Training Effectiveness and Innovation

Royal NLR - Netherlands Aerospace Centre

Welcome to Royal NLR. We invite you to discover more about the innovative training and safety programmes we develop for airlines and other clients. The common goal is to make training more effective and efficient and to assist airlines in understanding and managing their safety risks and in achieving excellence in safety performance. Everything we do is founded in a thorough science-base, which we have bridged into truly practical solutions.

Our vision of airline training is founded on competency-based and performance-based training (PBT) concepts. Our approach focuses on a thorough process of analysis, design, development and implementation with the client. Our staff have detailed knowledge of and expertise in training, simulation, human behavioural assessment and regulations. This knowledge is combined with applied technical research and development in simulation. NLR actively develops innovative training technologies and training media. These capabilities and our in-house research infrastructure ensure that NLR can oversee the entire spectrum and stay on top of – and ahead of – new developments and innovations in airline training and simulation.

NLRs Safety Institute is known across the globe for its pioneering work and practical solutions in safety management, safety data analysis, safety modelling, safety risk management, and safety culture . We support airlines and other organizations at various levels of safety maturity worldwide, both in dealing with safety challenges in response to serious incidents or accidents and in understanding and resolving complex safety implications of the introduction of the new technologies , operations and regulations necessary to stay competitive and compliant.

The projects and products in this brochure showcase our unique approach.

NLR – Royal Netherlands Aerospace Centre

Instructional design process for blended learning

To ensure operational readiness training needs to be effective and efficient. The time spent on the Aircraft or the Full Flight Simulator must be as effective as possible. This means more customized and less expensive training through an optimum blend of live, low-level simulated training. A modern vision of training in which training media are properly integrated in the training design is essential for this approach.

Aviation Blended Learning Environment (ABLE)

In cooperation with EASA, NLR developed the ABLE concept, based on a modern whole task training approach. This concept resulted in a Comprehensive Analysis Process for Aviation Blended Learning Environments (CAPABLE) which will be part of EASA's future Acceptable Means of Compliance (AMC) material. It opens the door towards the use of new and innovative training technologies with high quality and in a justified and accepted manner. The CAPABLE process encompasses a genuine understanding of training needs, development of a modern design and a thorough analysis of training media requirements. These requirements can support the acquisition or development of innovative training media. Applying the CAPABLE process not only helps airlines decide where innovative training concepts or technologies will truly benefit both training effectiveness ánd the bottom-line, but it will also ensure regulatory compliance, thus de-risking innovation.

Applied research

To assure effective and qualitative use of training media, NLR develops demonstrators and Proof of Concepts that are integrated in the training design and evaluates and improves effectiveness of training media while involving all stakeholders in this process.

