concerns the development of a barrier management plan to assure the operation and maintenance of the barrier system at an operational location.

Section 6 contains the glossary and a list of acronyms and definitions used throughout the white paper.

4. Lessons Learned

Reflecting on the experience of developing the white paper, seven important lessons were considered to have been learned:

- 1. There needs to be a clear gap that a white paper intends to fill or a compelling need for the CIEHF to correct poor HF/E practices. The gap must be clearly concerned with the professional activities of CIEHF members, i.e. there should be a clear case not only why a white paper is needed, but also why the CIEHF as a body has the authority and competence to fill the gap.
- 2. Both the effort needed and the elapsed time involved were significantly greater than had been anticipated based on previous experience working on industry guides produced by organisations representing corporate membership. However keen CIEHF members are to volunteer to work on a project, it is an organisation of individual members spending their time voluntarily. In comparison with guides and practices developed by organisations representing corporate membership, it can therefore be more difficult for working group members to devote time to the development of a white paper.
- 3. A CIEHF white paper effectively defines a position intended to broadly reflect the views of the CIEHF membership. That places a very significant onus on the developers to ensure the content undergoes sufficiently rigorous review by individuals capable of representing a sufficiently wide view of the CIEHF membership.

- 4. It was however necessary to find a workable balance between ensuring the content was reviewed by a sufficiently wide and suitably experienced sample of CIEHF membership while keeping the writing and editing process manageable and focused. It became clear after the third review cycle, that with the diversity of views, interests and experience among the CIEHF membership, there was a real danger of having too many reviewers commenting. This could lead not only to divergence in the content with a resultant loss of focus on key messages, but significant delays in publication as well as substantially more work for the editorial team. The original intention had also been to include a round of reviews by individuals and bodies external to CIEHF. For similar reasons, it was decided on pragmatic grounds to forego such a review stage.
- 5. There can be conflict between the views of the CIEHF membership and those of government, employers, regulators or other professional bodies who may have a stake in the way HF/E is implemented and presented. While it is clearly important to seek comment from a wide group of stakeholders, the working group took the view that it was important for a CIEHF white paper to focus on the professional views of the membership, and not to be overly influenced by the opinions or perspective of specific bodies, however important and influential. To do so would be to violate CIEHFs independence as a professional voice.
- 6. The working group was keen to ensure the white paper was as short, simple and clear as possible. It did however also recognise that it was important that the content should be properly grounded technically and scientifically. Most prominently, a number of reviewers suggested that the document would be "easier to use" if the Recommendations section (section 5 of the published document) formed all of the main body, and that the other material (including background on bowtie analysis and the role of people in socio-technical systems, as well as concerns with current practice in sections 2, 3 and 4) should be moved to appendices, where it can be accessed by the more interested readers without detracting from the recommendations. While acknowledging the possible benefits, the working group took the view that as a document presenting a CIEHF position, the technical background material was as important to achieving the objectives of the white paper as the recommendations arising from it: it is not possible to implement the recommendations properly without an understanding of the issues and context that gave rise to them. An important lesson was therefore that it is important not simply to provide recommendations, but to also provide the technical context and rationale behind those recommendations.
- 7. The published white paper is not perfect, and the Institute recognises that more time and effort could be invested to further improve the content and to ensure it is applicable to as wide a range of industrial contexts as possible. But given the gap that exists and the lack of existing sources of good practice, it was felt to be important that the document was published as soon as it was in an acceptable state, rather than incurring further delay in the hope of achieving "perfection". The Institute recognises that over time, once feedback has been received from members and other users of the document, an updated version may need to be produced.

Conclusion

The white paper 'Human Factors in Barrier Management' is the first attempt by CIEHF to publish a public position on good practice in an area of HF/E. It is anticipated that a series of other white papers will follow, dealing with other areas where gaps in good practice in HF/E are identified. While future white papers may adopt a very different approach the lessons learned from development of the barrier management document may provide value to those embarking on similar tasks in future.

Reference

McLeod, R. W., Randle, I.P.M., Hamilton, I., Wilkinson, J., Tomlinson, C., Jun, G.T., Miles, R., Wynn, T. (2016) Human Factors in Barrier Management. Chartered Institute of Ergonomics and Human Factors. http://www.ergonomics.org.uk/learn/barrier-management/