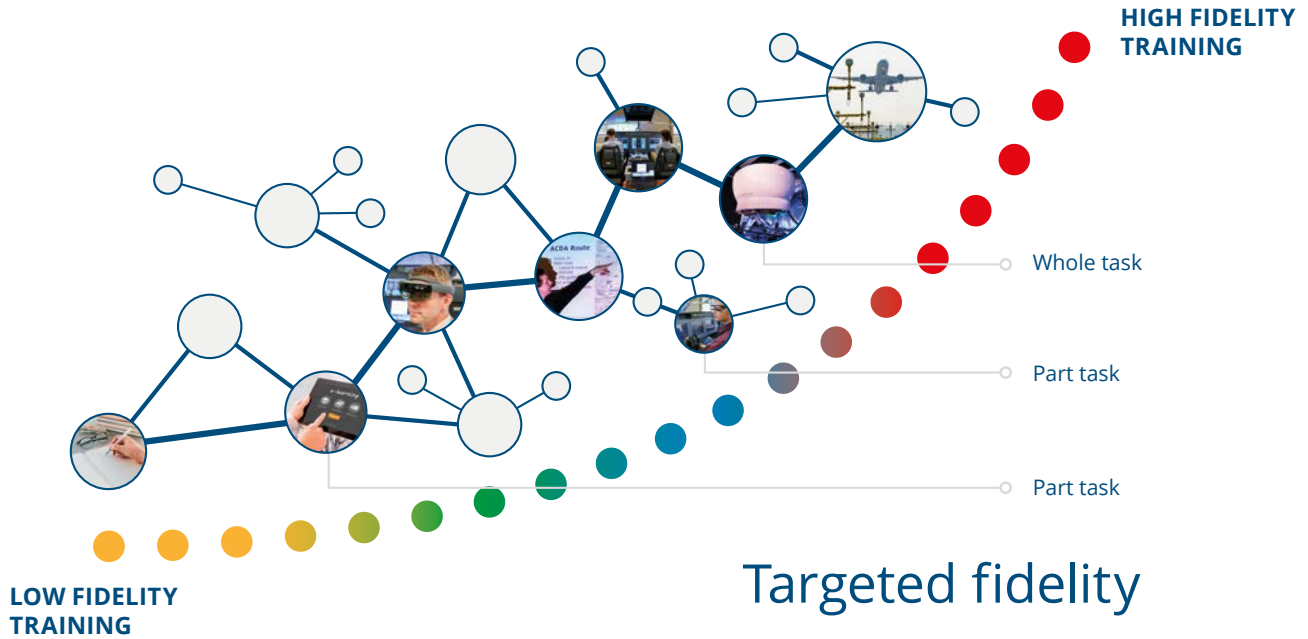The '**ADDIE**' approach from Royal NLR:

Analysis: analyse the operational training needs and determine the required competences through a Training Needs Analysis. The result: a qualification profile

Design: produce a rough outline of the training course. Define the learning scenarios and goals in line with the training needs. Determine the required supporting and procedural information. The result: a training blueprint

Development: develop and select training and simulation materials and tools. The result: training and simulation materials.

Implementation: support the whole change process and get all the stakeholders involved. The result: new or revised training

Evaluation: monitor the process and the product continuously. Perform experiments and evaluations to test and improve the training regularly. The result: gaps resolved and improvements made.

HIGH FIDELITY TRAINING

Whole task

Part task

Part task

LOW FIDELITY TRAINING

Targeted fidelity

Fit-for-purpose training environments

To achieve and maintain a high level of operational performance and resilience, both aircrew and groundcrew need a highly effective and affordable training environment. The time spent in training must be as effective as possible. Accomplishing that requires an optimum blend of live, low-fidelity and high-fidelity simulated training, along with learning analytics, to be able to continue tailoring the training toward personal or broader training needs.

Royal NLR believes a modern vision of training requires a holistic instructional design approach that is well prepared for the high level of integration and interoperability of systems. Only then can a thorough genuine understanding of training needs, analysis of simulation and evaluation requirements be guaranteed. Almost invariably, a change away from traditional training must contribute to continued compliance with regulatory obligations and hence must be accredited.

NLRs active participation in the EASA Rulemaking Tasks around training, licensing and simulation ensures that we have the knowledge and understanding needed to support you in taking full and early benefit from the evolution of the relevant standards, particularly when it comes to Blended Learning.

Training Needs Analysis (TNA) | Training Design | Training Media Analysis (TMA) | Training Technology & Eco Systems | Learning Analytics | Quality Assurance | Adoptation new training (systems)

Training Needs Analysis (TNA)

Analysis of operational training needs and determination of the required competences through a Training Needs Analysis. The result is a competency based qualification profile for use in the training design.

Training Media Analysis (TMA)

Developing the training syllabus and select training media like simulation, AR/VR, de-briefing tools, books, e-learning etc. Specification of user requirements if suitable media are not available. The result is a training 'fit for purpose training environment', with training media are well integrated in the competency based training design.

Training Design

Creation of a rough outline of the training course. Definition of learner scenarios and goals in line with the training needs. Determination of the required whole tasks and positioning of the supporting and procedural information where required. The resulting blue print supports the development of the training syllabus and training media requirements.

Training Technology & Ecosystems

Assuring that the training media adhere to the defined user requirement may involve bespoke development or improvement of targeted fidelity AR/VR based simulators, interconnectivity between different simulation platform or data gathering in support of learning analytics. Effective training requires a well-integrated learning ecosystem.

Learning Analytics

Critical to Competency and Performance Based training is learning analytics. It is the engine of modern learning ecosystems, providing a process to select, gather and analyse more detailed data on proficiencies.

Training culture

Changing a training method often also entails a cultural change, particularly among instructors. To achieve an organisational change, three factors are of key importance: stakeholder involvement, trainer and trainee mentoring and evaluation and feedback. Tackling these factors is a necessity to ensure success when implementing change.

Quality Assurance

Verifying, validating, evaluating and qualifying simulation and digital training devices in any phase of the lifecycle is extremely important. The result will allow maximum advantage to be taken of the blend of simulation and digital training media in advanced education & training programmes.

Training Culture Transformation

Modifying your training to include new styles of teaching, new media, learning culture or even just new types of trainees will often also entail a cultural change. Nurturing a shift in organisational culture is a critical success factor when changing your training programmes. Our approach consists of three main elements: stakeholder involvement, trainer and trainee mentoring, and evaluation and feedback.
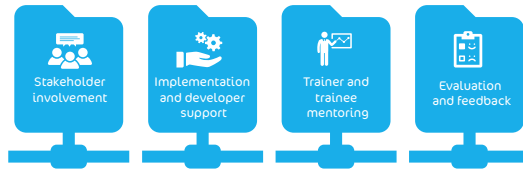
STAKEHOLDER INVOLVEMENT

To ensure acceptance of any organisational change, stakeholder involvement and buy-in is essential. Stakeholders must be inventoried and involved or consulted in all activities relating to the change in training. A stakeholder day is just one step in ensuring that stakeholders get on-board with the new training methods and resources.

IMPLEMENTATION AND DEVELOPER SUPPORT

Our training development projects result in a training blueprint and training media analysis (TMA) driving your syllabus and selection of training media. However, your training developers may have questions about the underlying thought processes. They may also want to share their own ideas about the further development of a training. We therefore offer assistance in facilitating their input while retaining alignment with your training blueprint and TMA.

TRAINER AND TRAINEE MENTORING

Changes in training often bring differing expectations from both trainers and trainees. The introduction of new methods and resources often involves a temporary increase in workload, which can be daunting for those involved. Guidance and coaching helps the trainers (and where necessary trainees) to embrace new methods of working and resources. We help them to not only understand what is expected of them, but also to recognize the benefits of the change.

EVALUATION AND FEEDBACK

Any training, old or new, must have a mature feedback-loop in place where feedback is collected at all stages of training: training design, training execution, training goals and training transfer. NLR supports training evaluation by the collection and analysis of data and feedback. We propose interventions as necessary, to ensure a thorough and profound process, safeguarding top quality training.

NUVEON:
augmented reality maintenance training

THE CHALLENGE

In cooperation with KLM Royal Dutch Airlines, we developed a new training method using Augmented Reality. It adds interactive holograms to your learning environment, significantly reducing the need for a real aircraft. This method is specially developed for aircraft maintenance training and has proven to be more effective than traditional training methods.

The advantages of a 3D virtual aircraft are numerous. It is usable both for theoretical and for practical training and other purposes. It is also possible to simulate normal and abnormal aircraft behavior. What's more, a virtual aircraft is available any place, any time, and nothing will ever wear out.

THE SOLUTION

This training method makes it possible to show aircraft parts in your classroom and to study their behavior through simulation and interactive exercises. This allows even the most difficult components (e.g. large components or inaccessible systems) to be examined in detail. The models are completely animated and annotated with information that is normally difficult to transfer by traditional means, such as changing temperatures and fuel flows. This new training method allows students to work together in groups in order to solve difficult problems. This cooperation is beneficial for training effectiveness, as interaction between students has been shown to increase competency.

WHAT WE ARE DOING

The service we offer consists of an Augmented Reality application, implementation guidelines and integration support.

See **www.nuveon.com** for more information.

Project partners

Industry (NL): Nuveon (joint venture NLR and KLM Royal Dutch Airlines).

Start: 2019
Duration: on-going

Startle and Surprise management training

THE CHALLENGE

While safety performance in commercial aviation is excellent, some accident types – such as Loss-of-Control In-flight (LoC- I) – continue to occur. Startle and surprise reactions played a key role in a significant number of incidents and accidents where an inappropriate crew response to unexpected in-flight events was found to be a contributing factor. Startle and surprise effects can influence pilot performance in many detrimental ways. At least these effects serve as a distraction, which can disrupt normal operation and erode safety margins. On a more critical level they can lead to wrong intuitive actions or hasty decision making. Providing pilots with more effective ways to deal with unexpected events may thus contribute significantly to aviation safety.

WHAT WE ARE DOING

Dealing with Startle and Surprise is about performing in highly demanding situations. Therefore, principles from sports- and performance psychology were used in developing a training programme. As long as humans are experiencing strong emotions such as uncertainty and fear (caused by Startle and/ or Surprise), they are incapable of performing a complex cognitive process. The training intervention will therefore focus on managing these emotions followed by rational and structured decision making. The training intervention intends to inhibit two basic human reactions to Surprise: flight/fight behaviour and cognitive paralysis (also known as 'freeze').

THE SOLUTION

Custom made solutions are avialable but a basic initial training programme consists of 1.5 hours of classroom and 1.5 hours of simulator training. Pilots are trained to apply the ROC technique: Reset, Observe, Confirm. Reset is focussed on recognising and managing physiological and emotional Startle and Surprise effects. Observe is focussed at information collection (situation awareness). Confirm is focussed at structured and team-based decision making. Three goals were leading in setting up the ROC technique:
- Controlling physiological and psychological reactions (emotions)
- Being 'fail safe', i.e. not making things worse
- Integration/connection with current airline practices
ROC provides pilots with the tools to recover from Startle and Surprise, caused by unexpected events.

Project partners
Industry: EASA, KLM

OUR FATIGUE ASSESSMENT CAPABILITIES
- Performing schedule evaluations for fatigue avoidance
- Benchmarking on work limits and rest minima regulations
- Non-intrusive operation measurements using logbooks or a mobile app
- Actigraphy sleep assessment, (online) surveys, debriefings and interviews/workshops

Managing operator fatigue in a safety-critical work environment

WHO DO WE SUPPORT?

Our support is directed at any airline, ANSP or air force looking into, implementing a Fatigue Risk Management (FRM), as well as regulators looking to accommodate FRM safely. We realize that every FRM program is unique. For this reason we offer our support in a modular, tailored way.

SO IF YOU NEED

- Expertise to help you protect your organisation against the risks of operator fatigue
- Assistance in identifying fatigue hazards as part of your safety assurance processes
- Procedures and measures for monitoring fatigue levels
- An evidence-based, data-driven duty schedule for your operation
- More awareness within your organisation of the detrimental impact of fatigue on operator performance
- Support in effectively managing your fatigue risks

WE CAN SUPPORT YOU WITH

- Vast experience in fatigue management solutions for the commercial and military aviation community

- An inspiring team of human factors, training and safety experts that can help manage your fatigue risks
- A modular FRM program that offers our support in a tailored way
- Compliance to the amendments in ICAO Annex 11 concerning FRM

RECENT EXAMPLE OF OUR FATIGUE MANAGEMENT WORK

REVIEW OF THE EFFECTIVENESS OF THE FLIGHT AND DUTY TIME LIMITATIONS AND REST REQUIREMENTS FOR EUROPEAN COMMERCIAL AIR TRANSPORT

- Data collection study (with 24 airlines participating)
- Online survey (over 15 thousand respondents)
- Airline roster analysis using bio-mathematical models (over a 1 year period)

>>>   **This work resulted in recommendations to EASA, mostly on applying appropriate FRM**

>>>   **Check the final report of this review on EASA's website**

Get more from your EBT program

EBT Implementation & Performance Support

Evidence Based Training (EBT) is a new training philosophy, developed over the last ten years, focusing on the development of flight crew resilience. EBT combines the concepts of evidence (data) driven training and competency based training. By using competency data generated in recurrent training, an EBT program directs the operator's competency training needs. In this way, EBT provides an elegant framework to continuously improve pilot core competencies.

THE CHALLENGE

Our EBT mission is to assist operators in achieving reliable pilot development programs. We are committed to the promotion and implementation of a higher standard of EBT programs, continuously driving their effectiveness in the development of flight crew resilience.

THE SOLUTION
We put training quality first

EBT is about developing pilot competencies: in all our support we keep the end goal of effective and efficient pilot development in perspective. We believe that high-quality EBT is better for both the operator and the pilot.

A modular, bespoke approach to EBT support

No two operators are the same, so why should your EBT program be the same?
Our support modules are tailored to your specific operational realities, ambitions, culture and training heritage.

WHAT WE ARE DOING

Five EBT support modules, each tailored to your specific situation and needs.

EBT Quick Scans	EBT Program Evolution	EBT Instructor effectiveness & concordance	EBT Software & Analytics Solutions	EBT Regulator Support

Ready for EBT?

EBT Quick Scans

Our quick scan provides fast and lean support to guide your decisions about EBT implementation. In essence we work with you to answer three questions: are you permitted, able and will you benefit from EBT? If you decide to continue, we are ready to help you in engaging internal and external stakeholders for subsequent implementation. Already running (Mixed-)EBT? We also offer a quick performance scan of your existing program to help you find the root cause of performance issues, or opportunities to enhance your program performance.

OUR SUPPORT

Quick Scan - Getting Started with EBT

Whether you are running legacy or A(T)QP training, we can support your initial orientation toward EBT. We provide a flexible, low-cost quick scan to help you identify whether you are permitted and whether you will benefit from a transition to EBT.

Our quick scan facilitates EBT decision making by:
• Engaging internal and external stakeholders
• Providing an overview of costs and benefits
• Suggesting a possible implementation plan and timeline
• Delivering a management report to facilitate decision making

Quick Scan - EBT Program Performance

We also support existing EBT programs by providing an external perspective on your EBT program and its performance. We integrate our expertise in instructor training, concordance assurance and data analytics to identify areas of potential performance improvement, and help identify the root cause to EBT program issues.

We offer this as a low-cost, flexible service.

EBT
Quick Scans

EVOLUTIONS IN TRAINING

Evolving beyond legacy training?
Your first step toward EBT is changing from a checking and compliance-heavy training program to introducing assessment of competencies. Your instructors familiarise with the concept of competencies and this is a first important change toward a training culture conducive to EBT.

Evolving beyond A(T)QP?
Advanced (Training) & Qualification Program (A(T)QP) is already a great step towards EBT. Your next step can be to evolve your grading and assessment system toward competency assessment.

Evolving beyond Mixed-EBT?
Under the EASA NPA, a mixed-EBT program must run for three years and demonstrate program reliability and training effectiveness before transitioning to baseline EBT. However, this transition is worthwhile as it removes the annual FCL check and therefore removes the need for recurrent training examiners: there are only EBT instructors.

Evolving beyond Full EBT?
The next evolution is to further improve your program by merging training data with operational and safety data to close the gap between training and operations. A baseline EBT program may also provide an opportunity to develop pilot competencies without a flight simulator, enabling new training technologies such as virtual reality and low-fidelity simulations.

Evolve your training - Evolve your pilots
EBT Program Evolution

There are many routes to a full (baseline) EBT program, and we are ready to support your move from one phase to the next. Whether you are starting from a legacy, ATQP or (mixed-)EBT training program, we can help you evolve your training program, in small or big steps. Transitioning to an EBT training program is not rocket science, but doing it well from the start saves readjustment later on and delivers EBT benefits sooner.

OUR SUPPORT

Offload your EBT team:
Our team is here to help you with additional team members to get through the busy stages of a transition to a new training program. We connect with your team and make sure you are in control of the final program.

Accelerate your transition:
Do you need to speed up your transition? We can help you move faster by providing support in smaller steps to keep the ball rolling. For example, we can provide instructor training capacity within our program support to train when your instructors are flying.

When you are stuck:
We provide a fresh, external perspective on your training and can help you figure out where your program may need improvement. We assist with (re)design to achieve that higher level of program performance.

EBT
Program
Evolution

OUR EBT INSTRUCTOR EFFECTIVENESS PHILOSOPHY

Being an EBT instructor is a big change from a classic (legacy) type instructor. By focussing on developing pilot competencies, instruction is aimed more at the big picture instead of separate tasks. Also, a checking attitude must make room for more training/instructional skills, particularly aimed at developing non-technical competencies. Done correctly, these new skills drive pilot resilience, as well as instructor professional development. Done incorrectly, an EBT program may never deliver what it was designed for.

Arguably one of, if not the most important factor for EBT effectiveness is instructor concordance. By ensuring that instructors are in agreement with each other and in alignment with assessment standards, the data they collect becomes more reliable, and the training they provide becomes more accurate and effective.

ASPECTS OF INSTRUCTOR CONCORDANCE ASSURANCE
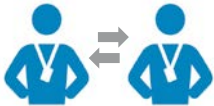
Agreement

Instructors generate the same ratings.

To assess this, instructors need to see the same content.

Alignment

Instructors generate accurate ratings.

To assess this, instructor ratings must be compared against assessment standards.

Less checking, more training

EBT Instructor Effectiveness & Concordance

The driving factor for effectiveness in any training program is the quality of your instructors. For EBT in particular, instructor-generated data is key to steering your training program. Therefore, instructor quality has even more leverage when it comes to determining and delivering suitable, effective training. Proper development in instructional techniques coupled with an effective and transparent instructor concordance program is key to success in EBT.

OUR SUPPORT

EBT Instructor Training

We provide a multi-day EBT instructor training course which can be provided to all instructors, or on a train-the-trainer basis. Our program design is highly interactive, facilitative and performance-based. Options include training in scenario building, and integrated concordance training.

EBT Instructor Reorientation

Our reorientation program is a combination of a quick performance scan and instructor EBT training. If instructional skills or lack of concordance have been identified as root-cause to performance problems, we offer a tailored course to reorient instructors toward best practices in EBT.

Instructor Concordance Assurance

We support EBT by developing and integrating a concordance assurance program tailored to the size and complexity of the EBT program. Our analytics software guide you through the process of determining and improving both alignment and agreement, keeping concordance training efforts lean and effective.
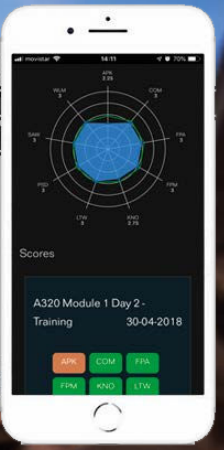
EBT
Instructor
effectiveness
& concordance

PARTNER IN QUALITY
Since 2019 NLR is partnered with UseBeforeFlight (UBF) in the **QUANTUM ETR, QMS and TMS** suite.

Let your software do the hard work

EBT Software & Analytics Solutions

To manage the complexity of a data-driven program like EBT, top-quality software and analytics are a necessity to get the most from your EBT program. We have integrated our training and user-centred design experience with UseBeforeFlight's QUANTUM platform, to provide solutions that make collecting and analyzing data easier, more reliable and more supportive of decision making. In this digital age, software should be working for you, not the other way around.

A fully customizeable software and analytic support to your EBT program contains three modules:

ORCA Assessment App

This revolutionary EBT assessment app is rooted in training delivery R&D to provide instructors with a more intuitive, time-efficient and accurate way to assess crews during busy simulator sessions. By reducing instructor workload and improving assessment accuracy, this app contributes to more reliable EBT data, and sharper training needs analyses.

Concordance Assurance App & Dashboard

This application allows your instructors to make video assessments with your own grading scheme anytime and anywhere, home or on the go. Our dashboard provides user-friendly analytics to guide you through the many modes of non-concordance and solution strategies. By collecting more data continuously, your concordance assurance program can target specific interventions to tailor classroom refresher programs.

Training Analytics

With training data coming in during each and every module, fast and accurate analysis of this data facilitates better course correction of your next EBT module. Our dashboard provides insights in identifying training weak spots, and helps differentiate between big problems and small problems.

Launch in Febuary 2020

EBT
Software &
Analytics
Solutions

From compliance to competence

Regulator Support in EBT

Our regulator support is oriented toward knowing the difference between reliable, effective EBT programs and those that are not. As EBT programs develop and training programs migrate from prescriptive regulations to performance-based regulations, CAA and oversight organizations must lead the way when it comes to setting performance indicators and acceptance criteria. EBT is a positive evolution for the better of aviation safety, however it absolutely depends on meaningful and empowered oversight to drive the quality of EBT to its maximum potential.

OUR SUPPORT

EBT Training for Regulators

For effective oversight of EBT programs, it is essential to understand the philosophy, principles, practices and implementation process of EBT. We share our knowledge on EBT instructor development, program development and performance insights to provide you a solid knowledge base for your EBT oversight program. Our training is tailored to your needs in scope and duration.

EBT Performance Criteria Guidance

The oversight of performance based training requires a shift from prescriptive, compliance-based approval methods to performance-risk balancing methods. One of the most difficult aspects of this change is setting suitable criteria and performance requirements that permit the growth, learning and development of EBT programs, while at the same time ensure an adequate (and at a minimum equivalent) level of safety of operations. We help regulators with stakeholder engagement, setting criteria for EBT programs, and support the possible development of safety ases and risk analyses for such oversight changes.

EBT
Regulator
Support

NLR in brief

One-stop-shop	Global player with Dutch roots	Since 1919	Amsterdam, Marknesse Rotterdam, Noordwijk, Brussel
Innovative, involved and practical	For industry and governmental	For civil and defence	800+ staff
€ 127 M turnover	78% Dutch, 19% EU and 3% worldwide	Active in 24 countries	Very high customer satisfaction

About NLR
Royal Netherlands Aerospace Centre

NLR is a leading international research centre for aerospace. Its mission is to make air transport safer, more efficient, more effective and more sustainable. Bolstered by its multidisciplinary expertise and unrivalled research facilities, NLR provides innovative and comprehensive solutions to the complex challenges of the aerospace sector.

NLR's activities span the full spectrum of Research, Development, Testing & Evaluation (RDT&E). Given NLR's specialist knowledge and state-of-the-art facilities, companies turn to NLR for validation, verification, qualification, simulation and evaluation. They also turn to NLR because of its deep engagement with the challenges facing our clients. This lets NLR bridge the gap between research and practical applications, while working for both government and industry at home and abroad.

Royal NLR stands for practical and innovative solutions, technical expertise and a long-term design vision regarding their fixed-wing aircraft, helicopters, drones and space exploration projects. This allows NLR's cutting-edge technology to find its way also into successful aerospace programmes of OEMs like Airbus, Boeing and Embraer.

NLR supports airlines in solving any challenge in training & safety,
helping to ensure effective and cost-efficient training and safety risk management.

Royal NLR is ready to assist in:
• Startle Effect Management
• Evidence-based Training
• Augmented Reality
• Blended Learning
• Training Culture Transformation
• Fatigue Risk

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